TECHNICAL SPECIFICATIONS
VOLUME II

PWC2223029

PO HOFFER WATER TREATMENT FACILITY AND GLENVILLE LAKE WATER TREATMENT FACILITY RELIABILITY IMPROVEMENTS
CONTRACT NO. 55

ISSUED FOR BID

JULY 2023

Fayetteville Public Works Commission
Administrative Building
955 Old Wilmington Road
Fayetteville, NC 28301

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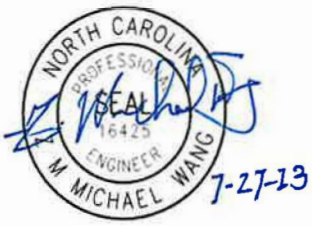
Professional Engineer Certifications



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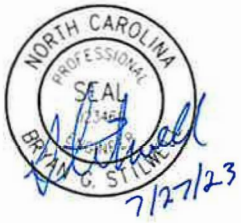

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PUBLIC WORKS COMMISSION OF THE
CITY OF FAYETTEVILLE, NORTH CAROLINA

P.O. HOFFER WATER TREATMENT FACILITY
GLENVILLE LAKE WATER TREATMENT FACILITY
RELIABILITY IMPROVEMENTS

SECTION 00003

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P.O. Hoffer

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Glenville Lake

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- END OF SECTION -

SECTION 01010

SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Work to be done under these Contracts and in accordance with these Specifications consists of furnishing all equipment, superintendence, labor, skill, material and all other items necessary for the construction of the:

P.O. Hoffer Water Treatment Facility
Glenville Lake Water Treatment Facility
Reliability Improvements

The Contractor shall perform all work required for such construction in accordance with the Contract Documents and subject to the terms and conditions of the Contract, complete and ready for use.

B. The principal features of the Work to be performed under this Contracts:

Includes furnishing, installing, and/or modifying facilities as described under Contract No. 55 hereafter.

Base Bid:

P.O. Hoffer WTF: New filtered water mixing vault; various process piping upgrades including 48-inch and 30-inch finished water butterfly valve replacement; and a new electrical building with masonry block and brick veneer.

Glenville Lake WTF: Replace entire existing SCADA control system at the plant with new system including all new PLC hardware, new in-plant network communication hardware, and new SCADA software; provide new RTUs to control the filter process; provide new in-plant SCADA fiber optic network backbone; provide new SCADA wireless network throughout the treatment plant including new wireless SCADA operator interface devices (tablets); provide new ultrasonic level instruments at each existing filter; provide new flow switches at all existing emergency eyewash/shower assemblies and alarm notification in SCADA; demolition of old filter consoles, floor patch and tile installation; replacement of multi-function protective relays for 4160V pumps; architectural upgrades to existing control room to include new desk and monitor configuration for SCADA and security uses; installation of new chemical ductbank between existing structures; replacement of filter effluent valves; and flocculation basin wall repairs.

Alternate Bid:

010816BR

P.O. Hoffer WTF: Raw water pump station upgrades including new duplex rotary screw air compressor; new powdered activated carbon storage and feed facility and powdered activated carbon feed manhole.

All work identified above in both Base and Alternate Bids shall include all other site/civil, structural, architectural, HVAC, electrical, and control system disciplines to furnish functional process and support systems noted above.

The foregoing description shall not be construed as a complete description of all work required.

C. The foregoing description(s) shall not be construed as a complete description of all work required.

1.02 CONTRACT DOCUMENTS

A. The Work to be done is shown on the set of Drawings entitled:

P.O. Hoffer Water Treatment Facility
Glenville Lake Water Treatment Facility
Reliability Improvements
July 2023

The numbers and titles of all Drawings appear on the index sheet of the Drawings, Drawing G1. All drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.

B. Certain Document Sections refer to Divisions of the Contract Specifications. Sections are each individually numbered portions of the Specifications (numerically) such as 08110, 13182, 15206, etc. The term Division is used as a convenience term meaning all Sections within a numerical grouping. Division 16 would thus include Sections 16000 through 16902.

C. Where references in the Contract Documents are made to Contractors for specific disciplines of work (i.e. Electrical Contractor, etc.), these references shall be interpreted to be the single prime Contractor when the project is bid or awarded as a single prime contract.

1.03 GENERAL ARRANGEMENT

A. Drawings indicate the extent and general arrangement of the work. If any departures from the Drawings are deemed necessary by the Contractor to accommodate the materials and equipment he proposes to furnish, details of such departures and reasons therefore shall be submitted as soon as practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Approved changes shall be made without additional cost to the Owner for this work or related work under other Contracts of the Project.

B. The specific equipment proposed for use by the Contractor on the project may require changes, in structures, auxiliary equipment, piping, electrical, mechanical, controls or

other work to provide a complete satisfactory operating installation. The Contractor shall submit to the Engineer, for approval, all necessary Drawings and details showing such changes to verify conformance with the overall project structural and architectural requirements and overall project operating performance. The Bid Price shall include all costs in connection with the preparation of new drawings and details and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other Contracts.

1.04 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

A. The Contractor shall obtain, keep current and pay all fees for any necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. Record copies of all permits shall be furnished to the Engineer.

B. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to his operations on this Project.

1.05 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Engineer is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the Contractor shall assume the responsibility for all costs of redesign and for any construction changes required to accommodate the equipment furnished, including the Engineer's expenses in connection therewith.

C. In the event that the Engineer is required to provide additional engineering services as a result of Contractor's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner.

1.06 ADDITIONAL OWNER'S EXPENSES

A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection

charges incurred by the Owner may be charged to the Contractor and deducted from the monies due him. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the Contractor, will be given due consideration by the Owner before assessing engineering and inspection charges against the Contractor.

B. Unless otherwise specifically permitted, the normal time of work under this Contract is limited to 8 hours per day, Monday through Friday. Work beyond these hours will result in additional expense to the Owner. Any expenses and/or damages, including the cost of the Engineer's on site personnel, arising from the Contractor's operations beyond the hours and days specified above shall be borne by the Contractor.

C. Charges assessed to the Contractor for additional engineering and inspection costs will be determined based on actual hours charged to the job by the Engineer. Daily rates will depend on the number and classifications of employees involved, but in no case shall such charges exceed $1,200 per day for field personnel and $1,800 per day for engineering personnel, based on an eight hour workday.

D. Charges for additional Owner's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

1.07 TIME OF WORK

A. The normal time of work for this Contract is limited to 40 hours per week and shall generally be between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday. The Contractor may elect to work beyond these hours or on weekends provided that all costs incurred by the Owner for additional engineering shall be borne by the Contractor.

1. The Owner shall deduct the cost of additional engineering costs from monies due the Contractor.

B. If it shall become imperative to perform work at night, the Owner and Engineer shall be informed a reasonable time in advance of the beginning of such work. Temporary lighting and all other necessary facilities for performing and inspecting the work shall be provided and maintained by the Contractor.

C. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. Contractor shall carefully protect his work against damage or injury from the weather, and when work is permitted during freezing weather, he shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

1.08 SUBSURFACE DATA

A. Subsurface data are offered in good faith solely for placing the Bidder in receipt of all information available to the Owner and Engineer and in no event is to be considered as part of the Contract Documents.

B. The Bidder must interpret such subsurface data according to his own judgment and acknowledge that he is not relying upon the same as accurately describing the subsurface conditions, which may be found to exist.

1. The test boring logs present factual information of the subsurface conditions at the specific test boring location only. The Bidder should not consider, or conclude, that the subsurface conditions will be consistent between test boring locations.

C. The Bidder further acknowledges that he assumes all risks contingent upon the nature of the sub-surface conditions to be actually encountered by him in performing the work covered by the Contract, even though such actual conditions may result in the Bidder performing more or less work than he originally anticipated.

D. The Bidder is further advised that the Owner has made sub-surface investigations and a report has been prepared, in connection with this project for the Engineer, a copy of which is appended to the rear of these specifications.

E. In making this data available, the Owner makes no guarantee, either expressed or implied, as to their accuracy or to the accuracy of any interpretation thereof.

1.09 SURVEYS AND LAYOUT

A. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as directed by the Engineer. Elevation of existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake out survey shall be referred immediately to the Engineer for interpretation or correction.

B. All survey work for construction control purposes shall be made by the Contractor at his expense. The Contractor shall provide a Licensed Surveyor as Chief of Party, competently qualified men, all necessary instruments, stakes, and other material to perform the work.

C. Contractor shall establish all baselines for the location of the principal component parts of the work together with a suitable number of bench marks and batter boards adjacent to the work. Based upon the information provided by the Contract Drawings, the Contractor shall develop and make all detail surveys necessary for construction, including slope stakes, batter boards, stakes for all working points, lines and elevations.

D. Contractor shall have the responsibility to carefully preserve the bench marks, reference points and stakes, and in the case of destruction thereof by the Contractor or resulting from his negligence, the Contractor shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.

E. Existing or new control points, property markers and monuments that will be or are destroyed during the normal causes of construction shall be reestablished by the Contractor and all reference ties recorded therefore shall be furnished to the Engineer. All

computations necessary to establish the exact position of the work shall be made and preserved by the Contractor.

F. The Engineer may check all or any portion of the work and the Contractor shall afford all necessary assistance to the Engineer in carrying out such checks. Any necessary corrections to the work shall be immediately made by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibilities for the accuracy or completeness of his work.

G. At completion of the work, the Contractor shall furnish Record Drawings indicating the final layout of all structures, roads, all structures, existing bench marks, etc. The Record Drawings shall indicate all critical elevations of piping, structures, finish grades, etc.

1.10 FIRE PROTECTION

A. Contractor shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which do occur. Burning, if permitted in Division 2, shall be limited to areas approved by the Engineer and Owner and properly controlled by the Contractor.

B. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately alert the local Fire Marshal, the Engineer, and the Owner of such tank or device. The Contractor shall exercise all safety precautions and shall comply with all instructions issued by the Fire Marshal and shall cooperate with the Owner of the tank or device to prevent the occurrence of fire or explosion.

1.11 CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.

1.12 FIRST AID FACILITIES AND ACCIDENTS

A. First Aid Facilities

1. The Contractor shall provide at the site such equipment and facilities as are necessary to supply first aid to any of his personnel who may be injured in connection with the work.

B. Accidents

1. The Contractor shall promptly report, in writing, to the Engineer and Owner all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.

2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Owner and the Engineer.

3. If any claim is made by anyone against the Contractor or a Subcontractor on account of any accidents, the Contractor shall promptly report the facts, in writing, to the Engineer and Owner, giving full details of the claim.

1.13 ULTIMATE DISPOSITION OF CLAIMS BY ONE CONTRACTOR ARISING FROM ALLEGED DAMAGE BY ANOTHER CONTRACTOR

A. During the progress of the work, other Contractors may be engaged in performing other work or may be awarded other Contracts for additional work on this project. In that event, the Contractor shall coordinate the work to be done hereunder with the work of such other Contractors and the Contractor shall fully cooperate with such other Contractors and carefully fit its own work to that provided under other Contracts as may be directed by the Engineer. The Contractor shall not commit or permit any act which will interfere with the performance of work by any other Contractor.

B. If the Engineer shall determine that the Contractor is failing to coordinate his work with the work of the other Contractors as the Engineer directed, then the Owner shall have the right to withhold any payments otherwise due hereunder until the Contractor completely complies with the Engineer's directions.

C. If the Contractor notifies the Engineer in writing that another Contractor is failing to coordinate his work with the work of this Contract as directed, the Engineer will promptly investigate the charge. If the Engineer finds it to be true, he will promptly issue such directions to the other Contractor with respect thereto as the situation may require. The Owner, the Engineer, nor any of their agents shall not, however, be liable for any damages suffered by the Contractor by reason of the other Contractor's failure to promptly comply with the directions so issued by the Engineer, or by reason of another Contractor's default in performance, it being understood that the Owner does not guarantee the responsibility or continued efficiency of any Contractor.

D. The Contractor shall indemnify and hold the Owner and the Engineer harmless from any and all claims of judgments for damages and from costs and expenses to which the Owner may be subjected or which it may suffer or incur by reason of the Contractor's failure to comply with the Engineer's directions promptly.

E. Should the Contractor sustain any damage through any act or omission of any other Contractor having a Contract with the Owner for the performance of work upon the site or of work which may be necessary to be performed for the proper execution of the work to be performed hereunder, or through any act or omission of a Subcontractor of such Contract, the Contractor shall have no claim against the Owner or the Engineer for such damage, but shall have a right to recover such damage from the other Contractor under the provision similar to the following provisions which have been or will be inserted in the Contracts with such other Contractors.

F. Should any other Contractor having or who shall hereafter have a Contract with the Owner for the performance of work upon the site sustain any damage through any act or omission

of the Contractor hereunder or through any act or omission of any Subcontractor of the Contractor, the Contractor agrees to reimburse such other Contractor for all such damages and to defend at his own expense any suit based upon such claim and if any judgment or claims against the Owner shall be allowed, the Contractor shall pay or satisfy such judgment or claim and pay all costs and expenses in connection therewith and shall indemnify and hold the Owner harmless from all such claims.

G. The Owner's right to indemnification hereunder shall in no way be diminished, waived or discharged, by its recourse to assessment of liquidated damages as provided in the Contract, or by the exercise of any other remedy provided for by Contract Documents or by law.

1.14 BLASTING AND EXPLOSIVES

A. When blasting is utilized at the site of the work, it shall conform to the requirements specified in Section 02202 – Excavation by Blasting.

1.15 LIMITS OF WORK AREA

A. The Contractor shall confine his construction operations within the Contract limits shown on the Drawings and/or property lines and/or fence lines. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the Owner, shall be used only with the Owner's approval. Such storage or temporary structures, even within the Contract's limits, shall be confined to the Owner's property and shall not be placed on properties designated as easements or rights-of-way unless specifically permitted elsewhere in the Contract Documents.

1.16 WEATHER CONDITIONS

A. No work shall be done when the weather is unsuitable. The Contractor shall take necessary precautions (in the event of impending storms) to protect all work, materials, or equipment from damage or deterioration due to floods, driving rain, or wind, and snow storms. The Owner reserves the right, through the opinion of the Engineer, to order that additional protection measures over and beyond those proposed by the Contractor, be taken to safeguard all components of the Project. The Contractor shall not claim any compensation for such precautionary measures so ordered, nor claim any compensation from the Owner for damage to the work from weather elements.

B. The mixing and placing of concrete or pavement courses, the laying of masonry, and installation of sewers and water mains shall be stopped during rainstorms, if ordered by the Engineer; and all freshly placed work shall be protected by canvas or other suitable covering in such manner as to prevent running water from coming in contact with it. Sufficient coverings shall be provided and kept ready at hand for this purpose. The limitations and requirements for mixing and placing concrete, or laying of masonry, in cold weather shall be as described elsewhere in these Specifications.

1.17 PERIODIC CLEANUP: BASIC SITE RESTORATION

A. During construction, the Contractor shall regularly remove from the site of the work all accumulated debris and surplus materials of any kind which result from his operations.

Unused equipment and tools shall be stored at the Contractor's yard or base of operations for the Project.

B. When the work involves installation of sewers, drains, water mains, manholes, underground structures, or other disturbance of existing features in or across streets, rights-of-way, easements, or private property, the Contractor shall (as the work progresses) promptly backfill, compact, grade, and otherwise restore the disturbed area to the basic condition which will permit resumption of pedestrian or vehicular traffic and any other critical activity or functions consistent with the original use of the land. The requirements for temporary paving of streets, walks, and driveways are specified elsewhere. Unsightly mounds of earth, large stones, boulders, and debris shall be removed so that the site presents a neat appearance.

C. The Contractor shall perform the cleanup work on a regular basis and as frequently as ordered by the Engineer. Basic site restoration in a particular area shall be accomplished immediately following the installation or completion of the required facilities in that area. Furthermore, such work shall also be accomplished, when ordered by the Engineer, if partially completed facilities must remain incomplete for some time period due to unforeseen circumstances.

D. Upon failure of the Contractor to perform periodic cleanup and basic restoration of the site to the Engineer's satisfaction, the Owner may, upon five (5) days prior written notice to the Contractor, without prejudice to any other rights or remedies of the Owner, cause such work for which the Contractor is responsible to be accomplished to the extent deemed necessary by the Engineer, and all costs resulting therefrom shall be charged to the Contractor and deducted from the amounts of money that may be due him.

1.18 USE OF FACILITIES BEFORE COMPLETION

A. The Owner reserves the right to enter and use any portion of the constructed facilities before final completion of the whole work to be done under this Contract. However, only those portions of the facilities which have been completed to the Engineer's satisfaction, as evidenced by his issuing a Certificate of Substantial Completion covering that part of the work, shall be placed in service.

B. It shall be the Owner's responsibility to prevent premature connections to or use of any portion of the installed facilities by private or public parties, persons or groups of persons, before the Engineer issues his Certificate of Substantial Completion covering that portion of the work to be placed in service.

C. Consistent with the approved progress schedule, the Contractor shall cooperate with the Owner, his agents, and the Engineer to accelerate completion of those facilities, or portions thereof, which have been designated for early use by the Owner.

1.19 CONSTRUCTION VIDEO

A. The Contractor shall video the entire project site including all concrete and asphalt pavements, curb and gutter, fencing to remain, structures to be demolished, and existing structures that are to be modified. The original video image shall be turned over to the Engineer prior to beginning construction activities. The video shall be provided as an

Audio Video Interleave File (.avi) and shall be provided on DVD+R/DVD-ROM compatible media or other format acceptable to the Owner. The video shall clearly identify existing site and structural conditions prior to construction.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01035

MODIFICATION PROCEDURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Work includes all labor, materials, equipment and appliances required for the complete execution of additions, modifications and alterations to existing buildings and structures as shown on the Drawings and specified under the various Sections of the Contract Specifications and as required by conditions at the site.

B. The Contractor shall have examined all work to be performed to the existing buildings and familiarize himself with the nature and extent to which the existing buildings will be damaged, items removed or rearranged due to the work under his Contract and that of other Contracts.

1. Cutting and patching shall conform to the requirements of the General Conditions, Supplemental Conditions, and as specified herein.

2. Patching work shall be performed with similar materials and in the same manner as adjoining work. Joining between old and new work shall be perfect and practically invisible. All due caution shall be taken to obtain a bond between old and new work.

C. Major portions of the work are indicated on the Drawings and the accompanying Specifications thereto. All work must be complete in all respects and executed with high quality workmanship.

D. Work not specifically indicated by details or general notes on the Drawings may include the following:

1. Re-pointing brickwork; removing and replacing broken, cracked, disintegrating and missing brickwork, utilizing mortar and face brick as specified under Division 4, Masonry.

2. Removing cracked and/or disintegrating sealant materials around window frames and panes of glass thereto; replacing missing and broken panes of glass; re-caulking and sealing window frames and glazing with sealants specified under Division 7 - Thermal and Moisture Protection and Division 8 - Doors and Windows.

3. Removing loose rust, sealing or peeling paint from metal surfaces by scraping, sanding or wire brushing; priming and repainting metal surface (inside and outside) as specified under Division 9 - Finishes.

4. Patching and repairing existing membrane or built-up roofing, metal flashing; correcting pitch of roof areas to eliminate ponding; cleaning out and/or replacing

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unusable roof drains, etc. Roofing materials shall be as specified under Division 7 - Thermal and Moisture Protection.

5. Cutting masonry and installing new expansion and control joints.

6. Removing existing and constructing new parapet walls and copings; clean and patch copings where practicable and replacing copings where broken.

7. Patching, cleaning, sealing and resurfacing concrete floors, walls, lintels, sills and trim and replacing lintels where broken.

8. Cutting and modifying existing openings as necessary to receive new work and providing new lintels, doors, frames, etc.

9. Patching existing doors and frames and refinishing as required.

10. Patching, refinishing and/or replacing ceilings.

11. Patching and/or replacing broken, spalled, cracked and disintegrating concrete encasing steel columns and piers.

12. Cleaning and repainting steel handrailing, brackets, sleeves, etc. Replacing existing railing with new aluminum railing, brackets, sleeves, etc.

1.02 SITE AND BUILDINGS

A. Site Visit

1. Prior to submission of Bids, the Contractor shall have visited the site and thoroughly acquainted himself with the exact nature of the work indicated on the Drawings and the Specifications requirements. Failure to comply with the aforementioned requirements shall not constitute a basis for claims for additional compensation.

B. Measurements

1. Prior to ordering any materials or doing any work, the Contractor shall verify all measurements, dimensions and other conditions of each building scheduled for work as may be necessary or required in connection with his work. The Contractor shall be responsible for the correctness of same.

1.03 MATERIALS

A. All materials to perform and complete the work shall be new. Salvaged materials, such as brick, stone copings, granite sills, may be used under certain conditions subject to the approval of the Owner and Engineer.

B. All salvaged materials shall be sound and undamaged. Materials to be reused shall be stored and protected as directed by the Engineer. Care shall be taken to prevent damage to materials or equipment to be reused.

1.04 SHORING, UNDERPINNING AND BRACING

A. When necessary and required, the Contractor shall provide underpinning and temporary shoring and bracings, all in accordance with code requirements, and as approved by the Engineer.

B. Shoring and bracing shall be of such form and so installed as to safely support the work and interfere as little as possible with the progress of the work. Suitable means shall be provided to adjust any settlement in the shoring supports. Temporary shoring shall consist of sound timbers or rolled shapes of required dimensions which shall be removed after necessity for same ceases to exist. All work removed or damaged through installation of temporary shoring or through improper shoring shall be replaced or repaired after the shoring is removed, at no additional cost to the Owner.

1.05 WORK PREPARATION AND TEMPORARY ACCESS

A. The Contractor, before commencing work, shall prepare and submit for approval a progress schedule in accordance with the requirements of Section 01300 - Submittals, in order to coordinate the work of all trades and to insure completion on or before the completion date. The Owner and the Engineer reserve the right to revise or modify such schedules as required to expedite each phase of work and to coordinate such work with the partial use of the building for purposes as directed.

B. No facility such as toilets, corridors, etc., shall be barricaded or access restricted without providing other temporary or interim means of access. It is further required that no work specified hereinafter shall disturb or interfere with the operation of the existing mechanical installation until proposed new work has been completed or satisfactorily installed. Exception may be made to this requirement only by written approval from the Owner and Engineer.

C. Detailed sequence of availability of areas within the present buildings where work is to be performed under each Contract shall be in accordance with Section 01520, Maintenance of Utility Operations During Construction, but may be modified by the Contractor, upon authorization by the Owner and Engineer as the work progresses.

D. Existing built-in equipment to remain in the final work, but requiring temporary removal for the installation of new construction, alterations, repairs and/or renovations, shall be disconnected by the Electrical Contractor (Subcontractor) and removed by the Contractor to temporary storage areas designated by the Owner. Resetting of existing equipment under this heading shall be performed by the Contractor and connecting to electric service lines shall be performed by the Electrical Contractor (Subcontractor).

E. The Contractor shall furnish and install all temporary fire exits, fire extinguishers, hose and safety devices as may be required by authorities having jurisdiction.

F. Work within existing buildings to be performed, once started, shall be completed as quickly as practicable and each trade shall determine before work is started that all required materials are at hand or readily obtainable to avoid delays.

G. Shutdowns of existing services within existing buildings which may be occupied during construction will be permitted only upon approval by the Owner subject to at least three weeks notice in writing to the Owner in each case. Shutdowns will be limited to times which will result in the least interference with normal operations. Refer to Section 01520 - Maintenance of Utility Operations During Construction for additional requirements.

1.06 DUST-PROOF PARTITIONS

A. The Contractor shall furnish and erect all necessary temporary dust-proof partitions where required to protect unaltered portions of existing buildings and structures or as directed by the Owner or Engineer.

B. Partitions shall be constructed of wood studs with plywood on both sides. Partitions shall extend from floor to ceiling with a closure plate at floor and ceiling. The Contractor shall furnish and install one door in each enclosure complete with hardware attached and keyed as directed. Such enclosures will be required in areas of major demolition work and for protection of existing equipment.

1.07 WEATHER PROTECTION

A. Where exterior walls or roofs are being altered, or disturbed for any adjacent alteration, the Contractor shall provide temporary weather protection in those areas to keep interior of buildings absolutely dry and unaffected by the weather. The Contractor will be held responsible for any damage caused by improper protection against weather.

B. Where existing exterior walls or roofs are disturbed due to alterations, disturbances shall be kept to a minimum and walls or roofs shall be repaired and patched in such a manner that the buildings will be absolutely watertight and meet the conditions of the existing roofing flashing and waterproofing bonds and guarantees.

1.08 CUTTING, PATCHING, REPAIRING, AND REFINISHING

A. The Contractor shall be responsible for cutting all openings in walls, floors and ceilings (indicated to remain) to accommodate alteration work under his Contract in accordance with the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified. Rough patching and all finish patching shall be by the Contractor.

1. Where new openings are to occur in existing exterior and interior concrete and masonry bearing walls and structural concrete floor, the Contractor will be required to notify the Owner and Engineer in writing and shall obtain approval prior to cutting operations. The Engineer will determine whether such openings affect the structural stability or load bearing capacities of walls and floors.

2. All holes and openings to be cut in existing walls, floors and ceilings of any nature shall be geometrically correct and no larger than necessary to accommodate the new work.

3. No cutting of finished or structural work may be done without the approval of the Engineer.

B. Major demolition and removal work such as demolition of buildings and structures, complete or nearly complete removal of floors, walls and ceilings indicated on the Drawings, shall be performed by the Contractor. The Contractor shall also be responsible for all finish patching operations of holes and openings in existing floors, walls, ceilings and roofs to accommodate the alteration work under the Plumbing, HVAC and Electrical Sections as well as that required for the Contractor's work hereinafter specified.

C. Each Contractor and/or his Subcontractors shall provide sleeves, forms and inserts for installation by the General Contractor as specified in Section 01010, Summary of Work.

1.09 EXISTING EQUIPMENT AND FURNISHINGS

A. Existing built-in equipment to remain in the final work and requiring temporary removal shall be as hereinbefore specified under paragraph 1.05, D.

B. Existing appliances and portable equipment such as desks, chairs, tables, etc., shall remain the property of the Owner and will be removed from rooms and spaces to be altered by the Contractor prior to construction and alteration operations, and stored where directed by the Owner.

C. All unsalvageable equipment shall become the property of the Contractor in accordance with the requirements of Section 01540, Demolition and Removal of Existing Structures and Equipment, and shall be removed from each building and away from the site. Equipment to be retained, or relocated, shall be as shown on the Drawings or as specified.

1.10 SCHEDULE OF INTERIOR FINISHES FOR EXISTING BUILDINGS

A. Unless otherwise specified, all materials required for the work in the existing buildings shall be new, and where required shall match existing adjacent finishes.

B. As indicated on the Drawings, specified or otherwise required to complete the work, the Contractor shall cut new openings and block up existing openings in floors, walls, partitions and ceilings; remove existing floors; remove, relocate existing and/or install new windows, doors, frames, transoms, access doors, partition sash and trim.

C. The Contractor shall remove window sash, frame, sill, stool and trim at exterior door openings to be blocked up; remove door, frame and trim and, unless otherwise hereinafter specified or indicated on the Drawings to be blocked up with other materials, window and door openings shall be blocked up with brick and/or masonry block.

1. At door, sash and other openings in interior partitions and walls to be closed, block up such openings with same materials and construction as adjacent, unless otherwise indicated on the Drawings. Plaster and finishes applied at blocked up openings shall finish even and straight, flush with and of the same texture or other surface characteristics of existing adjacent finishes.

D. Existing finishes or subfloor surfaces which are scheduled to receive new floor finishes shall be repaired, patched with concrete, asphalt latex type emulsion and underlayment as required to suit existing surfaces or the new floor surfacing material to be applied.

E. Concrete and floors disturbed by alterations shall be patched to finish even, straight and flush with adjacent surfaces.

F. Where new ceramic tile flooring or base is to be installed over present concrete floors or base, and where a cove exists at the floor, the Contractor shall cut away part of the cove by grinding or other approved means to the extent required for installation of the new flooring or base.

G. Existing partitions to be removed shall be removed for their entire height.

H. Where existing bases and other trim are removed and grounds are exposed and will not be covered by new finishing materials such as resilient base, new trim, or wall covering, grounds shall be removed and wall surfaces patched with plaster to finished even, straight and flush with adjacent existing plaster surfaces. Where existing plaster ceilings are scheduled to be removed, the ceilings shall be replaced with new metal furring, lathing and plaster finish or acoustical ceilings or other ceiling system as indicated on the Drawings.

I. Where partitions or walls are removed and existing ceiling on each side of the partition or wall is to remain, the gap shall be patched; a vertical break shall be provided if the ceilings are at different levels. Where the ceiling on one side is to remain and a new ceiling is scheduled for the area on the other side, the new ceiling shall be constructed so that the new and existing finished ceiling areas will be at the same level.

J. Existing floors, walls and ceilings shall be cut as required for removal of existing services and for installation of new plumbing, heating, ventilating and air conditioning, and electrical work and related piping, duct work, conduits, fixtures and equipment.

K. In addition to work specifically called for in the finish schedule on the Drawings, all finishes disturbed in the performance of any alterations or new work by any Contractor shall be patched or repaired to match existing surfaces or finishes. Holes, slots, chases, etc., in floors, walls and ceilings left by the removal of existing, or installation of new piping, plumbing fixtures, radiators, duct work, registers, grills, conduit, receptacles, switches, lighting fixtures and other items of the other Contracts shall also be patched or repaired by the Contractor.

L. Existing spaces not listed on the finish schedule on the Drawings may require no work other than complete painting and patching by the Contractor of surfaces damaged in performance of any work included under this Contract.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01040

COORDINATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall allow the Owner or his agents, and other project Contractors or their agents, to enter upon the work for the purpose of constructing, operating, maintaining, removing, repairing, altering, or replacing such pipes, sewers, conduits, manholes, wires, poles, or other structures and appliances which may be required to be installed at or in the work. The Contractor shall cooperate with all aforesaid parties and shall allow reasonable provisions for the prosecution of any other work by the Owner, or others, to be done in connection with his work, or in connection with normal use of the facilities.

B. Each Contractor shall cooperate fully with the Owner, the Engineer, and all other Contractors employed on the work, to effect proper coordination and progress to complete the project on schedule and in proper sequence. Insofar as possible, decisions of all kinds required from the Engineer shall be anticipated by the Contractor to provide ample time for inspection, or the preparation of instructions.

C. Each Contractor shall assume full responsibility for the correlation of all parts of his work with that of other Contractors. Each Contractor's superintendent shall correlate all work with other Contractors in the laying out of work. Each Contractor shall lay out his own work in accordance with the Drawings, Specifications, and instructions of latest issue and with due regard to the work of other Contractors.

D. Periodic coordinating conferences shall be held per Section 01200, Project Meetings, of these Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01070

ABBREVIATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The following is a partial list of typical abbreviations which may be used in the Specifications, and the organizations to which they refer:

AASHTO	-	American Association of State Highway and Transportation Officials
ACI	-	American Concrete Institute
ACIFS	-	American Cast Iron Flange Standards
AFBMA	-	Anti-Friction Bearing Manufacturer's Association
AGA	-	American Gas Association
AGMA	-	American Gear Manufacturers Association
AIA	-	American Institute of Architects
AISC	-	American Institute of Steel Construction
AISI	-	American Iron and Steel Institute
ANSI	-	American National Standard Institute
API	-	American Petroleum Institute
ASCE	-	American Society of Civil Engineers
ASHRAE	-	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWS	-	American Welding Society
AWWA	-	American Water Works Association
CEMA	-	Conveyor Equipment Manufacturer's Association
CRSI	-	Concrete Reinforcing Steel Institute
DIPRA	-	Ductile Iron Pipe Research Association
Fed Spec	-	Federal Specifications
IEEE	-	Institute of Electrical and Electronic Engineers
IPCEA	-	Insulated Power Cable Engineers Association
ISO	-	Insurance Services Offices
NBS	-	National Bureau of Standards
NCDOT	-	North Carolina Department of Transportation
NEC	-	National Electric Code
NEMA	-	National Electrical Manufacturers Association
OSHA	-	Occupational Safety and Health Act
PCI	-	Precast Concrete Institute
UL	-	Underwriters Laboratories, Inc.
USGS	-	United States Geological Survey

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PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01090

REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Wherever reference is made to any published standards, codes, or standard specifications, it shall mean the latest standard code, specification, or tentative specification of the technical society, organization, or body referred to, which is in effect at the date of invitation for Bids.

B. All materials, products, and procedures used or incorporated in the work shall be in strict conformance with applicable codes, regulations, specifications, and standards.

C. A partial listing of codes, regulations, specifications, and standards includes the following:

Air Conditioning and Refrigeration Institute (ARI)

Air Diffusion Council (ADC)

Air Moving and Conditioning Association (AMCA)

The Aluminum Association (AA)

American Architectural Manufacturers Association (AAMA)

American Concrete Institute (ACI)

American Gear Manufacturers Association (AGMA)

American Hot Dip Galvanizers Association (AHDGA)

American Institute of Steel Construction, Inc. (AISC)

American Iron and Steel Institute (AISI)

American National Standards Institute (ANSI)

American Society of Civil Engineers (ASCE)

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

American Society of Mechanical Engineers (ASME)

American Society for Testing and Materials (ASTM)

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American Standards Association (ASA)

American Water Works Association (AWWA)

American Welding Society (AWS)

American Wood-Preserver's Association (AWPA)

Anti-Friction Bearing Manufacturers Association (AFBMA)

Building Officials and Code Administrators (BOCA)

Conveyor Equipment Manufacturers Association (CEMA)

Consumer Product Safety Commission (CPSC)

Factory Mutual (FM)

Federal Specifications

Instrument Society of America (ISA)

Institute of Electrical and Electronics Engineers (IEEE)

National and Local Fire Codes

Lightning Protection Institute (LPI)

National Electrical Code (NEC)

National Electrical Manufacturer's Association (NEMA)

National Electrical Safety Code (NESC)

National Electrical Testing Association (NETA)

National Fire Protection Association (NFiPA)

Regulations and Standards of the Occupational Safety and Health Act (OSHA)

Southern Building Code Congress International, Inc. (SBCCI)

Sheet Metal & Air Conditioning Contractors National Association (SMACCNA)

Standard Building Code

Standard Mechanical Code

Standard Plumbing Code

Uniform Building Code (UBC)

Underwriters Laboratories Inc. (UL)

D. Contractor shall, when required, furnish evidence satisfactory to the Engineer that materials and methods are in accordance with such standards where so specified.

E. In the event any questions arise as to the application of these standards or codes, copies shall be supplied on-site by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01200

PROJECT MEETINGS

PART 1 -- GENERAL

1.01 PRE-BID MEETING

A. A pre-bid meeting will be held at the time and place to be designated in the Instructions to Bidders.

B. The Engineer will be available to discuss the project and answer pertinent questions. No oral interpretation will be made as to the meaning of the Documents. Interpretation, if deemed necessary by the Engineer, will be in the form of an Addendum to the Contract Documents.

1.02 PRECONSTRUCTION MEETING

A. A preconstruction meeting will be held after Award of Contract, but prior to starting work at the site.

B. Attendance:

1. Owner

2. Engineer

3. Contractor

4. Major subcontractors

5. Safety representative

6. Representatives of governmental or other regulatory agencies.

C. Minimum Agenda:

1. Tentative construction schedule

2. Critical work sequencing

3. Designation of responsible personnel

4. Processing of Field Decisions and Change Orders

5. Adequacy of distribution of Contract Documents

6. Submittal of Shop Drawings and samples

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7. Procedures for maintaining record documents

8. Use of site and Owner's requirements

9. Major equipment deliveries and priorities

10. Safety and first aid procedures

11. Security procedures

12. Housekeeping procedures

13. Processing of Partial Payment Requests

14. General regard for community relations

1.03 PROGRESS MEETING

A. Progress meetings will be held monthly at the P.O. Hoffer WTF Conference Room during the performance of the work of this Contract. Additional meetings may be called as progress of work dictates.

B. Engineer will preside at meetings and record minutes of proceedings and decisions. Engineer will distribute copies of minutes to participants.

C. Attendance:

1. Engineer

2. Contractor

3. Subcontractors, only with Engineer's approval or request, as pertinent to the agenda

D. Minimum Agenda:

1. Review and approve minutes of previous meetings.

2. Review progress of Work since last meeting.

3. Review proposed 30-60 day construction schedule.

4. Note and identify problems which impede planned progress.

5. Develop corrective measures and procedures to regain planned schedule.

6. Revise construction schedule as indicated and plan progress during next work period.

7. Maintaining of quality and work standards.

8. Complete other current business.

9. Schedule next progress meeting.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01300

SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Progress Schedule

1. Within thirty (30) days after issuance of the Notice to Proceed, the Contractor shall prepare and submit an electronic copy of his proposed progress schedule to the Engineer for review and approval.

2. If so required, the schedule shall be revised until it is approved by the Engineer.

3. Schedule shall be updated monthly, depicting progress to the last day of the month and an electronic copy submitted to the Engineer not later than the fifth day of the month, and prior to the application for progress payment. Failure to provide monthly schedule updates will be grounds for the Engineer or Owner to withhold progress payment approval.

4. Schedule shall be prepared in the form of a horizontal bar chart showing in detail the proposed sequence of the work and identifying construction activities for each structure and for each portion of work.

5. Schedule shall be time scaled, identifying the first day of each week. The Schedule shall be provided with estimated dates for Early Start, Early Finish, Late Start and Late Finish. The work shall be scheduled to complete the Project within the Contract time. The Late Finish date shall equal the Contract Completion Date.

6. Schedule shall show duration (number of days) and float for each activity. Float shall be defined as the measure of leeway in starting or completing a scheduled activity without adversely affecting the project completion date established by the Contract Documents.

7. Updated schedule shall show all changes since the previous submittal.

8. All revisions to the schedule must have the prior approval of the Engineer.

B. Equipment and Material Orders Schedule

1. Contractor shall prepare and submit an electronic copy of his schedule of principal items of equipment and materials to be purchased to the Engineer for review and approval.

2. If so required, the schedule shall be revised until it is approved by the Engineer.

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3. Schedule shall be updated monthly and an electronic copy submitted to the Engineer not later than the fifth day of every month with the application for progress payment.

4. The updated schedule shall be based on the Progress Schedule developed under the requirements of Paragraph 1.01(A) of this Section.

5. Schedule shall be in tabular form with appropriate spaces to insert the following information for principal items of equipment and materials:

    a. Dates on which Shop Drawings are requested and received from the manufacturer.

    b. Dates on which certification is received from the manufacturer and transmitted to the Engineer.

    c. Dates on which Shop Drawings are submitted to the Engineer and returned by the Engineer for revision.

    d. Dates on which Shop Drawings are revised by manufacturer and resubmitted to the Engineer.

    e. Date on which Shop Drawings are returned by Engineer annotated either "Furnish as Submitted" or "Furnish as Corrected".

    f. Date on which accepted Shop Drawings are transmitted to manufacturer.

    g. Date of manufacturer's scheduled delivery.

    h. Date on which delivery is actually made.

C. Working Drawings

1. Within thirty (30) days after the Notice to Proceed, each prime Contractor shall prepare and submit an electronic copy of his preliminary schedule of Working Drawing submittals to the Engineer for review and approval. If so required, the schedule shall be revised until it is approved by the Engineer.

2. Working Drawings include, but are not limited to, Shop Drawings, layout drawings in plan and elevation, installation drawings, elementary wiring diagrams, interconnecting wiring diagrams, manufacturer's data, etc. Contractor shall be responsible for securing all of the information, details, dimensions, Drawings, etc., necessary to prepare the Working Drawings required and necessary under this Contract and to fulfill all other requirements of his Contract. Contractor shall secure such information, details, Drawings, etc., from all possible sources including the Drawings, Working Drawings prepared by subcontractors, Engineers, suppliers, etc.

3. Working Drawings shall accurately and clearly present the following:

a. All working and installation dimensions.

b. Arrangement and sectional views.

c. Units of equipment in the proposed positions for installation, details of required attachments and connections, and dimensioned locations between units and in relation to the structures.

d. Necessary details and information for making connections between the various trades including, but not limited to, power supplies and interconnecting wiring between units, accessories, appurtenances, etc.

4. In the event that the Engineer is required to provide additional engineering services as a result of a substitution of materials or equipment by the Contractor, the additional services will be provided in accordance with Section 01010 - Summary of Work, and will be covered in supplementary or revised Drawings which will be issued to the Contractor. All changes indicated that are necessary to accommodate the equipment and appurtenances shall be incorporated into the Working Drawings submitted to the Engineer.

5. Working Drawings specifically prepared for this Project shall be on mylar or other approved reproducible material sheets of the same size as the Drawings. Working Drawings shall conform to recognized drafting standards and be neat, legible and drawn to a large enough scale to show in detail the required information.

6. The Drawings are used for engineering and general arrangement purposes only and are not to be used for Working Drawings.

7. Shop Drawings

a. Contractor shall submit for review by the Engineer Shop Drawings for all fabricated work and for all manufactured items required to be furnished by the Contract Documents.

b. Structural and all other layout Drawings prepared specifically for the Project shall have a plan scale of not less than 1/4-inch = 1 foot.

c. Where manufacturer's publications in the form of catalogs, brochures, illustrations or other data sheets are submitted in lieu of prepared Shop Drawings, such submittals shall specifically indicate the item for which approval is requested. Identification of items shall be made in ink, and submittals showing only general information are not acceptable.

8. Layout and Installation Drawings

a. Contractor shall prepare and submit for review by the Engineer layout and installation drawings for all pipes, valves, fittings, sewers, drains, heating and ventilation ducts, all electrical, heating, ventilating and other conduits, plumbing lines, electrical cable trays, lighting fixture layouts, and circuiting, instrumentation, interconnection wiring diagrams, communications, power

supply, alarm circuits, etc., under this Contract. The final dimensions, elevation, location, etc., of pipe, valves, fittings, sewers, ducts, conduits, electrical cable trays, equipment, etc., may depend upon the dimensions of equipment and valves to be furnished by the Contractor.

b. Layout and installation drawings are required for both interior and exterior piping, valves, fittings, sewers, drains, heating and ventilation ducts, conduits, plumbing lines, electrical cable trays, etc.

c. Layout and installation Drawings shall show connections to structures, equipment, sleeves, valves, fittings, etc.

d. Drawings shall show the location and type of all supports, hangers, foundations, etc., and the required clearances to operate valves, equipment, etc.

e. The Drawings for pipes, ducts, conduits, etc., shall show all 3-inch and larger electrical conduits and pressure piping, electrical cable trays, heating and ventilation ducts or pipes, structure, manholes or any other feature within four (4) feet (measured as the clear dimension) from the pipe duct, conduit, etc., for which the profile is drawn.

9. Contractor Responsibilities

a. All submittals from subcontractors, manufacturers or suppliers shall be sent directly to the Contractor for checking. Contractor shall thoroughly check all Drawings for accuracy and conformance to the intent of the Contract Documents. Drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors, manufacturers, or suppliers by the Contractor for correction before submitting them to the Engineer.

b. All submittals shall be bound, dated, properly labeled and consecutively numbered. Information on the label shall indicate Specification Section, Drawing number, subcontractor's, manufacturer's or supplier's name and the name or type of item the submittal covers. Each part of a submittal shall be marked and tabulated.

c. Working Drawings shall be submitted as a single complete package including all associated drawings relating to a complete assembly of the various parts necessary for a complete unit or system.

d. Shop Drawings shall be submitted as a single complete package for any operating system and shall include all items of equipment and any mechanical units involved or necessary for the functioning of such system. Where applicable, the submittal shall include elementary wiring diagrams showing circuit functioning and necessary interconnection wiring diagrams for construction.

e. ALL SUBMITTALS SHALL BE THOROUGHLY CHECKED BY THE CONTRACTOR FOR ACCURACY AND CONFORMANCE TO THE

INTENT OF THE CONTRACT DOCUMENTS BEFORE BEING SUBMITTED TO THE ENGINEER AND SHALL BEAR THE CONTRACTOR'S STAMP OF APPROVAL CERTIFYING THAT THEY HAVE BEEN SO CHECKED. SUBMITTALS WITHOUT THE CONTRACTOR'S STAMP OF APPROVAL WILL NOT BE REVIEWED BY THE ENGINEER AND WILL BE RETURNED TO THE CONTRACTOR.

f. If the submittals contain any departures from the Contract Documents, specific mention thereof shall be made in the Contractor's letter of transmittal. Otherwise, the review of such submittals shall not constitute approval of the departure.

g. No materials or equipment shall be ordered, fabricated, shipped or any work performed until the Engineer returns to the Contractor the submittals, herein required, annotated "Furnish as Submitted", "Furnish as Corrected", or “Furnish as Corrected – Confirm.” If a submittal is returned “Furnish as Corrected – Confirm” the portions of work covered by the submittal that require confirmation by the Engineer shall not be ordered, fabricated, shipped, or any work performed until those portions are approved in a subsequent submittal either "Furnish as Submitted" or "Furnish as Corrected".

h. Where errors, deviations, and/or omissions are discovered at a later date in any of the submittals, the Engineer's prior review of the submittals does not relieve the Contractor of the responsibility for correcting all errors, deviations, and/or omissions.

10. Procedure for Review

a. Submittals shall be transmitted in sufficient time to allow the Engineer at least thirty (30) working days for review and processing.

b. Contractor shall transmit an electronic copy of all technical data or drawing to be reviewed.

c. Submittal shall be accompanied by a letter of transmittal containing date, project title, Contractor's name, number and titles of submittals, a list of relevant specification sections, notification of departures from any Contract requirement, and any other pertinent data to facilitate review.

d. Submittals will be annotated by the Engineer in one of the following ways:

"Furnish as Submitted" (FAS) - no exceptions are taken

"Furnish as Corrected" (FAC) - minor corrections are noted and shall be made.

“Furnish as Corrected – Confirm” (FACC) - some corrections are noted and a partial resubmittal or additional information are required as specifically requested.

"Revise and Resubmit" (R&R) - major corrections are noted and a full resubmittal is required.

"For Information Only – Not Reviewed" (FIO) – submittal was received and was distributed for record purposes without review.

e. If a submittal is satisfactory to the Engineer in full or in part, the Engineer will annotate the submittal "Furnish as Submitted", "Furnish as Corrected", or "Furnish as Corrected – Confirm". If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Contractor. In the case of "Furnish as Corrected – Confirm" a partial resubmittal or additional information are required as specifically requested.

f. If a full resubmittal is required, the Engineer will annotate the submittal "Revise and Resubmit". If reproducible transparencies are submitted, the Engineer will retain the copies and return the reproducible transparencies to the Contractor.

g. Contractor shall continue to resubmit submittals in part if they are returned "Furnish as Corrected – Confirm" or in full if they are returned "Revise and Resubmit" as required by the Engineer until submittals are acceptable to the Engineer. It is understood by the Contractor that Owner may charge the Contractor the Engineer's charges for review in the event a submittal is not approved (either "Furnish as Submitted" or "Furnish as Corrected") by the third submittal for a system or piece of equipment. These charges shall be for all costs associated with engineering review, meetings with the Contractor or manufacturer, etc., commencing with the fourth submittal of a system or type of equipment submitted for a particular Specification Section.

h. Acceptance of a Working Drawing by the Engineer will constitute acceptance of the subject matter for which the Drawing was submitted and not for any other structure, material, equipment or appurtenances indicated or shown.

11. Engineer's Review

a. Engineer's review of the Contractor's submittals shall in no way relieve the Contractor of any of his responsibilities under the Contract. An acceptance of a submittal shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Drawings and Specifications.

b. Engineer's review will be confined to general arrangement and compliance with the Contract Drawings and Specifications only, and will not be for the purpose of checking dimensions, weights, clearances, fittings, tolerances, interferences, coordination of trades, etc.

12. Record Working Drawings

a. Contractor shall maintain current record drawings onsite for the Engineer's review. Record drawings shall be updated monthly at a minimum.

b. Prior to final payment, the Contractor shall furnish the Engineer one complete set of all accepted Working Drawings, including Shop Drawings, for equipment, piping, electrical work, heating system, ventilating system, air conditioning system, instrumentation system, plumbing system, structural, interconnection wiring diagrams, etc.

c. Working Drawings furnished shall be corrected to include any departures from previously accepted Drawings.

D. Operation and Maintenance Manuals

1. Electronic preliminary copies of Operation and Maintenance Manuals, prepared specifically for this Project, shall be furnished for each item of equipment furnished under this Contract. The preliminary manuals shall be provided to the Engineer not less than 60 days prior to the start-up of the respective equipment.

2. The preliminary manuals shall be reviewed by the Engineer prior to the Contractor submitting final copies for distribution to the Owner. Following review of the preliminary Operation and Maintenance Manuals, the Contractor shall receive electronically from the Engineer the required revisions noted, or the acceptance of the Engineer noted.

3. Manuals shall contain complete information in connection with assembly, operation, lubrication, adjustment, wiring diagrams and schematics, maintenance, and repair, including detailed parts lists with drawings or photographs identifying the parts.

4. Manuals furnished shall be assembled and bound in separate volumes, by major equipment items or trades, and properly indexed to facilitate locating any required information. In addition, manuals should be labeled in the front cover with the project, name, equipment description, and manufacturer contact information.

5. Engineer and the Owner shall be the sole judge of the acceptability and completeness of the manuals and may reject any submittal for insufficient information included, incorrect references and/or the manner in which the material is assembled.

6. Following the Engineer's review of the preliminary manuals, the Contractor shall submit one (1) paper copy and two (2) electronic copies of the final Operation and Maintenance Manuals to the Engineer. The manuals shall reflect the required revisions noted during the Engineer's review of the preliminary documents. Failure of the final manuals to reflect the required revisions noted by the Engineer during a review of the Preliminary documents will result in the manuals being returned to the Contractor. Acceptable final Operation and Maintenance Manuals shall be provided not less than two week prior to equipment start-up.

E. Certified Shop Test Reports

1. Each piece of equipment for which pressure, head, capacity, rating, efficiency, performance, function or special requirements are specified or implied shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and applicable test codes and standards. Contractor shall keep the Engineer advised of the scheduling of shop tests so that the Engineer may arrange for the witnessing or inspection at the proper time and place.

2. The Contractor shall secure from the manufacturers an electronic copy of the actual test data, the interpreted results and a complete description of the testing facilities and testing setup, all accompanied by a certificate of authenticity sworn to by a responsible official of the manufacturing company and notarized. These reports shall be forwarded to the Engineer for review.

3. In the event any equipment fails to meet the test requirements, the manufacturer shall make all necessary changes, adjustments or replacements and the tests shall be repeated, at no additional cost to the Owner or Engineer, until the equipment test requirements are acceptable to the Engineer.

4. No equipment shall be shipped to the Project until the Engineer notifies the Contractor, in writing, that the shop test reports are acceptable.

F. Samples

1. Contractor shall furnish for review all samples as required by the Contract Documents or requested by the Engineer.

2. Samples shall be of sufficient size or quantity to clearly illustrate the quality, type, range of color, finish or texture and shall be properly labeled to show the nature of the material, trade name of manufacturer and location of the work where the material represented by the sample will be used.

3. Samples shall be checked by the Contractor for conformance to the Contract Documents before being submitted to the Engineer and shall bear the Contractor's stamp of approval certifying that they have been so checked. Transportation charges on samples submitted to the Engineer shall be prepaid by the Contractor.

4. Engineer's review will be for compliance with the Contract Documents and his comments will be transmitted to the Contractor with reasonable promptness.

5. Accepted samples will establish the standards by which the completed work will be judged.

G. Construction Electronic Documentation

1. Pre-Construction Documentation

a. Contractor shall take photographic and video documentation of the Site where Work is being performed. Engineer and Owner reserve the right to be present during documentation.

b. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site prior to commence Work.

c. Contractor shall submit pre-construction documentation to Engineer and Owner for review. Contractor, Engineer, and Owner shall visit Site to field verify electronic documentation prior to commencing the Work. Site visit verification shall establish existing conditions prior to commencing Work.

2. Construction Progress Documentation

a. Contractor shall document Work progress at locations and construction as directed by Engineer, at a minimum.

b. Contractor shall provide electronic documentation prior to and following any shutdown, switchover, demolition, de-commissioning, cutting, patching, repair, etc. Engineer and Owner reserve the right to be present during documentation.

c. Contractor shall document following exposure of buried utilities, piping, valve, appurtenance, and other underground elements.

d. Engineer reserves the right to provide construction progress documentation to confirm Contractor electronic documentation.

3. Post-Construction Documentation

a. Contractor shall take photographic and video documentation of the Site where Work has been completed and prior to Substantial Completion or partial utilization by Owner. Engineer and Owner reserve the right to be present during documentation.

b. Contractor shall provide both photographic and video documentation at grade-level and aerial of the Site following completion of the Work.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –

SECTION 01350

ANCHORAGE AND BRACING OF NONSTRUCTURAL COMPONENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to design and provide anchorage and bracing for all nonstructural components in accordance with the Contract Documents and Building Code requirements, including the seismic design requirements of Chapter 13 in ASCE 7.

B. This Section covers requirements for only the anchorage and bracing of nonstructural components. Design requirements for nonstructural components (other than their anchorage and bracing) are covered in the Section for that component.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01450 – Special Inspections

B. Section 05010 – Metal Materials

C. Section 05050 – Metal Fastening

D. Further requirements for anchorage and bracing are included in other Sections of the Specifications. See Section for the specific nonstructural component in question.

1.03 DEFINITIONS

A. Nonstructural components: All architectural, mechanical, electrical, or plumbing elements or systems and their supports or attachments provided under this contract which are permanently attached to new or existing structures.

1. Architectural nonstructural components include, but are not limited to, interior nonstructural walls and partitions, exterior wall panels and glazing elements, glass curtain walls, skylights, cabinets, suspended ceilings, fascia, and cladding.

2. Mechanical nonstructural components include, but are not limited to, HVAC units, fans, water and wastewater treatment process equipment, instrumentation cabinets, piping and ductwork.

3. Electrical nonstructural components include, but are not limited to, conduit systems, cable tray systems, boxes, transformers, panelboards, switchboards,

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switchgear, busway, individual motor controllers, motor control centers, variable frequency drives, automatic transfer switches, and lighting systems.

4. Plumbing nonstructural components include, but are not limited to, sprinkler systems and associated piping, and sump pumps.

B. Attachment: Elements including anchor bolts, welded connections, and mechanical fasteners which secure nonstructural components or supports to the structure.

C. Essential Components: Nonstructural components considered necessary to public safety for which the component importance factor I_p is required by chapter 13 in ASCE 7 to be taken as 1.5, including:

1. Life safety systems which must function following an earthquake, including but not limited to, sprinklers for fire protection, emergency lighting, egress corridors and stairways, and smoke purge systems.

2. Components which contain, convey or support toxic, highly toxic, or explosive substances where the quantity of the material exceeds a threshold quantity established by the Building Code.

3. Components which are within or attached to an Occupancy or Risk Category IV structure as defined in ASCE 7 Chapter 1 and are needed for continued operation of the facility or failure could impair the continued operation of the facility.

4. Components which contain, convey, or support hazardous substances and are attached to a structure or portion thereof classified by the Building Code as a hazardous occupancy.

5. Process systems and elements designated below:

a. P.O. Hoffer WTF finished water pumps, piping, and valves to maintain water pressure used for fire suppression.

b. Glenville Lake WTF monochloramines chemical feed lines.

D. Nonbuilding Structures: All self-supporting structures which are supported by an independent foundation or by other structures which include, but are not limited to, storage tanks, silos, exhaust stacks, storage racks, and towers.

E. Delegated Design: Design of a structure or structural element(s) which has been deferred by the contract documents to be performed during the project construction stage, by a registered design professional retained by the Contractor and with the design submitted as a shop drawing to the Engineer.

1.04 REQUIREMENTS

A. Anchorage and bracing of nonstructural components shall be designed and installed to resist the controlling load combination of gravity loads, operational forces (including static and dynamic), wind forces, seismic forces and any other applicable forces required in accordance with the governing Building Code.

B. Anchorage and bracing of nonstructural components shall comply with seismic design requirements of ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt. The following nonstructural components are exempt from requirements specific to seismic anchorage and bracing: (See paragraph 1.07.F.3 herein for Seismic Design Category)

1. Storage cabinets no more than 6 feet tall, furniture, and movable equipment, regardless of Seismic Design Category.

2. All architectural, mechanical, electrical, and plumbing nonstructural components in Seismic Design Category A.

3. All mechanical, electrical, and plumbing nonstructural components in Seismic Design Category B.

4. Architectural nonstructural components in Seismic Design Category B, other than parapets, provided that $I_p = 1.0$.

5. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category C provided that either:

   a. $I_p = 1.0$, and the component is positively attached to the structure, or

   b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.

6. Mechanical, electrical, and plumbing nonstructural components in Seismic Design Category D, E or F that are positively attached to the structure, provided that either:

   a. $I_p = 1.0$, component weighs 400 lbs or less and its center of mass is 4 ft or less above a floor level, and flexible connections are provided between the components and associated ductwork, piping and conduit: or

   b. Component weighs 20 lbs. or less, or 5 lb/ft or less for distribution systems.

7. Other exemptions as allowed by the Specifications, Codes and Standards referenced herein.

1.05 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. The Building Code shall be the version in effect at the time of Bid within the jurisdiction where the Work is located. All other referenced specifications, codes, and standards refer to the version as referenced by the Building Code. If no version is referenced by the Building Code, then the most current issue available at the time of Bid shall be used.

1. North Carolina Building Code

2. ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures

3. NFPA 13 Standard for Installation of Sprinkler Systems

4. FEMA 412 Installing Seismic Restraints for Mechanical Equipment

5. FEMA 413 Installing Seismic Restraints for Electrical Equipment

6. FEMA 414 Installing Seismic Restraints for Duct and Pipe

7. SMACNA Sheet Metal and Air Conditioning Contractors' National Association, Seismic Restraint Manual: Guidelines for Mechanical Systems

8. ACI 318 Building Code Requirements for Structural Concrete and Commentary

9. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete

10. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

1.06 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Anchorage and bracing submittals for all architectural, mechanical, electrical, and plumbing nonstructural components, elements and systems that do not have a design for anchorage and bracing provided within the Contract Documents. Submittals shall include the following:

a. Component manufacturer's cut sheets and fabrication details for equipment bases and foundations, including dimensions, structural member sizes, support point locations and equipment operational loads. Equipment anchorage details shall clearly indicate anchor size, pattern, embedment, and edge distance requirements to satisfy operational, wind, seismic and other forces required by the governing Building Code. Details shall also indicate grout, bearing pads, isolators, etc. required for complete installation.

b. Design calculations, signed and sealed by a Professional Engineer registered in the State or Commonwealth in which the project is located. Design shall include all loads and load combinations required by the governing Building Code. Separate calculation submittals for vertical and lateral load support systems shall not be allowed.

c. Detailed Shop Drawings, signed and sealed by a Professional Engineer registered in the State or Commonwealth in which the project is located, showing specific details of the support design including material, installation, attachments, connection hardware, etc., and the layout and location of all hangers and supports (resisting both gravity and lateral loads), including bracing orientation and direction of force(s) to be resisted.

d. Seismic loads and requirements are not required to be included in design for anchorage and bracing of components which are exempt in accordance with Section 1.04B.

e. For components required to be certified as seismically qualified in accordance with paragraph 1.06.A.1.f below, submit installation guidelines provided by the equipment manufacturer for proper seismic mounting of the equipment.

f. Seismic qualification testing shall be based on ASCE 7 and on a nationally recognized testing standard procedure such as ICC-ES AC 156.

1.07 DESIGN REQUIREMENTS

A. Mechanical fasteners used to secure nonstructural components shall meet the requirements of Section 05050 – Metal Fastening. Post-installed concrete anchors shall be prequalified for use in seismic applications.

B. No reaction loads (either vertical or lateral) from nonstructural component anchorage and bracing shall be allowed on any element where design has been delegated unless the additional loads on the element have been coordinated with the delegated designer and the submittal is accompanied by a sealed letter from the delegated designer indicating the element has been designed to support the reaction loads.

C. Reaction loads from nonstructural component anchorage and bracing shall be transferred directly to the primary structural members (girders, beams, etc.), with no components supported from secondary members (purlins, bracing, etc.) unless otherwise approved.

D. No holes shall be drilled into any structural steel for attachment of component supports without prior approval of the Engineer.

E. Attachments of nonstructural component anchorage and bracing that cause overstressing of any structural element shall not be permitted.

F. Seismic Requirements

1. Seismic anchorage and bracing for nonstructural components shall be subject to the current local Building Code in conjunction with the seismic provisions of the International Building Code (IBC) Section 1613 and referenced ASCE 7 Chapter 13.

2. Where the weight of a nonstructural component is greater than or equal to 25 percent of the effective seismic weight (as defined by ASCE 7) of the structure it is attached to, the component shall be classified as a nonbuilding structure for purposes of seismic design. Seismic design for nonbuilding structures shall comply with Building Code requirements in conjunction with the provisions of ASCE 7 Chapter 15.

3. Nonstructural components shall be assigned to the same Seismic Design Category as the structure they occupy or to which they are attached. Design of seismic support system and anchorage shall incorporate the site-specific seismic criteria given on the Contract Drawings. Criteria shall include site-specific spectral response coefficients, Site Class, Seismic Design Category, and Risk Category.

4. Component Importance Factor Ip shall be 1.5 for all essential nonstructural components noted in item 1.03.E above. All other nonstructural components shall utilize I_p = 1.0 unless noted otherwise.

5. Components shall be anchored and braced for earthquake forces both in the vertical and each orthogonal direction. Seismic anchorage and bracing shall limit deflections of components per ASCE 7, and the displacements shall not impede component functionally and containment.

6. Anchorage design shall account for disparate seismic response behavior of supporting structures. Seismic supports or bracing shall not cross structural expansion joints. Nonstructural components shall not be attached to multiple structural elements which may respond differently during a seismic event without provisions to accommodate independent movement. Flexible expansion loops or offsets, flexible joints, bellows type pipe expansion joints, couplings, etc. shall be provided at structure expansion joints to allow for independent structure movement and thermal movement of piping, ductwork, and conduit. Minimum movement capability in the vertical and each orthogonal direction shall equal the width of the joint.

7. Provide flexible connections, piping, conduit, etc. at foundation levels where below grade utilities enter the structure.

8. Design of support system for components with multiple attachments shall consider the stiffness and ductility of the supporting members. Equipment designed as free-standing shall only be attached at its base. Use of non-free-standing equipment requiring both vertical and lateral attachment is contingent upon loads applied to the structure and requires approval by the Engineer.

9. The seismic anchorage and bracing design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from the specifications or the approved equipment manufacturer. The equipment manufacturer shall verify the attachment points on the equipment can safely withstand the combination of seismic, self-weight and other loads imposed.

G. Powder actuated fasteners in steel or concrete shall not be used for sustained tension loads in Seismic Design Categories D, E or F unless approved for seismic loading or specifically exempted by ASCE 7. Powder actuated fasteners in masonry shall not be used unless approved for seismic loading regardless of Seismic Design Category.

H. Friction clips shall not be used in Seismic Design Categories D, E or F for supporting sustained tension loads in combination with resisting seismic forces. C-type and large flange clamps may be used for hanger attachments provided restraining straps meeting NFPA 13 requirements are utilized and loosening of threaded connections is prevented by lock nuts, burred threads, etc.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Anchorage and bracing of nonstructural components shall be constructed of appropriate materials and connecting hardware to provide a continuous load path between the component and supporting structure of sufficient strength and stiffness to resist the calculated design seismic forces and displacements.

B. Component anchorage, bracing and connection materials shall be compatible with and in general match the component and component gravity support materials. Contact between dissimilar metals shall be prevented.

PART 3 – EXECUTION

3.01 INSTALLATION OF ANCHORAGE AND BRACING

A. No anchorage and bracing of nonstructural components shall be installed prior to review and acceptance by the Engineer and permitting agency.

B. Equipment shall be installed per the manufacturer’s recommendations. Fasteners shall meet manufacturer’s requirements.

C. Following installation, all anchorage and bracing and seismically qualified equipment shall be inspected. See Section 01450 – Special Inspections for requirements.

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Testing Laboratory Services

1. Laboratory testing and checking required by the Specifications, including the cost of transporting all samples and test specimens, shall be provided and paid for by the Owner unless otherwise indicated in the Specifications.

2. Materials to be tested include, but are not necessarily limited to the following: cement, concrete aggregate, concrete, bituminous paving materials, structural and reinforcing steel, waterproofing, select backfill, crushed stone or gravel and sand.

3. Tests required by the Owner shall not relieve the Contractor from the responsibility of supplying test results and certificates from manufacturers or suppliers to demonstrate conformance with the Specifications.

4. Procedure

a. The Contractor shall plan and conduct his operations to permit taking of field samples and test specimens, as required, and to allow adequate time for laboratory tests.

b. The collection, field preparation and storage of field samples and test specimens shall be as directed by the Engineer with the cooperation of the Contractor.

5. Significance of Tests

a. Test results shall be binding on both the Contractor and the Owner, and shall be considered irrefutable evidence of compliance or noncompliance with the Specification requirements, unless supplementary testing shall prove, to the satisfaction of the Owner, that the initial samples were not representative of actual conditions.

6. Supplementary and Other Testing

a. Nothing shall restrict the Contractor from conducting tests he may require. Should the Contractor at any time request the Owner to consider such test results, the test reports shall be certified by an independent testing laboratory acceptable to the Owner. Testing of this nature shall be conducted at the Contractor's expense.

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1.02 FIELD TESTING OF EQUIPMENT

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions.

B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall check the equipment for alignment, direction of rotation and that it is free from defects.

2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.

3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.

4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag

1. Upon completion of the installation, and at a time approved by the Engineer, equipment will be tested by operating it as a unit with all related piping, ducting, electrical controls and mechanical operations.

2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.

3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Equipment shall be tested for the characteristics as specified for the item.

4. Each pump shall be tested at maximum rated speed for at least four points on the pump curve for capacity, head and electric power input. The rated motor nameplate current and power shall not be exceeded at any point within the specified range. Vibrometer readings shall be taken when directed by the Engineer and the results recorded. Additional tests shall be performed as prescribed in other sections of the Specifications.

5. Pumps with drive motors rated at less than five horsepower shall only be tested for excess current or power when overheating or other malfunction becomes evident in general testing.

6. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.

7. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.

8. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.

9. All costs in connection with such tests including all materials, equipment, instruments, labor, etc., shall be borne by the Contractor.

1.03 IMPERFECT WORK, EQUIPMENT, OR MATERIALS

A. Any defective or imperfect work, equipment, or materials furnished by the Contractor which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it may have been overlooked by the Engineer and estimated for payment. Any equipment or materials condemned or rejected by the Engineer shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.

B. The Engineer may order tests of imperfect or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor; and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the work, equipment, or material was not impaired, consistent with the final general appearance of same, the work, equipment, or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work, equipment, or materials has been impaired, then such work, equipment, or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect work, equipment, or material in lieu of performing the tests.

1.04 INSPECTION AND TESTS

A. The Contractor shall allow the Engineer ample time and opportunity for testing materials and equipment to be used in the work. He shall advise the Engineer promptly upon placing orders for material and equipment so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Engineer and his representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must anticipate possible delays that may be caused in the execution of his work due to the necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the Engineer for testing, and shall make his own arrangements for providing water, electric power, or fuel for the various inspections and tests of structures and equipment.

B. The Contractor shall furnish the services of representatives of the manufacturers of certain equipment, as prescribed in other Sections of the Specifications. The Contractor shall also place his orders for such equipment on the basis that, after the equipment has been tested prior to final acceptance of the work, the manufacturer will furnish the Owner with certified statements that the equipment has been installed properly and is ready to be placed in functional operation. Tests and analyses required of equipment shall be paid for by the Contractor, unless specified otherwise in the Section which covers a particular piece of equipment.

C. Where other tests or analyses are specifically required in other Sections of these Specifications, the cost thereof shall be borne by the party (Owner or Contractor) so designated in such Sections. The Owner will bear the cost of all tests, inspections, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, inspection, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, inspections, or investigations, the Contractor shall bear the full cost thereof or shall reimburse the Owner for said cost. In this connection, the cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents, shall be borne by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01450

SPECIAL INSPECTIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. This Section defines the requirements for Special Inspections as required by Section 1704 of the International Building Code (IBC) and any State or local amendments.

B. Either the Engineer of Record (EOR) or Registered Design Professional in Responsible Charge (RDPIRC) will prepare a Statement of Special Inspections, which identifies the type and extent of required Special Inspections.

C. The Owner will retain one or more Special Inspections Agencies to perform Special Inspection services. These Agencies shall be independent from the Contractor and approved by the Building Official. The EOR may perform Special Inspection services where qualifications for a specific inspection task are met.

D. The Contractor shall plan and conduct his operations as to schedule and allow Special Inspections, providing adequate time and safe access for inspections. The Contractor shall coordinate requirements for Special Inspections with the Special Inspections Agency.

E. Special Inspections shall be in addition to inspections performed by Building Officials that are specified in IBC Section 104.

F. Special Inspections shall be in addition to any Structural Observations required by IBC Section 1704.6.

G. Special Inspections do not supersede other inspections and testing required by the Contract Documents to satisfy the Contractor's quality control responsibility. Contractor shall be responsible for all costs associated with quality control requirements as required by other Sections of the Specifications.

H. Special Inspections shall not relieve Contractor's obligation to perform and complete work in accordance with Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.

I. This Section does not apply to construction equipment, shoring, earth retention systems, and temporary structures used by the Contractor in construction and not detailed in the Contract Documents. The Contractor shall be solely responsible for means, methods, techniques, sequences, or procedures of construction and any associated building code

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requirements.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Special Inspections requirements apply to work detailed in other Sections of the Specifications. Special Inspections requirements shall be in addition to any other inspection or quality control requirements detailed in other Sections of the Specifications. See individual Specification Sections for type of work in question.

1.03 DEFINITIONS

A. Periodic Special Inspections: The part-time or intermittent observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.

B. Continuous Special Inspections: The full-time observation of work requiring Special Inspection by a Special Inspector who is present in the area where the work is being performed.

C. Engineer of Record (EOR): The engineer of each system in responsible charge for the design of each specific building system including structural, mechanical, electrical, and architectural components

D. Registered Design Professional in Responsible Charge (RDPIRC): The RDPIRC in charge of Special Inspections during construction for each specific building system including structural, mechanical, electrical, and architectural components. The RDPIRC shall be a currently Registered Professional Engineer in the State or Commonwealth in which the project is located. The EOR may serve in this role.

E. Special Inspections Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The EOR may serve in this role where qualifications for specific inspection tasks are met.

F. Special Inspector: Individual employed by or retained by the Special Inspections Agency who is qualified in inspection of specific aspects or components of the construction and conducts inspection activities in these specific aspects of the construction, as required by this Section. The EOR may serve in this role where qualifications for specific inspection tasks are met.

G. Statement of Special Inspections: Document prepared by the EOR or RDPIRC and submitted to the Building Official which identifies the type and extent of required Special Inspections.

H. Approved Fabricator: Fabricator who has been registered and approved by the Building Official to manufacture or fabricate specific components of the construction without Special Inspections.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents and all other documents referenced in the Specifications. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. ACI 318 – Building Code Requirements for Structural Concrete

3. TMS 402/TMS 602 – Building Code for Masonry Structures/Specifications for Masonry Structures

4. AISC – Code of Standard Practice

5. AISC 341 – Seismic Provisions for Structural Steel Buildings

6. AISC 360 – Specification for Structural Steel Buildings

7. AISC 348 – Specification for Structural Joints Using High Strength Bolts

8. AWS – Structural Welding Code

9. ADMI – Aluminum Design Manual: A Specification for Aluminum Structures

1.05 SUBMITTALS

A. The Contractor shall submit the following in accordance with Section 01300 - Submittals.

1. The Contractor shall submit a written statement of responsibility to the Building Official and RDPIRC prior to beginning work. A statement is required from each Contractor who has responsibility for construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections.

2. The Contractor shall submit qualifications of any fabricators they intend to use that may qualify as Approved Fabricators to the Special Inspections Agency for review.

B. The Special Inspections Agency shall submit the following in accordance with Section 01300 – Submittals.

1. The Special Inspections Agency shall provide a statement of qualifications showing relative experience, training, and certification(s) for each Special Inspector to the Building Official, if requested.

2. The Special Inspections Agency shall review fabricator qualifications and submit them to the Building Official for approval as an Approved Fabricator if requested.

3. Special Inspectors shall keep detailed inspection records, including all inspections, tests, similar services, and any discrepancies and corrections. Any discrepancies and corrections shall be reported to the Building Official, the EOR, and the RDPIRC in all required reports, unless otherwise required by the Building Official.

4. The Special Inspections Agency shall submit Interim Reports to the Building Official and the RDPIRC documenting required Special Inspections and correction of any discrepancies at the frequency specified in the Statement of Special Inspections.

5. The Special Inspections Agency shall submit to the Building Official and the RDPIRC a Final Report documenting required Special Inspections and correction of any discrepancies. The Final Report shall be submitted at a point in time agreed upon by the Owner and the Building Official at the Pre-inspection Meeting.

6. Where work is done by Approved Fabricators, the Special Inspections Agency shall coordinate the submittal of a certificate of compliance to the Building Official, the EOR, and the RDPIRC.

1.06 SPECIAL INSPECTOR QUALIFICATIONS

A. Special Inspectors shall meet minimum qualifications established by the Building Official and shall be approved by the Building Official.

1.07 OFF-SITE FABRICATIONS

A. When structural elements or assemblies are fabricated off site, Special Inspections shall be performed in the fabricator's shop unless the fabricator is an Approved Fabricator. Special Inspections are not required if work is done on the premises of an Approved Fabricator.

B. Fabricators shall maintain detailed fabrication and quality control procedures to ensure workmanship and conformance with Contract Documents and reference standards. The Special Inspections Agency shall review the fabricator's quality control procedures and coordinate required Special Inspections with the fabricator and the Contractor.

C. The Contractor shall submit qualifications of fabricators seeking Approved Fabricator status to the Special Inspections Agency for review. Approval as an Approved Fabricator shall be given by the Building Official upon the recommendation of the Special

Inspections Agency or upon review of the fabricator's written fabrication procedures and quality control manuals that provide a basis for control of materials and workmanship, with periodic auditing of fabrication and quality control practices by an Approved Agency or the Building Official.

D. At completion of fabrication, the Approved Fabricator shall submit a certificate of compliance to the Owner or the RDPIRC for submittal to the Building Official stating that the work was performed in accordance with the approved Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 PRE-INSPECTION MEETING

A. At least two weeks prior to beginning work, a Pre-inspection Meeting shall be held to discuss the Special Inspection procedures and submittals. The following parties shall participate: EOR, RDPIRC, Special Inspections Agency representative, Contractor, Subcontractors, Testing Agencies, and Building Official. The type of meeting (in-person or teleconference) and location of meeting shall be determined by the Building Official.

3.02 STATEMENT AND SCHEDULE OF SPECIAL INSPECTIONS

A. The Special Inspections Agency and all Special Inspectors are required to comply with all requirements of the Statement of Special Inspections and the Schedule of Special Inspections. Together, these documents identify materials, systems, components, and work that are required to have Special Inspections, the type and extent of Special Inspections, and whether they will be continuous or periodic. The Schedule of Special Inspections is included at the end of this Section. A form which may be used for the Statement of Special Inspections is also included at the end of this Section.

3.03 SPECIAL INSPECTIONS AGENCY REQUIREMENTS AND RESPONSIBILITIES

A. The Special Inspections Agency shall be an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, which has been approved by the Building Official and is retained by the Owner. The Agency shall demonstrate competence, to the satisfaction of the Building Official, for the inspection of the specific aspects of construction or operation requiring Special Inspection.

B. The Special Inspections Agency shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Agency shall submit all required reports to the EOR, RDPIRC and Building Official. Where EOR approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all

required reports. The Agency shall coordinate all required Special Inspection activities with the Special Inspectors, the Contractor, and any fabricators and shall coordinate designation of fabricators as Approved Fabricators when requested.

3.04 SPECIAL INSPECTORS' REQUIREMENTS AND RESPONSIBILITIES

A. All Special Inspectors shall meet the qualification requirements determined by the Building Official for the specific type of inspection services they will be providing and shall be approved by the Building Official. Special Inspectors shall submit written documentation demonstrating their competence and experience or training to the Building Official for approval of their qualifications.

B. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC, or the Building Official. Special Inspectors shall submit all required reports to the RDPIRC and the Building Official. Where EOR approval is required for corrections, the Special Inspector shall maintain copies of all related correspondence and submit with all required reports. Special Inspectors shall coordinate inspection requirements and time when inspections can be conducted with the Contractor.

C. Any discrepancies in work noted by the Special Inspector shall be brought to the immediate attention of the Contractor for correction. Special Inspectors shall coordinate correction of discrepancies with the Contractor. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. If noted discrepancies are not corrected, the Special Inspector shall notify the Contractor, the EOR, the RDPIRC and the Building Official. All noted discrepancies and corrections shall be documented in all inspection records and all required reports.

3.05 CONTRACTOR RESPONSIBILITIES

A. Each Contractor responsible for the construction or fabrication of a main wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections shall submit a Statement of Responsibility to the Building Official, RDPIRC, and EOR prior to the commencement of work. The Statement of Responsibility shall contain acknowledgement of the specific requirements contained in the Statement of Special Inspections.

B. The Contractor shall coordinate requirements of Special Inspections with the Special Inspections Agency and the Special Inspectors and shall provide adequate time and access to conduct inspections. The Contractor is solely responsible for providing safe access and any necessary safety equipment required to conduct inspections. The

Special Inspector shall not supervise, direct, control, or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the Contractor to comply with Laws and Regulations applicable to the performance of the Work.

C. Special Inspections shall not relieve the Contractor's obligation to perform and complete work in accordance with the Contract Documents. Results of Special Inspections activities, including any discrepancies that are noted or not noted, shall never constitute an acceptance of work that is not in accordance with the Contract Documents.

D. The Contractor shall provide advance notice of work to be conducted that will require Special Inspections. If the Special Inspector is delayed in inspecting the work due to inadequate notice or completion of the work, the Contractor shall reimburse the Owner for the cost of additional subsequent Special Inspections.

E. The Contractor shall promptly correct any discrepancies noted by the Special Inspectors. Any corrections of discrepancies that result in changes to the work as shown on the Contract Documents shall be approved by the EOR. Where EOR approval is required, the Contractor shall report the discrepancy to the EOR in accordance with provisions of the General Conditions. The EOR will authorize any changes to the Contract Documents required for the correction in accordance with provisions of the General Conditions. Copies of all correspondence related to the correction shall be submitted concurrently to the Special Inspections Agency.

3.06 BUILDING OFFICIAL OR AUTHORITY RESPONSIBILITIES

A. The Building Official will approve qualifications of the Special Inspections Agency, all Special Inspectors, and any Approved Fabricators. The Building Official will approve all forms submitted by the Contractor, any Approved Fabricators, the EOR, the RDPIRC, the Special Inspections Agency, and the Special Inspectors. The Building Official and the Special Inspections Agency shall agree to the frequency of Interim Reports and the submittal deadline for the Final Report.

3.07 RDPIRC RESPONSIBILITIES

A. The RDPIRC shall complete the Statement of Special Inspections and the Schedule of Special Inspections, unless previously completed by the EOR. The Statement of Special Inspections form included in this Section shall be used unless the Building Official has a preferred form for the Statement of Special Inspections, in which case the Building Official's form may be used and shall be completed by the RDPIRC.

B. The RDPIRC shall review and coordinate certain aspects of the project, as determined by the Building Official, for compatibility with the design of the building, structure or building system, including, but not limited to, submittal documents prepared by others, deferred submittal documents and phased submittal documents.

3.08 OWNER RESPONSIBILITES

A. The Owner will retain a Special Inspections Agency to perform Special Inspections during construction. The Special Inspections Agency will retain the RDPIRC.

3.09 MINIMUM INSPECTION REQUIREMENTS

A. Detailed requirements for Special Inspections are shown in the Statement of Special Inspections and the Schedule of Special Inspections, which references the IBC, applicable code standards, and any State or local amendments. Special Inspections shall be performed in accordance with all requirements of the Statement of Special Inspections, the Schedule of Special Inspections, the IBC, and any State or local amendments. Additional requirements for specific materials listed in other Sections of these Specifications shall also be satisfied. The frequency of inspections shall be continuous or periodic as indicated in the Schedule of Special Inspections and in accordance with applicable building codes.

3.10 REPORTS

A. Special Inspectors shall maintain detailed inspection records, including a copy at the jobsite, and all records shall be available upon request by the EOR, RDPIRC or the Building Official. The Special Inspections Agency shall submit all required reports to the Building Official, EOR, and RDPIRC as agreed upon with the Building Official. Reports shall indicate the inspections and testing performed and whether work inspected was or was not completed in conformance to Contract Documents and any corrective measures taken. Where EOR approval is required for corrections, the Agency shall maintain copies of all related correspondence and submit with all required reports.

3.11 SPECIAL INSPECTIONS FORMS

A. This Section includes forms which may be used to meet requirements for written documentation during the performance of Special Inspections in accordance with the IBC. These forms may be replaced with forms meeting IBC requirements provided by the Building Official if available.

1.1 SCHEDULE OF SPECIAL INSPECTIONS—STEEL CONSTRUCTION (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Inspection Tasks Prior to Welding:					AISC 360 Section N.5.4	1705.2.1
a. Welder qualification records and continuity records						
1) Quality Assurance provided by inspector		O				
2) Quality Control provided by fabricator, erector, or contractor	P					
b. WPS available	P					
c. Manufacturer certifications for welding consumables available	P					
d. Material identification (type/grade)		O				
e. Welder identification system[a]		O				
f. Fit-up of groove welds (including joint geometry)		O				
1) Joint preparations						
2) Dimensions (alignment, root opening, root face, bevel)						
3) Cleanliness (condition of steel surfaces)						
4) Tacking (tack weld quality and location)						
5) Backing type and fit (if applicable)						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
g. Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) - Quality Assurance provided by inspector		O			AISC 360 Section N.5.4	1705.2.1
1) Joint preparations						
2) Dimensions (alignment, root opening, root face, bevel)						
3) Cleanliness (condition of steel surfaces)						
4) Tacking (tack weld quality and location)						
h. Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) - Quality Control provided by fabricator, erector, or contractor	P					
1) Joint preparations						
2) Dimensions (alignment, root opening, root face, bevel)						
3) Cleanliness (condition of steel surfaces)						
4) Tacking (tack weld quality and location)						
i. Configuration and finish of access holes		O				
j. Fit-up of fillet welds		O				
1) Dimensions (alignment, gaps at root)						
2) Cleanliness (condition of steel surfaces)						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
3) Tacking (tack weld quality and location)						
k. Check welding equipment		O				
[a] Fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.						
2. Inspection Tasks During Welding:					AISC 360 Section N.5.4	1705.2.1
a. Control and handling of welding consumables		O				
1) Packaging						
2) Exposure control						
b. No welding over cracked tack welds		O				
c. Environmental conditions		O				
1) Wind speed within limits						
2) Precipitation and temperature						
d. WPS followed		O				
1) Settings on welding equipment						
2) Travel speed						
3) Selected welding materials						
4) Shielding gas type/flow rate						
5) Preheat applied						
6) Interpass temperature maintained (min/max)						
7) Proper position (F, V, H, OH)						
e. Welding techniques		O				
1) Interpass and final cleaning						
2) Each pass within profile limitations						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
3) Each pass meets quality requirements						
f. Placement and installation of steel headed stud anchors	P					
3. Inspection Tasks After Welding:					AISC 360 Section N.5.4	1705.2.1
a. Welds cleaned		O				
b. Size, length, and location of welds	P					
c. Welds meet visual acceptance criteria	P					
1) Crack prohibition						
2) Weld/base-metal fusion						
3) Crater cross section						
4) Weld profiles						
5) Weld size						
6) Undercut						
7) Porosity						
d. Arc strikes	P					
e. k-area[b]	P					
f. Weld access holes in rolled heavy shapes and built-up heavy shapes[c]	P					
g. Backing removed and weld tabs removed (if required)	P					
h. Repair activities	P					
i. Document acceptance or rejection of welded joint or member	P					
j. No prohibited welds have been added without the approval of the EOR		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
[b] When welding of doubler plates, continuity plates or stiffeners has been performed in the k-area, visually inspect the web k-area for cracks within 3 in. of the weld. [c] After rolled heavy shapes (see AISC 360 Section A3.1c) and built-up heavy shapes (see AISC 360 Section A3.1d) are welded, visually inspect the weld access hole for cracks.						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
4. Inspection Tasks Prior to Bolting:					AISC 360 Section N.5.6	1705.2.1
a. Manufacturer's certifications available for fastener materials						
1) Quality Assurance provided by inspector	O					
2) Quality Control provided by fabricator, erector, or contractor		P				
b. Fasteners marked in accordance with ASTM requirements		O				
c. Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)		O				
d. Correct bolting procedure selected for joint detail		O				
e. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements		O				
f. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used						
1) Quality Assurance provided by inspector		O				
2) Quality Control provided by fabricator, erector, or contractor	P					
g. Protected storage provided for bolts, nuts,		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
washers, and other fastener components						
5. Inspection Tasks During Bolting:					AISC 360 Section N.5.6	1705.2.1
a. Fastener assemblies placed in all holes and washers and nuts are positioned as required		O				
b. Joint brought to the snug-tight condition prior to the pre-tensioning operation		O				
c. Fastener component not turned by the wrench prevented from rotating		O				
d. Fasteners are pre-tensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges		O				
6. Inspection Tasks After Bolting:					AISC 360 Section N.5.6	1705.2.1
a. Document acceptance or rejection of bolted connections	P					
7. Steel elements of composite construction prior to concrete placement:					AISC 360 Section N.6	1705.2.1
a. Placement and installation of steel deck	P					
b. Placement and installation of steel headed stud anchors	P					
c. Document acceptance or rejection of steel elements	P					
Structural Steel Definitions: Observe (O) – the inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections. Perform (P) – these tasks shall be performed for each welded joint or member.						

1.2 STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Inspection or Execution Tasks Prior to Deck Placement:					SDI QA/QC	1705.2.2
a. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness	P					
b. Document acceptance or rejection of deck and deck accessories	P					
2. Inspection or Execution Tasks After Deck Placement:					SDI QA/QC	1705.2.2
a. Verify compliance of deck and all deck accessories installation with construction documents	P					
b. Verify deck materials are represented by the mill certifications that comply with the construction documents	P					
c. Document acceptance or rejection of installation of deck and deck accessories	P					
3. Inspection or Execution Tasks Prior to Welding:					SDI QA/QC	1705.2.2
a. Welding procedure specifications (WPS) available		O				
b. Manufacturer certifications for welding consumables available		O				
c. Material identification (type/grade)		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
d. Check welding equipment		O				
4. Inspection or Execution Tasks During Welding:					SDI QA/QC	1705.2.2
a. Use of qualified welders		O				
b. Control and handling of welding consumables.		O				
c. Environmental conditions (wind speed, moisture, temperature)		O				
d. WPS followed		O				
5. Inspection or Execution Tasks After Welding:					SDI QA/QC	1705.2.2
a. Verify size and location of welds, including support, sidelap, and perimeter welds	P					
b. Welds meet visual acceptance criteria.	P					
c. Verify repair activities.	P					
d. Document acceptance or rejection of welds	P					
6. Inspection or Execution Tasks Prior to Mechanical Fastening:					SDI QA/QC	1705.2.2
a. Manufacturer installation instructions available for mechanical fasteners		O				

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
b. Proper tools available for fastener installation		O				
c. Proper storage for mechanical fasteners		O				
7. Inspection or Execution Tasks During Mechanical Fastening:					SDI QA/QC	1705.2.2
a. Fasteners are positioned as required		O				
b. Fasteners are installed in accordance with manufacturer's instructions		O				
8. Inspection or Execution Tasks After Mechanical Fastening:					SDI QA/QC	1705.2.2
a. Check spacing, type, and installation of support fasteners	P					
b. Check spacing, type, and installation of sidelap fasteners	P					
c. Check spacing, type, and installation of perimeter fasteners	P					
d. Verify repair activities.	P					
e. Document acceptance or rejection of mechanical fasteners	P					
9. Inspection of welding:					SDI QA/QC	1705.2.2
a. Cold-formed steel deck						
1) Complete and partial joint penetration groove welds; multi-pass fillet welds; single-pass fillet welds >	X					

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
5/16"; plug and slot welds						
2) Single-pass fillet welds < 5/16"		X				
3) Floor and roof deck welds		X				
b. Reinforcing steel						
1) Verification of weldability of reinforcing steel other than ASTM A706		X				
2) Reinforcing steel resisting flexural and axial forces in intermediate and special moment frames, and boundary elements of special structural walls of concrete and shear reinforcement	X				AWS D1.4	1705.3.1
3) Shear reinforcement	X					
4) Other reinforcing steel		X				

Structural Steel Definitions:
Observe (O) – the inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.
Perform (P) – these tasks shall be performed for each welded joint or member.

1.3 SCHEDULE OF SPECIAL INSPECTIONS—OPEN-WEB STEEL JOISTS AND JOIST GIRDERS (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference[d]
	CONT	PER	Y/N	Agent		
1. Installation of open-web steel joists and joist girders:						
a. End connections – welding or bolted		X			SJI specifications listed in IBC Section 2207.1	
b. Bridging – horizontal or diagonal						
1) Standard bridging		X			SJI specifications listed in IBC Section 2207.1	1705.2.3
2) Bridging that differs from the SJI specifications listed in Section 2207.1		X				

[d] Where applicable, see also IBC Section 1705.12, Special Inspections for seismic resistance

2. SCHEDULE OF SPECIAL INSPECTIONS—CONCRETE CONSTRUCTION (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Inspect reinforcement, including prestressing tendons, and verify placement		X			ACI 318: Ch 20, 25.2, 25.3, 26.6.1-26.6.3	1705.3, 1908.4
2. Reinforcing bar welding:					AWS D1.4, ACI 318: 26.6.4	1705.3
a. Verify weldability of reinforcing bars other than ASTM A706		X				
b. Inspect single-pass fillet welds, maximum 5/16”		X				
c. Inspect all other welds	X					
3. Inspect anchors cast in concrete		X			ACI 318: 17.8.2	1705.3
4. Inspect anchors post-installed in hardened concrete members [f]:	X	X			ACI 318:17.8.2.4, ACI 318: 17.8.2	1705.3
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads						
b. Mechanical anchors and adhesive anchors not defined in 4. a						
5. Verify use of required design mix		X			ACI 318: Ch 19, 26.4.3, 26.4.4	1705.3, 1904.1, 1904.2, 1908.2, 1908.3
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete	X				ASTM C172, ASTM C31, ACI 318: 26.5, 26.12	1705.3, 1908.10
7. Inspect concrete and shotcrete placement for proper application techniques	X				ACI 318: 26.5	1705.3, 1908.6, 1908.7, 1908.8
8. Verify maintenance of specified curing temperature and techniques		X			ACI 318: 26.5.3-26.5.5	1705.3, 1908.9
9. Inspect formwork for shape, location, and dimensions of the concrete member being formed		X			ACI 318: 26.11.1.2(b)	1705.3

[e] Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance.

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
[f] Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.						

3. SCHEDULE OF SPECIAL INSPECTIONS—DEEP FOUNDATION ELEMENTS (IBC 2018)

Inspection Task	Frequency		Applicable to project		IBC Reference
	CONT	PER	Y/N	Agent	
1. Driven deep foundation elements:					
a. Verify element materials, sizes and lengths comply with the requirements	X				
b. Determine capacities of test elements and conduct additional load tests, as required	X				
c. Inspect driving operations and maintain complete and accurate records for each element	X				1705.7
d. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element	X				
e. Steel elements					1705.7, 1705.2
f. Concrete elements and concrete-filled elements					1705.7, 1705.3
g. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge (Engineer)					1705.7
2. Cast-in-place deep foundation elements:					
a. Inspect drilling operations and maintain complete and accurate records for each element	X				
b. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes	X				1705.8

c. Concrete elements					1705.8, 1705.3
3. Helical pier foundations. Information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the Engineer. Approved geotechnical report and Contract Documents shall be used to determine compliance.	X				1705.9

4. SCHEDULE OF SPECIAL INSPECTIONS—PRECAST CONCRETE CONSTRUCTION (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference[g]
	CONT	PER	Y/N	Agent		
1. Inspect prestressed concrete for:	X				ACI 318: 26.10	1705.3
a. Application of prestressing forces						
b. Grouting of bonded prestressing tendons						
2. Inspect erection of precast concrete members		X			ACI 318: 26.9	1705.3
3. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.		X			ACI 318: 26.11.2	1705.3
[g] Where applicable, see IBC Section 1705.12, Special Inspections for seismic resistance						

5. SCHEDULE OF SPECIAL INSPECTIONS—MASONRY CONSTRUCTION – LEVEL 2 QUALITY ASSURANCE (IBC 2018)

Minimum Verification	Applicable to project		Reference Standard		IBC Reference
	Y/N	Agent	TMS 402	TMS 602	
Prior to construction, verification of compliance of submittals				Art. 1.5	1705.4
Prior to construction, verification of f'_m, except where specifically exempted by the Code				Art. 1.4B	
During construction, verification of slump flow and Visual Stability Index (VSI) when self-consolidating grout is delivered to the project site				Art. 1.5, 1.6.3	

Minimum Special Inspection							
Inspection Task	Frequency		Applicable to project		Reference Standard		IBC Reference
	CONT	PER	Y/N	Agent	TMS 402	TMS 602	
1. As masonry construction begins, verify that the following comply:							1705.4
a. Proportions of site-prepared mortar		X				Art. 2.1, 2.6A, 2.6C	
b. Grade, type and size of reinforcement, connectors, and anchor bolts		X				Art. 3.4, 3.6A	
c. Sample panel construction		X				Art. 1.6C	
2. Prior to grouting, verify that the following comply:							
a. Grout space		X				Art. 3.2D, 3.2F	
b. Placement of reinforcement, connectors, and anchor bolts		X			Sec. 6.1, 6.3.1, 6.3.6, 6.3.7	Art. 3.2E, 3.4	
c. Proportions of site-prepared grout		X				Art. 2.6B, 2.4 G.1.b	

Minimum Special Inspection							
Inspection Task	**Frequency**		**Applicable to project**		**Reference Standard**		**IBC Reference**
	CONT	**PER**	**Y/N**	**Agent**	**TMS 402**	**TMS 602**	
3. Verify compliance of the following during construction:							1705.4
a. Materials and procedures with the approved submittals		X				Art. 1.5	1705.4
b. Placement of masonry units and mortar joint construction		X				Art. 3.3B	
c. Size and location of structural members		X				Art. 3.3F	
d. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction		X			Sec. 1.2.1(e), 6.2.1, 6.3.1		
e. Welding of reinforcement	X				Sec. 6.1.6.1.2		
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F)		X				Art. 1.8C, 1.8D	
g. Placement of grout complies	X					Art. 3.5, 3.6C	
4. Observe preparation of grout specimens, mortar specimens, and/or prisms		X				Art. 1.4B.2.a.3, 1.4B.2.b.3, 1.4B.2.c.3, 1.4B.3, 1.4B.4	1705.4

6. SCHEDULE OF SPECIAL INSPECTIONS—MECHANICAL AND ELECTRICAL COMPONENTS (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Observe anchorage of electrical equipment for emergency and standby power systems in structures assigned to SDC C, D, E or F		X				1705.12.6
2. Observe anchorage of other electrical equipment in structures assigned to SDC E or F		X				1705.12.6
3. Observe installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to SDC C, D, E or F		X				1705.12.6
4. Observe installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to SDC C, D, E or F		X				1705.12.6
5. Observe installation and anchorage of vibration isolation systems in structures assigned to SDC C, D, E or F where the approved construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint		X				1705.12.6
6. Observe installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed in structures assigned to SDC C, D, E or F to verify one of the following:		X				1705.12.6
a. Minimum clearances have been provided as required by Section 13.2.3 ASCE 7.						
b. A nominal clearance of not less than 3 inches has been provided between fire protection sprinkler system drops and sprigs and: structural members not used						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems' piping.						
c. Where flexible sprinkler hose fittings are used, special inspection of minimum clearances is not required.						1705.12.6
7. Observe anchorage of storage racks that are 8 feet or greater in height in structures assigned to SDC D, E or F		X				1705.12.7
8. Observe seismic isolation systems in seismically isolated structures assigned to SDC B, C, D, E or F during the fabrication and installation of isolator units and energy dissipation devices		X				1705.12.8

7. SCHEDULE OF SPECIAL INSPECTIONS—ARCHITECTURAL COMPONENTS (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Observe erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior veneer in structures assigned to SDC D, E or F. **Exceptions:**		X				1705.12.5
a. Exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer 30 feet or less in height above grade or walking surface						
b. Exterior cladding and interior and exterior veneer weighing 5 psf or less						
c. Interior nonbearing walls weighing 15 psf or less						
2. Observe anchorage of access floors in structures assigned to SDC D, E or F.		X				1705.12.5.1
3. Sprayed fire-resistant materials:		X				1705.14
a. Special inspection shall be based on the fire-resistance design as designated in the approved construction documents and shall comply with requirements of 1705.14.1 through 1705.14.6. Special inspections and tests shall include the following:						
1) Condition of substrates						
2) Thickness of application						
3) Density in pounds per cubic foot						
4) Bond strength adhesion/cohesion						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
5) Condition of finished application						
4. Mastic and intumescent fire-resistant coatings:		X				1705.15
a. Special inspections shall be based on the fire-resistance design as designated in the approved construction documents						
5. Exterior Insulation and finish systems (EIFS):		X				1705.16
a. Special inspections are required for all EIFS applications. Exceptions:						
1) EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior						
2) EIFS applications installed over masonry or concrete walls						
b. A water-resistive barrier coating complying with ASTM E2570 requires special inspection of the water-resistive barrier coating where installed over a sheathing substrate						
6. Smoke control:		X				1705.18
a. Test scope shall be as follows:						
1) During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location						
2) Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
detection and control verification						

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
7. Fire-resistant penetrations and joints:		X				
a. In buildings assigned to Risk Category III or IV, special inspections for through-penetrations, membrane penetration firestops, fire-resistant joint systems, and perimeter fire barrier systems that are tested and listed in accordance with IBC Section 714.4.1.2, 714.5.1.2, 715.3 and 715.4 shall be in accordance with Section 1705.17.1 or 1705.17.2						1705.17

8. SCHEDULE OF SPECIAL INSPECTIONS—SOILS (IBC 2018)

Inspection Task	Frequency		Applicable to project		Reference Standard	IBC Reference
	CONT	PER	Y/N	Agent		
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity		X				1705.6
2. Verify excavations are extended to proper depth and have reached proper material		X				
3. Perform classification and testing of compacted fill materials		X				
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill	X					
5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly		X				

9. Special Inspections Agency Contact Information:

1.

2.

3.

4.

STATEMENT OF SPECIAL INSPECTIONS

PROJECT: _____

LOCATION: _____

PERMIT APPLICANT: _____

APPLICANT'S ADDRESS: _____

ARCHITECT OF RECORD: _____

STRUCTURAL ENGINEER OF RECORD: _____

MECHANICAL ENGINEER OF RECORD: _____

ELECTRICAL ENGINEER OF RECORD: _____

REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE: _____

This Statement of Special Inspections is submitted in accordance with Section 1704 of the International Building Code. It shall be considered in conjunction with the Schedule of Special Inspections included in this Specification Section 01450. If applicable, it includes *Requirements for Seismic Resistance and/or Requirements for Wind Resistance*.

Are Requirements for Seismic Resistance included in the Statement of Special Inspections? ☐ Yes ☐ No

Are Requirements for Wind Resistance included in the Statement of Special Inspections? ☐ Yes ☐ No

The Special Inspector(s) shall keep detailed records of all inspections, including a copy at the jobsite. All records shall be available upon request by the Engineer or the Building Official. Any discrepancies shall be brought to the immediate attention of the Contractor. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Engineer prior to completion of that phase of work. The Special Inspections Agency shall furnish Interim Reports to the Building Official and to the Engineer at the frequency indicated in the Statement of Special Inspections. A Final Report shall be submitted to the Building Official and the Engineer at the time agreed upon by the Owner and the Building Official.

Frequency of Interim Report submittals to the Building Official:

___ Weekly ___ Bi-Weekly ___ Monthly Other; specify:_____

Frequency of Interim Report submittals to the Engineer:

___ Weekly ___ Bi-Weekly ___ Monthly Other; specify:_____

Special Inspections do not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

Statement of Special Inspections Prepared by:

Registered Design Professional's Seal

_____
Type or print name

_____
Signature Date

Building Official's Acceptance:

Type or print name

Signature Date

STATEMENT OF SPECIAL INSPECTIONS

REQUIREMENTS FOR SEISMIC RESISTANCE

See the Schedule of Special Inspections for inspection and testing requirements.

Seismic Design Category: _____

Statement of Special Inspection for Seismic Resistance Required (Yes/No): _____

Description of seismic force-resisting system subject to special inspection and testing for seismic resistance:

Description of designated seismic systems in accordance with Chapter 13 of ASCE 7 subject to special inspection and testing for seismic resistance. Special inspector shall verify that the label, anchorage and mounting of these systems conforms to the Contract Documents and Approved Submittals:

Description of additional seismic systems and components requiring special inspections:

Description of additional seismic systems and components requiring testing:

Statement of Responsibility:

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

STATEMENT OF SPECIAL INSPECTIONS

REQUIREMENTS FOR WIND RESISTANCE

See the Schedule of Special Inspections for inspection and testing requirements.

Basic Wind Speed (3 second gust): _____ m.p.h.

Wind Exposure Category: _____

Statement of Special Inspection for Wind Resistance Required (Yes/No): _____

Description of main wind force-resisting system subject to special inspection for wind resistance:

Description of wind force-resisting components subject to special inspection for wind resistance:

Statement of Responsibility:

Each Contractor responsible for the construction or fabrication of a system or component described above must submit a Statement of Responsibility.

INTERIM REPORT OF SPECIAL INSPECTIONS

City/County of:							
Project Name/Address:				**Inspection Type(s) Coverage:**			
				☐ **Continuous**		☐ **Periodic**	
Describe Inspections Made, Including Locations:							
Tests Made:							
Total Inspection Time Each Day	**Date:**						
	Hours:						
List items requiring Special Inspection, and any discrepancies and corrections. If Engineer approval is required for any corrections, note this, and indicate that approval was obtained. Attach copies of all related correspondence.							
Comments:							

To the best of my knowledge, work inspected was in accordance with the Contract Documents and applicable standards except as noted above.

Signed: _____ Date: _____

Print Full Name: _____ I.D.: _____

Phone Number: _____

This report is to be submitted to the Building Official and the Engineer. A copy shall be maintained at the jobsite.

FINAL REPORT OF SPECIAL INSPECTIONS

PROJECT: _____

LOCATION: _____

PERMIT APPLICANT: _____

APPLICANT'S ADDRESS: _____

_____

ARCHITECT OF RECORD: _____

STRUCTURAL ENGINEER OF RECORD: _____

MECHANICAL ENGINEER OF RECORD: _____

ELECTRICAL ENGINEER OF RECORD: _____

REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE: _____

To the best of my information, knowledge, and belief, Special Inspections required for this Project in accordance with Section 1704 of the International Building Code and any State or local amendments have been performed, and all work has been completed in accordance with the Contract Documents and all applicable standards, except as indicated.

The Special Inspection program does not relieve the Contractor of the obligation to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

This Final Report includes information submitted in previous Interim Reports numbered _____ to _____, as well as any Special Inspections, discrepancies, and corrections occurring since the last Interim Report, dated _____.

All items requiring Special Inspection are listed below. All inspections, tests, and similar services that were performed are listed and any discrepancies and corrections are indicated. If Engineer approval was required for any corrections, this is noted, and copies of all related correspondence are attached.

_____

_____

_____

_____

_____

_____

(Attach 8 ½"x11" continuation sheet(s) if required to complete the description of corrections)

Prepared By:

Special Inspector's Seal

_____

Special Inspection Agency:

_____

Type or print name

Signature Date

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

Each Contractor responsible for the construction or fabrication of a main-wind- or seismic-force-resisting system, designated seismic system, or a wind- or seismic-resisting-component listed in the Statement of Special Inspections must submit this Statement of Responsibility prior to commencement of work on the system or component.

Project: _____

Contractor's Name: _____

Address: _____

License No.: _____

Description of building systems and components included in Statement of Responsibility:

_____

_____

_____

_____

_____

_____

_____

Contractor's Acknowledgement of Special Requirements

I hereby acknowledge that I have received, read, and understand the Statement of Special Inspections and its requirements.

_____
Name and Title (type or print)

_____ _____
Signature Date

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per Section 1704 of the International Building Code must submit this Fabricator's Certificate of Compliance at the completion of fabrication.

Project: _____

Fabricator's Name: _____

Address: _____

Description of structural members and assemblies that have been fabricated:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

I hereby certify that items described above were fabricated on my premises in strict accordance with the Contract Documents and applicable standards.

_____
Name and Title (type or print)

_____ _____
Signature Date

Attach copy of Building Official's approval of fabricator as an Approved Fabricator.

NOTIFICATION OF FAILURE TO CORRECT DISCREPANCY

City/County of:
Project Name/Address:
List discrepancies, proposed correction, and Contractor response. If Engineer approval is required for any corrections, note this, and indicate whether approval was obtained. Attach copies of all related correspondence.
Comments:

Signed: _____ Date: _____

Print Full Name: _____ I.D.: _____

Phone Number: _____

This report is to be submitted to the Building Official, the Contractor, and the Engineer.

END OF SECTION

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SECTION 01470

WATERTIGHTNESS TESTING OF CONCRETE STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. It is the intent of these Specifications that all concrete work and sealing work around built-in items and penetrations be performed as required to insure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe galleries, habitable areas or other generally dry areas.

B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.

C. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source.

D. All water holding structures shall be tested for leakage by the Contractor. The Contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01400 – Quality Control

B. Section 03300 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ACI 350.1-10 - Specification for Tightness Testing of Environmental Engineering Concrete Structures

1.04 SUBMITTALS

A. Testing procedures shall be submitted for approval prior to the test.

B. Testing Report: Prior to placing the structure in service, submit for review and approval a detailed bound report summarizing the watertightness test data, describing the testing procedure and showing the calculations on which the test data is based.

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PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 TEST PREPARATION

A. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic tightness testing without approval of the Engineer.

B. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.

C. Unless otherwise specified, coatings shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies (pinholes, tears and partially fused splices) and must pass integrity testing. Deficiencies shall be prepared.

D. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water in or outside of the structure that would interfere with the inspection of the exposed concrete surfaces of the structure shall be removed.

E. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage shall be repaired before filling the containment structure with water.

F. All openings, fittings, and pipe penetrations in the structure shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing. All structural penetrations and inlet/outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the watertightness of these appurtenances. If the structure is to be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving through this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage

G. The flow from any underdrain system, if a system is provided, shall be monitored during this same period, and any increase in flow shall be recorded and considered for information as a part of the hydrostatic tightness testing.

H. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.

I. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

3.02 PROCEDURE

A. The initial filling of a new structure should not exceed a rate of 4 ft/h. Filling shall be continued until the water surface is at the design maximum liquid level, or either 1 in. below any fixed overflow level in covered containment structure or 4 in. in open structure, whichever is lower.

B. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.

C. Watertightness Test - Part 1: Qualitative Criteria

1. The water shall be kept at the test level for at least 3 days prior to Part 2 of the testing.

2. The exterior surfaces of the structure shall be observed in both the early mornings and later afternoons during the 3-day period before Part 2 of the test. If any water is observed on the structure exterior surfaces, including joints, repaired honeycombed areas and cracks, where moisture can be picked up on a dry hand, the containment structure shall be considered to have failed Part 1 of the test.

3. Wet areas on top of wall footing shall not be cause to fail Part 1 of the test unless the water can be observed to be flowing.

4. Part 2 of the test may begin prior to completion of repairs for Part 1. However, all defects causing the failure of Part 1 shall be repaired before the structure is accepted.

D. Watertightness Test - Part 2: Quantitative Criteria

1. The test measurements shall not be scheduled for a period when the forecast is for a difference of more than 35°F between the ambient temperature readings at the times of the initial and final level measurements of the water surface. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed.

2. The vertical distance to the water surface shall be measured to within 1/16 in. from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals. Measurements taken at the same time of day will reduce the probability of temperature difference.

3. Measurements shall be taken at two locations, 180° apart, which will minimize the effect of differential settlement. Measurements shall be taken at the same locations to reduce the probability of measurement differences.

4. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.

5. The water temperature shall be recorded at a depth of 18 in. below the water surface at the start and end of the test.

6. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals. Determination of evaporation by a shallow pan-type measuring device is not acceptable due to possible heating of the bottom of the shallow pan resulting in accelerated evaporation.

3.03 EVALUATION

A. The containment structure shall continue to be observed in both the early mornings and late afternoons to verify compliance with Part 1 of the test during Part 2.

B. At the end of the test period, the water surface shall be recorded to within 1/16-in at the location of original measurements. The water temperature and the evaporation and precipitation measurements shall be recorded.

C. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.

D. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test.

E. During Part 2 of the test, observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. The structure shall also be considered to have failed the test if moisture can be transferred from the exterior surface to a dry hand. Dampness or wetness on top of a footing shall not be considered as a failure test.

3.04 RETESTING

A. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other external factors.

B. The Contractor shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.

C. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.

D. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

3.05 NOTIFICATION BY ENGINEER

A. If any leaks, in excess of the specified amount, are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the General Contractor.

- END OF SECTION -

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SECTION 01510

TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The General Contractor shall provide temporary light and power, heating, water service and sanitary facilities for his operations, for the construction operations of the other Contractors of this Project at the site. The temporary services shall be provided for use throughout the construction period.

B. The General Contractor shall coordinate and install all temporary services in accordance with the requirements of the utility companies having jurisdiction and as required by applicable codes and regulations.

C. At the completion of the work, or when the temporary services are no longer required, the facilities shall be restored to their original conditions.

D. All costs in connection with the temporary services including, but not limited to, installation, utility company service charges, maintenance, relocation and removal shall be borne by the Contractor at no additional cost to the Owner.

E. Some temporary facilities that may be required may be indicated on the Drawings; however, the Drawings do not necessarily show any or all of the temporary facilities that the Contractor ultimately uses to complete the work.

F. Temporary Light and Power

1. The temporary general lighting and small power requirements shall be serviced by 120/240 V, 1 phase, 3 wire temporary systems furnished and installed by the General Contractor. This service shall be furnished complete with main disconnect, overcurrent protection, meter outlet, branch circuit breakers, and wiring as required; including branch circuit breakers and wiring as required for furnishing temporary power to the various Contractor's field office service connections, all in accordance with the requirements of the servicing power company and applicable standards and codes. The meter for the temporary 120/240 V service for construction purposes shall be registered in the name of the General Contractor and all energy charges for furnishing this temporary electric power shall be borne by the General Contractor. Any Contractor with a need for power other than the 120/240 V, 1 phase, 3 wire shall provide such power at his own expense.

2. The General Contractor shall make all necessary arrangements, and pay for all permits, inspections, and power company charges for all temporary service installations. All temporary systems shall comply with and meet the approval of the local authorities having jurisdiction. All temporary electrical systems shall

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consist of wiring, switches, necessary insulated supports, poles, fixtures, sockets, receptacles, lamps, guards, cutouts, and fuses as required to complete such installations. The General Contractor shall furnish lamps and fuses for all temporary systems furnished by him and shall replace broken and burned out lamps, blown fuses, damaged wiring and as required to maintain these systems in adequate and safe operating condition. All such temporary light and power system shall be installed without interfering with the work of the other Contractors.

When it is necessary during the progress of construction that a temporary electrical facility installed under this Division interferes with construction operations, the General Contractor shall relocate the temporary electrical facilities to maintain temporary power as required at no additional cost to the Owner. The General Contractor shall be responsible at all times for any damage or injury to equipment, materials, or personnel caused by improperly protected or installed temporary installations and equipment.

3. The various Contractors doing the work at the site shall be permitted to connect into the temporary general lighting system small hand tools, such as drills, hammers, and grinders, provided that:

   a. Equipment and tools are suitable for 120 V, single phase, 60 Hz operation and operating input does not exceed 1,500 volt-amperes.

   b. Tools are connected to outlets of the system with only one (1) unit connected to a single outlet.

   c. In case of overloading of circuits, the General Contractor will restrict use of equipment and tools as required for correct loading.

4. The General Contractor shall keep the temporary general lighting and power systems energized fifteen minutes before the time that the earliest trade starts in the morning and de-energized fifteen minutes after the time the latest trade stops. This applies to all weekdays, Monday through Friday, inclusive, which are established as regular working days.

   Any Contractor requiring temporary light and power before or after the hours set forth hereinbefore, or on a Saturday, Sunday, or holiday, shall pay for the additional cost of keeping the system energized and repaired. If more than one Contractor is involved, the charges shall be prorated, such amounts to be determined from the meter readings or other acceptable means previously agreed upon by the Contractors involved. If it is necessary for any Contractor or his employees to be in any structure after regular working hours and the temporary general lighting system is not required for illumination, that Contractor shall provide such illumination required by means of flashlights, electric lanterns, or other devices not requiring use of electricity from the temporary general lighting system.

5. Each Contractor requiring additional power and lighting other than that specified herein (including power for temporary heating equipment to be provided by the General Contractor) shall furnish his own service complete with all fuses, cutouts, wiring and other material and equipment necessary for a complete system

between the service point and the additional power consumers and shall install his own metering equipment in accordance with the requirements of the servicing power company.

6. The temporary general lighting system shall be installed progressively in structures as the various areas are enclosed or as lighting becomes necessary because of partial enclosure. Lighting intensities shall be not less than 10 foot candles.

7. The General Contractor shall provide a separate temporary night lighting circuit for construction security. This system shall be energized at the end of each normal working day and de-energized at the start of each normal working day by the General Contractor. The system is to be left energized over Saturdays, Sundays, and all holidays. Lighting intensities shall be not less than 2 foot candles.

8. Electrical welders provided by each trade used in the erection and fabrication of the buildings, structures and equipment shall be provided with an independent grounding cable connected directly to the structure on which the weld is being made rather than adjacent conduit piping, etc.

   Electricians and other tradesmen necessary for the required connections and operation of welding equipment and generator, standby generators and similar equipment shall be furnished by the individual Contractors. All costs for such labor and equipment shall be borne by the individual Contractors.

9. Upon completion of the work, but prior to acceptance by the Owner, the General Contractor shall remove all temporary services, security lighting systems, temporary general lighting systems and all temporary electrical work from the premises.

G. Temporary Heating

1. The General Contractor shall provide temporary heating, ventilation coverings and enclosures necessary to properly protect all work and materials against damage by dampness and cold, to dry out the work and to facilitate work in all structures.

2. The equipment, fuel, materials, operating personnel and methods used shall be at all times satisfactory and adequate to maintain critical installation temperatures and ventilation for all work in those areas where the same is required.

3. After any structure is enclosed, the minimum temperature to be maintained is 50°F, unless otherwise specified, where work is actually being performed.

4. Before and during the application of interior finishing, painting, etc., the General Contractor shall provide sufficient heat to maintain a temperature of not less than 65°F.

5. Any work damaged by dampness or insufficient or abnormal heating shall be replaced by the General Contractor at no additional cost to the Owner.

H. Temporary Sanitary Service

1. Sanitary conveniences, in sufficient numbers, for the use of all persons employed on the work and properly screened from public observation, shall be provided and maintained at suitable locations by the General Contractor, all as prescribed by State Labor Regulations and local ordinances. The contents of same shall be removed and disposed of in a manner consistent with local and state regulations, as the occasion requires. Each Contractor shall rigorously prohibit the committing of nuisances within, on, or about the work. Sanitary facilities shall be removed from the site when no longer required.

I. Temporary Water

1. The General Contractor shall provide temporary water service for construction purposes, sanitary facilities, fire protection, field offices and for cleaning. The Contractor shall make all arrangements for connections to the potable water at the plant site.

   The Contractor shall pay all charges associated with the connection and all charges for potable water used under this Contract.

2. Each Contractor shall supply potable water for his employees either by portable containers or drinking fountains.

3. An adequate number of hose bibbs, hoses, and watertight barrels shall be provided for the distribution of water.

4. Water service shall be protected from freezing and the service shall be extended and relocated as necessary to meet temporary water requirements.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01520

MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The existing plant will be maintained in continuous operation by the Owner during the entire construction period of all Contracts as hereinafter specified. The intent of this section is to outline the minimum requirements necessary to allow the Owner to continuously operate and maintain the treatment facility in order to remain in compliance with all permit requirements.

B. Work under each Contract shall be scheduled and conducted by each Contractor so as not to impede any treatment process, reduce the quality of the plant effluent or cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the Contractor shall plan and schedule his work to meet the plant and transmission system operating requirements, and the constraints and construction requirements as outlined in this Section. No transmission of inadequately treated water shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any discharge of inadequately treated water associated with the Contractor's work.

C. The General Contractor shall be responsible for coordinating the general construction and electrical, HVAC and plumbing construction schedules and for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.

D. The Contractor has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without cost to the Owner and provided that all requirements of these Specifications are fulfilled. The Contractor shall submit any such plan for providing additional temporary facilities to eliminate a constraint to the PM for review. Such plans must be approved by the Engineer and Owner prior to the Contractor proceeding. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.

1.02 GENERAL CONSTRAINTS

A. The Contractor shall schedule the Work so that the plant is maintained in continuous operation. All treatment processes shall be maintained in continuous operation during the construction period except during approved process interruptions. All short-term system or partial systems shutdowns and diversions shall be approved by the Engineer. Long-term process shutdowns and diversions shall conform to the requirements hereinafter specified and shall be minimized by the Contractor as much as possible. If in the judgement of the Engineer a requested shutdown is not required for the Contractor to

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perform the Work, the Contractor shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the Owner. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period shall commence at a time approved by the Owner, and the Contractor shall proceed with the Work continuously, start to finish, until the Work is completed and normal plant operation is restored. If the Contractor completes all required Work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service.

B. The Contractor shall schedule short-term and long-term shutdowns in advance and shall present all desired shutdowns in the 30 and 60-day schedules at the progress meetings (see Section 01200). Shutdowns shall be fully coordinated with the Plant Superintendent at least 1 week before the scheduled shutdown. Owner personnel shall operate Owner's facilities involved in the short-term and long-term shutdowns and diversions.

C. Short term shutdowns in plant flow will be allowed for tie-ins to existing facilities, installation of temporary bulkheads, etc. All such shutdowns shall be scheduled for week-end low-flow periods and shall be limited to less than two (2) hours depending on incoming flow rate and storage volume in the treatment and storage system. Any shutdown of two (2) hours or longer duration shall be defined as a long-term shutdown. The Contractor shall provide appropriate diversion facilities to be approved by the Owner, and at no additional cost to the Owner, when the plant cannot be shut down for a sufficient long time to accomplish the required work. The Contractor may be allowed additional time for short-term interruptions if he can demonstrate to the Owner and Engineer that the collection system will not surcharge or overflow during the requested shutdown period. Duration of short-term interruptions allowed will depend on prevailing water demands. The schedule and duration of short-term shutdowns shall be at the discretion of the Owner.

D. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the Contractor's work limits to maintain continuous and dependable plant operation shall be furnished by the Contractor at the direction of the Engineer at no extra cost to the Owner.

E. The Owner shall have the authority to order Work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the plant operations.

F. If the contractor impairs performance or operation of the plant as a result of not complying with specified provisions for maintaining plant operations, then the contractor shall immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the Engineer. Such work shall progress continuously to completion on a 24-hours per day, seven work days per week basis.

G. The Contractor shall provide the services of emergency repair crews on call 24-hours per day to affect repairs to portions of the plant affected by the Contractor’s operations.

1.03 GENERAL OPERATING REQUIREMENTS, CONSTRAINTS, AND CONSTRUCTION REQUIREMENTS

A. Access to Plant Site, Roadways, and Parking Areas

1. An unobstructed traffic route through the Main Gate shall be maintained at all times for the Owner's operations personnel and maintenance equipment. Parking for personal vehicles of construction personnel shall not be allowed within the fence of the treatment plant. Construction personnel may park on City property outside the
plant fence in areas approved by the Engineer. The General Contractor shall be responsible for providing access to and for preparing and maintaining/approved parking areas.

2. An unobstructed traffic route around the plant site shall be maintained at all times for the Owner's operations personnel and maintenance equipment. Vehicular access to the treatment units and buildings for Owner personnel shall be maintained at all times by the Contractor.

3. The Contractor shall provide temporary measures to protect the existing pavement by filling over with earthen material or supplying other measures acceptable to the Engineer, and he shall repair any damage to existing paved surfaces that occurs during the construction period. Any areas disturbed along the shoulders of the access road and interior roads and elsewhere inside and outside of the plant shall be repaired, graded, seeded, etc. as necessary to match pre-existing conditions.

4. The General Contractor shall not undertake the restoration/construction of new roadway (paved, gravel, or asphalt overlay) shown on the Contract Drawings, until all other work on the plant improvements has been completed.

B. Personnel Access

1. Treatment plant personnel shall have access to all areas which remain in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as directed by the Engineer to maintain personnel access to areas in operation. Access and adequate parking areas for plant personnel must be maintained throughout construction.

C. Plumbing Facilities

1. Unless otherwise allowed by the Engineer, sanitary facilities in the existing structures shall be operational at all times for plant operating personnel. All other building plumbing systems such as roof and floor drains, pumping, etc., shall be maintained for all structures.

D. Building Heating and Ventilating

1. Building heating and ventilating for the existing plant structures shall be in service for the entire construction period. Additional temporary heating and ventilation shall be provided as required to maintain facilities under construction adequately heated and vented. The temperatures to be maintained in any areas occupied by plant operating personnel such as offices, lunchrooms, locker rooms, bathrooms, etc., shall be at least 65°F. The temperatures to be maintained in all other interior plant areas, whether new, existing or temporary, shall be maintained at a minimum of 55°F.

E. Power, Light and Communications Systems (General)

1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement, but service shall be available at all times including periods when plant elements are out of service. Shutdown of electrical facilities shall be limited to not more than five (5) hours. The Owner may allow longer outages under conditions determined by the Owner by making use of the existing and/or the proposed engine-generator at the plant. All costs associated with operation of the engine-generators shall be paid by the Contractor. The Electrical Contractor shall coordinate shutdowns required with the General Contractor to minimize the total number of shutdowns required to complete construction. Owner's phone service to the plant shall be maintained in continuous operation during construction.

F. Draining Process Pipes and Conduits (General)

1. The contents of all pipes and conduits to be removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the Owner through hoses or piping, or by using pumps if hydraulic conditions so require them. The Contractor shall provide the pumps, piping and hoses at no additional cost to the Owner. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed into the appropriate process flow train.

G. Potable Water System

1. Potable water service shall be maintained in continuous service at all times during construction except for short term interruptions required for tie-ins. Shutdown of the potable water system shall be fully planned and coordinated with the Plant Superintendent and shall be limited to not more than two (2) hours. Existing fire hydrants within the plant site shall be operational at all times, unless otherwise approved by the Owner.

H. Non-potable Water System

1. The existing non-potable water service shall be maintained in continuous operation during construction except for short term tie-ins of new or temporary facilities to existing facilities, until the new system is brought into service. Temporary

non-potable service for the chlorine and pump seal water systems shall be provided by the Contractor as necessary to insure continuous, uninterrupted service of these critical systems. The Contractor shall furnish any required temporary non-potable water systems at no additional cost to the Owner. The Contractor may require temporary support or relocation or demolition of existing non-potable water facilities to proceed with construction. The Contractor shall provide all temporary supports, relocation of existing piping, or demolition of existing non-potable water piping including placement with temporary or permanent non-potable water piping as required at no additional cost to the Owner. Shutdown of the non-potable water system shall be fully coordinated with the Plant Superintendent and shall be limited to not more than five (5) hours.

I. Sump Pumps and Sumps

1. All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps. Interim piping, power and controls shall be provided as required by the staged construction sequence.

J. Seal Water and Service Water Piping

1. A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction. Interim piping shall be provided as required.

1.04 SPECIFIC OPERATIONAL CONSTRAINTS

A. The respective Contractors shall schedule the work for the following based on the constraints given in such a manner as to maintain the water treatment plant in continuous operation to the extent possible. Contractors shall schedule and coordinate all work items with the Owner and Engineer prior to commencing any construction-related activities. Unless otherwise noted or approved by the Owner and Engineer, all full plant shutdowns shall be limited to no more than twelve (12) hours, unless otherwise stated, and shall not be allowed during high flow months defined as April – October. Low flow months are defined as November – March. Contractor shall be fully responsible for any dewatering efforts associated with the work activities further detailed below and shall provide dewatering measures at no additional costs to the Owner.

B. P.O. Hoffer Water Treatment Facility

1. Raw Water Intake Air Compressor – Air Burst System Replacement (Drawings M100 and M104)

a. This work item pertains to the replacement of the air compressor system serving the existing air burst system used to clean the raw water intake screens and the pump control valves at the P.O. Hoffer Raw Water Pump Station.

b. During the replacement effort, the Owner shall utilize the existing Glenville Lake Raw Water Pump Station to convey raw water to the P.O. Hoffer Water Treatment Plant. Contractor shall coordinate with the Owner

approximately two (2) weeks in advance of the scheduled replacement effort to allow the Owner adequate time to prepare the Glenville Lake Raw Water Pump Station for this temporary pumping scenario.

c. Contractor shall complete air compressor system replacement within ten (10) working days.

2. New Powdered Activated Carbon Facility and Feed Piping (Drawings M3 – M4 and M200 – M250)

a. This work item pertains to the installation of the new powdered activated carbon (PAC) facility and associated feed piping.

b. Plant shutdowns should not be required for construction of the PAC Facility, PAC Feed Manhole, and chemical ductbanks or for installation of the new raw water flow meters and chemical injectors in the Raw Water Pump Station.

c. The new PAC facility, feed manhole, chemical ductbanks and piping to application points, raw water flow meters, and chemical injectors shall be successfully tested and started up before the existing PAC feed system and associated piping are demolished.

3. Filtered Water Mixing Station (Drawings M2, M860 – M862)

a. The work item pertains to the construction of a new filtered water mixing station and the installation of two vertical mixers.

b. The Contractor shall coordinate with the Owner and Engineer to determine a duration of time when 4-MG Clearwell # 1 can be bypassed and drained. The Contractor shall then dewater the 54” FLW influent line to 4-MG Clearwell #1 as necessary and construct the filtered water mixing station except for the tie-in of the new 54” FLW piping running north and east of the mixing station.

c. The Contractor shall coordinate with the Owner and Engineer to isolate 4-MG Clearwell #2 to complete the tie-in of the new 54” FLW piping (i.e. 4-MG Clearwell #1 bypass) to the existing 54-inch FLW. Existing butterfly valves and the slide gate bypass at the 12 MG Clearwell Distribution Box shall be used to provide the necessary isolation to facilitate the tie-in. The existing 54-inch FLW piping shall be dewatered as necessary to complete the tie-in effort. All new piping and tie-in connections shall be pressure tested in accordance with Section 15000.

d. Upon completion of the mixing station and piping tie-ins, the station, valves piping, and 4-MG Clearwell #1 shall be disinfected as specified in Section 13450 and 15000.

e. The new filtered water mixing station bypass piping shall be completed within a single low flow season. This will allow the additional filtered water

mixing station work to continue into the high flow season without limiting use of both 4 MG clearwells

4. Finished Water Pumps No. 5 to 8 Butterfly Valve Replacement (Drawings M2 and M8)

    a. This work item pertains to the replacement of 48-inch and 30-inch isolation butterfly valves on the downstream side of Finished Water Pumps 5 to 8.

    b. Contractor shall be responsible for the design and implementation of an excavation support system to facilitate access to the buried valves for replacement efforts. Excavation support systems shall adhere to the requirements of Section 02200.

    c. Contractor shall coordinate with plant personnel as only the Owner shall close all pertinent valves in the finished water piping to provide the isolation necessary for completion of the valve replacement work.

    d. Valve replacement shall begin with Finished Water Pump 5 (west-most pump) and proceed eastward until work on all four pumps is complete. During replacement of each 48-inch finished water cross and 30" finished water piping and valve, no more than one pump shall be down at a time, with the exception of the shutdown window needed to complete the tie-in to the existing 30-inch finished water line on the north side of the cross. No more than two pumps shall be down during the replacement of each 48-inch finished water valve. Once a pump is initially taken out-of-service, the Contractor shall complete the demolition, installation, testing, and disinfection of the new valves and piping associated with that finished water pump and return the pump to the Owner for use prior to beginning work on the next pump's valves and piping.

    e. During completion of valve and piping replacement work, finished water pumping operations for pumps 5 through 8 shall avoid use of the southern-most high-pressure zone 48-inch finished water line until adequate curing of the new concrete thrust block.

    f. Valve and piping replacement for all four finished water pumps shall be completed within forty-four (44) working days.

    g. Use of each existing finished water pump shall be provided to the Owner immediately after the new valves and piping associated with this pump have been properly installed, tested and disinfected.

    h. New piping and valves shall be tested in accordance with Section 15000 before being placed into service.

    i. Prior to placing the new butterfly valves into service, proper disinfection procedures shall be performed in accordance with Section 13450.

    j. This valve replacement shall be completed during the low flow season with necessary shutdowns scheduled on the weekends. This will allow the

finished water pumps to continue to feed the distribution system during high flow season without limiting capacity.

k. This valve replacement work shall not be scheduled concurrently with the Finished Water Pump No. 1 Butterfly Valve replacement effort or removal of the 30-inch finished water valve located between the discharge of Finished Water Pump No. 2 and No. 3.

l. This work item shall be coordinated with the Finished Water Pump No. 6 and 8 upgrades to the extent possible to mitigate the time that these two pumps are unavailable to the Owner for use.

5. Finished Water Pump No. 1 Butterfly Valve Replacement (Drawings M2 and M8)

a. This work item pertains to the replacement of the 30-inch isolation butterfly valves on the downstream side of Finished Water Pump No. 1.

b. Contractor shall be responsible for the design and implementation of an excavation support system to facilitate access to the buried valve for replacement efforts. Excavation support systems shall adhere to the requirements of Section 02200.

c. Shutdown of Finished Water Pump No. 1 and Finished Water Pump No. 2 shall be required to begin the replacement effort after the excavation support system is in place. Plant personnel shall close all pertinent valves in the finished water piping to provide isolation of the valve. Contractor shall dewater the 42” FW and 30” FW pipes as necessary to facilitate the replacement effort.

d. Use of Finished Water Pump No. 1 shall be provided to the Owner immediately after the new valve and piping have been properly installed, tested and disinfected. Once Finished Water Pump No. 1 is taken off-line, the Contractor shall complete the installation, testing, and disinfection of the new valves and piping within five (5) working days.

e. New piping and valves shall be tested in accordance with Section 15000 before being placed into service.

f. Prior to placing the new butterfly valves into service, proper disinfection procedures shall be performed in accordance with Section 13450.

g. This valve replacement shall be completed during the low flow season with the necessary shutdown on the weekend. This will allow the finished water pumps to continue to feed the distribution system during high flow season without limiting capacity.

h. This valve replacement work shall not be scheduled concurrently with the Finished Water Pump No. 5 to 8 Butterfly Valve replacement effort or removal of the 30-inch finished water valve located between the discharge of Finished Water Pump No. 2 and No. 3.

6. 42” Finished Water Valve Removal (Drawings M2 and M8)

    a. This work item pertains to the removal of the 42-inch isolation butterfly located in the 42-inch header between the discharge piping of Finished Water Pumps No. 2 and No. 3.

    b. Contractor shall be responsible for the design and implementation of an excavation support system to facilitate access to the buried valve for removal efforts. Excavation support systems shall adhere to the requirements of Section 02200.

    c. Shutdown of Finished Water Pumps No. 1 – 3 shall be required to begin the replacement effort. Plant personnel shall close all pertinent valves in the finished water piping to provide isolation of the valve. Contractor shall dewater the 42” FW and 30” FW pipes as necessary to facilitate the removal effort.

    d. Use of the pumps shall be provided to the Owner immediately after valve removal and disinfection of the impacted finished water piping. Once the finished water pumps are taken off-line, the Contractor shall complete the removal, testing, and disinfection of the piping modifications within five (5) working days.

    e. Pressure testing shall be completed in accordance with Section 15000 before the finished water piping is placed into service.

    f. Prior to placing the finished water lines into service, proper disinfection procedures shall be performed in accordance with Section 13450.

    g. This valve removal effort shall not be scheduled concurrently with the Finished Water Pump No. 5 to 8 Butterfly Valve replacement effort or the Finished Water Pumps No. 1 Butterfly Valve Replacement

7. Electrical Building

    a. This work item pertains to the installation of the new Electrical Building with MVMCC-TF and SWBD-TF inside.

    b. Prior to beginning the upgrades to the new medium voltage motor control center that serves the finished water pumps and wash water pump, construction of the new Electrical Building shall be completed.

    c. Finished Water Pumps No. 1 – 8 shall be taken out-of-service one at a time and connected to their respective RVSS/VFD, successfully installed, tested and placed back into service prior to beginning work on the next pump and starter/drive assembly. Work on another pump shall not commence until the Owner has been provided use of the previously, upgraded pump.

d. Each pump shall be taken out-of-service for no longer than three (3) working days to complete the installation or relocation of starter/drive.

e. Starter relocation / drive installation for each pump shall be coordinated with the Finished Water Butterfly Valve replacement effort to mitigate multiple out-of-service events for each pump.

f. Pumps shall not be taken out-of-service during the high flow months to ensure adequate pumping capacity to the high-pressure zone of the distribution system.

g. Construction of the new Electrical Building shall be completed prior to beginning the Finished Water Pump upgrades.

C. Glenville Lake Water Treatment Facility

1. Filter Effluent Flow Control Valve Replacement

a. Filter valve replacement efforts shall be scheduled and coordinated with the Engineer and Owner.

b. Only one filter shall be removed from service at a time unless otherwise permitted by the Owner. All work associated with the individual valve replacement shall be completed prior to commencing work on a subsequent filter. While work is underway in an individual filter, all other filters shall remain in service.

c. All equipment used in the performance of the rehabilitation effort shall utilize food grade oil/lubricants meeting the requirements of NSF 61 for use in a potable water supply.

d. Upon completion of the replacement effort, the filter effluent piping shall be disinfected as specified in Section 15000.

e. Contractor shall coordinate replacement effort with the SCADA system control upgrades proposed for each filter to minimize downtime of the individual filters.

2. Chemical Ductbank Replacement

a. Chemical ductbank replacement efforts shall be scheduled and coordinated with the Engineer and Owner.

b. Contractor shall complete the extents of the ductbank replacement work necessary to facilitate the completed tie-in of all small diameter chemical and sample piping to the Flow Measurement and Chemical Injection Vault prior to commencing with tie-in efforts to the Chemical Injection Vault. Chemical feed and sample collection at the Chemical Injection Vault shall remain continuous through the completion of the tie-in effort at the Flow Measurement and Chemical Injection Vault. Likewise, chemical feed and sample collection at the

Flow Measurement Chemical Injection Vault shall remain continuous through the completion of the tie-in effort at the Chemical Injection Vault.

c. Shutdown of any individual chemical feed point shall be scheduled and coordinated approximately one (1) week in advance with both the Engineer and Owner to allow appropriate operational changes to be coordinated and implemented to ensure continuous disinfection practices of all finished water produced at the plant. Any plant shutdown needed to complete this replacement effort shall adhere to the requirements described above in 1.02.C above. Shutdowns shall not be permitted during the months of April through September, unless otherwise approved by the Owner and Engineer.

d. Existing chemical and sample piping to be abandoned in yard shall be flushed and capped/plugged.

e. All piping shall be adequately pressure tested prior to being placed into service meeting the testing requirements as specified in Section 15000. Likewise, sample piping shall be disinfected as specified in Section 15000 prior to being placed in to service.

3. SCADA System Upgrades

a. SCADA system upgrades shall be scheduled and coordinated with the Engineer and Owner.

b. Contractor shall develop a schedule for RTU replacement with I&C subcontractor, Owner, and Engineer. Unless otherwise approved by Owner, individual RTUs shall be upgraded sequentially with no more than one (1) RTU out of service at any time. The schedule shall allow a maximum of one (1) week for each RTU replacement with the exception of RTU-1 (two (2) weeks) to include general and electrical construction work, I&C subcontractor services, system testing, and startup. Individual RTUs may require additional time if recommended by I&C subcontractor, Owner, or Engineer.

c. Prior to replacement of the RTUs, new temporary SCADA system (VTScada) consisting of a new server and network switch shall be designed so that each new RTU system can be made available for the Owner to control and monitor process equipment after commissioning of that RTU.

d. RTU replacement work shall be in the following order:

i. RTU – 3 (Ammonia Building)

ii. RTU – 2 (Chemical Building)

iii. RTU – 4, 5, and 6 (Filter Gallery)

iv. RTU – 1 (Administration Building)

e. RTU Nos. 4, 5, and 6 require that work be performed by Contractor and the

I&C subcontractor to transition all signals from the filter valves, associated instrumentation, and the existing backwash supply loops when the new Filter RTUs are shipped to site to minimize downtime of the filters and to allow equipment to be operated manually / locally by Owner prior to removing existing signals from the existing filter consoles from service, installation of new PLCs, and general / electrical / I&C subcontractor work. Due to the existing wiring scheme of the backwash supply control loop which allows the Owner to control the backwash supply during each filter backwash across all existing filter consoles each individual backwash flow rate controllers at Filter Console No. 1 and Filter Console No. 12, and start/stop pushbuttons for the backwash pump, it is required that any work associated with removing the I/O signals at each filter to transition them to the new RTUs shall only disable control capability of the backwash supply loop one at a time. Furthermore, Filter No. 1 and No. 12 work shall be performed last in order to maintain the backwash flow controllers to be active while other filters are modified.

f. Existing PLC hardware shall be returned to the Owner.

g. RTU – 4, 5, and 6 (Filters 1 – 12):

   i. Complete general and electrical construction work, I&C subcontractor services, system testing, and startup for one filter at a time, starting with RTU-6.

   ii. Demolish existing filter consoles after all filter controls have been converted to new SCADA control system.

   iii. Only one filter console shall be removed from service at a time. All work associated with the individual valve replacement shall be completed prior to commencing work on a subsequent filter. While work is underway in an individual filter, all other filters shall remain in service.

h. RTU – 3 (Ammonia Building):

   i. Re-use the existing NEMA 4X stainless steel enclosure. Replace existing sub-panel. Provide new PLC hardware and new electrical components.

i. RTU – 2 (Chemical Building):

   i. Re-use the existing NEMA 4X stainless steel enclosure. Replace existing sub-panels. Provide new PLC hardware and new electrical components.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01530

PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Contractor shall be responsible for the preservation and protection of property adjacent to the work site against damage or injury as a result of his operations under this Contract. Any damage or injury occurring on account of any act, omission or neglect on the part of the Contractor shall be restored in a proper and satisfactory manner or replaced by and at the expense of the Contractor to an equal or superior condition than previously existed.

B. Contractor shall comply promptly with such safety regulations as may be prescribed by the Owner or the local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, his employees. In the event of the Contractor's failure to comply, the Owner may take the necessary measures to correct the conditions or practices complained of, and all costs thereof will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.

C. In the event of any claims for damage or alleged damage to property as a result of work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against such claims. Prior to commencement of work in the vicinity of property adjacent to the work site, the Contractor, at his own expense, shall take such surveys as may be necessary to establish the existing condition of the property. Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damage have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained.

1.02 PROTECTION OF WORK AND MATERIAL

A. During the progress of the work and up to the date of final payment, the Contractor shall be solely responsible for the care and protection of all work and materials covered by the Contract, except as provided for in Article 14.05 of the Supplementary Conditions.

B. All work and materials shall be protected against damage, injury or loss from any cause whatsoever, and the Contractor shall make good any such damage or loss at his own expense. Protection measures shall be subject to the approval of the Engineer.

1.03 BARRICADES, WARNING SIGNS AND LIGHTS

A. The General Contractor shall provide, erect and maintain as necessary, strong and suitable barricades, danger signs and warning lights along all roads accessible to the public, as required by the authority having jurisdiction, to insure safety to the public. All

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barricades and obstructions along public roads shall be illuminated at night and all lights for this purpose shall be kept burning from sunset to sunrise.

B. Each Contractor shall provide and maintain such other warning signs and barricades in areas of and around their respective work as may be required for the safety of all those employed in the work, the Owner's operating personnel, or those visiting the site.

1.04 EXISTING UTILITIES AND STRUCTURES

A. The term existing utilities shall be deemed to refer to both publicly-owned and privately-owned utilities such as electric power and lighting, telephone, water, gas, storm drains, process lines, sanitary sewers and all appurtenant structures.

B. Where existing utilities and structures are indicated on the Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any work in the vicinity of existing utilities.

C. Prior to beginning any excavation work, the Contractor shall, through field investigations, determine any conflicts or interferences between existing utilities and new utilities to be constructed under this project. This determination shall be based on the actual locations, elevations, slopes, etc., of existing utilities as determined in the field investigations, and locations, elevation, slope, etc. of new utilities as shown on the Drawings. If an interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that an interference exists, he shall modify the design as required. Additional costs to the Contractor for this change shall be processed through a Change Order as detailed elsewhere in these Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, any actual conflict or interference which does arise during the Project shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.

D. The work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to ensure uninterruption of existing services. Any damage resulting from the work of this Contract shall be promptly repaired by the Contractor at his own expense in a manner approved by the Engineer and further subject to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.

E. Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or

protection to any existing utility, the Engineer may, at his discretion, have the respective authority to provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

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SECTION 01540

DEMOLITION AND REMOVAL OF EXISTING STRUCTURES AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. This Section covers the demolition, removal, and disposal of existing buildings, structures, pavement, curbs, and sidewalk, removal and disposal of asbestos materials, and any existing equipment including electrical, plumbing, heating and ventilating equipment and piping not required for the operation of the rehabilitated plant as indicated on the Drawings and as specified hereinafter. The Contractor shall furnish all labor, materials and equipment to demolish buildings and structures and to remove fixtures, anchors, supports, piping and accessories designated to be removed on the Drawings.

1.02 TITLE TO EQUIPMENT AND MATERIALS

A. Contractor shall have no right or title to any of the equipment, materials or other items to be removed from the existing buildings or structures unless and until said equipment, materials and other items have been removed from the premises. The Contractor shall not sell or assign, or attempt to sell or assign any interest in the said equipment, materials or other items until the said equipment, materials or other items have been removed.

B. Contractor shall have no claim against the Owner because of the absence of such fixtures and materials.

1.03 CONDITION OF STRUCTURES AND EQUIPMENT

A. The Owner does not assume responsibility for the actual condition of structures and equipment to be demolished and removed.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner so far as practicable.

C. The information regarding the existing structures and equipment shown on the Drawings is based on visual inspection and a walk-through survey only. Neither the Engineer nor the Owner will be responsible for interpretations or conclusions drawn therefrom by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

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PART 3 -- EXECUTION

3.01 DEMOLITION AND REMOVALS

A. The removal of all equipment and piping, and all materials from the demolition of buildings and structure shall, when released by the Owner and Engineer, shall be done by the Contractor and shall become the Contractor's property, unless otherwise noted, for disposition in any manner not contrary to the Contract requirements and shall be removed from the site to the Contractor's own place of disposal.

B. The Electrical Contractor (Subcontractor) specifically, shall de-energize all panelboards, lighting fixtures, switches, circuit breakers, electrical conduits, motors, limit switches, pressure switches, instrumentation such as flow, level and/or other meters, wiring, and similar power equipment prior to removal. Any electric panels or equipment which are to be retained shall be relocated or isolated by the Electrical Contractor (Subcontractor) specifically, prior to the removal of the equipment specified herein.

C. The Contractor shall proceed with the removal of the equipment, piping and appurtenances in a sequence designed to maintain the plant in continuous operation as described in Section 01520, Maintenance of Utility Operations During Construction, and shall proceed only after approval of the Engineer.

D. Any equipment piping and appurtenances removed without proper authorization, which are necessary for the operation of the existing facilities shall be replaced to the satisfaction of the Engineer at no cost to the Owner.

E. Excavation caused by demolitions shall be backfilled with fill free from rubbish and debris.

3.02 PROTECTION

A. Demolition and removal work shall be performed by competent experienced workmen for the various type of demolition and removal work and shall be carried out through to completion with due regard to the safety of Owner employees, workmen on-site and the public. The work shall be performed with as little nuisance as possible.

B. The work shall comply with the applicable provisions and recommendation of ANSI A10.2, Safety Code for Building Construction, all governing codes, and as hereinafter specified.

C. The Contractor shall make such investigations, explorations and probes as are necessary to ascertain any required protective measures before proceeding with demolition and removal. The Contractor shall give particular attention to shoring and bracing requirements so as to prevent any damage to new or existing construction.

D. The Contractor shall provide, erect, and maintain catch platforms, lights, barriers, weather protection, warning signs and other items as required for proper protection of the public, occupants of the building, workmen engaged in demolition operations, and adjacent construction.

E. The Contractor shall provide and maintain weather protection at exterior openings so as to fully protect the interior premises against damage from the elements until such openings are closed by new construction.

F. The Contractor shall provide and maintain temporary protection of the existing structure designated to remain where demolition, removal and new work is being done, connections made, materials handled or equipment moved.

G. The Contractor shall take necessary precautions to prevent dust from rising by wetting demolished masonry, concrete, plaster and similar debris. Unaltered portions of the existing buildings affected by the operations under this Section shall be protected by dust-proof partitions and other adequate means.

H. The Contractor shall provide adequate fire protection in accordance with local Fire Department requirements.

I. The Contractor shall not close or obstruct walkways, passageways, or stairways and shall not store or place materials in passageways, stairs or other means of egress. The Contractor shall conduct operations with minimum traffic interference.

J. The Contractor shall be responsible for any damage to the existing structure or contents by reason of the insufficiency of protection provided.

3.03 WORKMANSHIP

A. The demolition and removal work shall be performed as described in the Contract Documents. The work required shall be done with care, and shall include all required shoring, bracing, etc. The Contractor shall be responsible for any damage which may be caused by demolition and removal work to any part or parts of existing structures or items designated for reuse or to remain. The Contractor shall perform patching, restoration and new work in accordance with applicable Technical Sections of the Specifications and in accordance with the details shown on the Drawings. Prior to starting of work, the Contractor shall provide a detailed description of methods and equipment to be used for each operation and the sequence thereof for review by the Engineer.

B. All supports, pedestals and anchors shall be removed with the equipment and piping unless otherwise specified or required. Concrete bases, anchor bolts and other supports shall be removed to approximately 1-inch below the surrounding finished area and the recesses shall be patched to match the adjacent areas. Superstructure wall and roof openings shall be closed, and damaged surfaces shall be patched to match the adjacent areas, as specified under applicable Sections of these Specifications, as shown on the Drawings, or as directed by the Engineer. Wall sleeves and castings shall be plugged or blanked off, all openings in concrete shall be closed in a manner meeting the requirements of the appropriate Sections of these Specifications, as shown on the Drawings, and as directed and approved by the Engineer.

C. Materials or items designated to remain the property of the Owner shall be as hereinafter tabulated. Such items shall be removed with care and stored at a location at the site to be designated by the Owner.

D. Where equipment is shown or specified to be removed and relocated, the Contractor shall not proceed with removal of this equipment without specific prior approval of the Engineer. Upon approval, and prior to commencing removal operations, the equipment shall be operated in the presence of representatives of the Contractor, Owner and Engineer. Such items shall be removed with care, under the supervision of the trade responsible for reinstallation and protected and stored until required. Material or items damaged during removal shall be replaced with similar new material or item. Any equipment that is removed without proper authorization and is required for plant operation shall be replaced at no cost to the Owner.

E. Wherever piping is to be removed for disposition, the piping shall be drained by the Contractor and adjacent pipe and headers that are to remain in service shall be blanked off or plugged and then anchored in an approved manner.

F. Materials or items demolished and not designated to become the property of the Owner or to be reinstalled shall become the property of the Contractor and shall be removed from the property and legally disposed of.

G. The Contractor shall execute the work in a careful and orderly manner, with the least possible disturbance to the public and to the occupants of the building.

H. In general, masonry shall be demolished in small sections, and where necessary to prevent collapse of any construction, the Contractor shall install temporary shores, struts, and bracing.

I. Where alterations occur, or new and old work join, the Contractor shall cut, remove, patch, repair or refinish the adjacent surfaces to the extent required by the construction conditions, so as to leave the altered work in as good a condition as existed prior to the start of the work. The materials and workmanship employed in the alterations, unless otherwise shown on the Drawing or specified, shall comply with that of the various respective trades which normally perform the particular items or work.

J. The Contractor shall finish adjacent existing surfaces to new work to match the specified finish for new work. The Contractor shall clean existing surfaces of dirt, grease, loose paint, etc., before refinishing.

K. The Contractor shall cut out embedded anchorage and attachment items as required to properly provide for patching and repair of the respective finishes.

L. The Contractor shall confine cutting of existing roof areas designated to remain to the limits required for the proper installation of the new work. The Contractor shall cut and remove insulation, etc., and provide temporary weather tight protection as required until new roofing and flashings are installed.

M. The Contractor shall remove temporary work, such as enclosures, signs, guards, and the like when such temporary work is no longer required or when directed at the completion of the work.

3.04 MAINTENANCE

A. The Contractor shall maintain the buildings, structures and public properties free from accumulations of waste, debris and rubbish, caused by the demolition and removal operations.

B. The Contractor shall provide on-site dump containers for collection of waste materials, debris and rubbish, and he shall wet down dry materials to lay down and prevent blowing dust.

C. At reasonable intervals during the progress of the demolition and removal work or as directed by the Engineer, the Contractor shall clean the site and properties, and dispose of waste materials, debris and rubbish.

- END OF SECTION –

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SECTION 01550

SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Access Roads

1. The General Contractor shall construct and maintain such temporary access roads as required to perform the work of this Contract.

2. Access roads, where possible, shall be located over the areas of the future road system.

3. Access roads shall be located within the property lines of the Owner unless the Contractor independently secures easements for his use and convenience. Contractor shall submit written documentation to the Engineer for any Contractor secured easements across privately held property. Easement agreement shall specify terms and conditions of use and provisions for site restoration. A written release from the property owner certifying that all terms of the easement agreement have been complied by the Contractor shall be furnished to the Engineer prior to final payment.

4. Existing access roads used by the Contractor shall be suitably maintained by the Contractor at his expense during construction. Contractor shall not be permitted to restrict Owner access to existing facilities. Engineer may direct Contractor to perform maintenance of existing access roads when Engineer determines that such work is required to insure all weather access by the Owner.

5. The Contractor shall obtain and pay all cost associated with any bonds required by the N.C. Department of Transportation for the use of State maintained roads.

B. Parking Areas

1. Each Contractor shall construct and maintain suitable parking areas for his construction personnel on the project site where approved by the Engineer and the Owner.

C. Restoration

1. At the completion of the work, the surfaces of land used for access roads and parking areas shall be restored by each Contractor to its original condition and to the satisfaction of the Engineer. At a minimum, such restoration shall include establishment of a permanent ground cover adequate to restrain erosion for all disturbed areas.

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D. Traffic Regulations

1. Contractor shall obey all traffic laws and comply with all the requirements, rules and regulations of the NCDOT and other local authorities having jurisdiction to maintain adequate warning signs, lights, barriers, etc., for the protection of traffic on public roadways.

E. Storage of Equipment and Materials

1. Contractor shall store his equipment and materials at the job site in accordance with the requirements of the General Conditions, the Supplemental Conditions, and as hereinafter specified. All equipment and materials shall be stored in accordance with manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations and rulings of the public authority having jurisdiction. Where space or strip heaters are provided within the enclosure for motors, valve operators, motor starters, panels, instruments, or other electrical equipment, the Contractor shall make connections to these heaters from an appropriate power source and operate the heaters with temperature control as necessary until the equipment is installed and being operated according to its intended use.

2. Contractor shall enforce the instructions of Owner and Engineer regarding the posting of regulatory signs for loadings on structures, fire safety, and smoking areas.

3. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

4. Contractor shall not store unnecessary materials or equipment on the job site, and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

5. Materials shall not be placed within ten (10) feet of fire hydrants. Gutters, drainage channels and inlets shall be kept unobstructed at all times.

6. Contractor shall provide adequate temporary storage buildings/facilities, if required, to protect materials or equipment on the job site.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01560

TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Dust Control

1. Contractor shall take all necessary measures to control dust from his operations, and to prevent spillage of excavated materials on public roads.

2. Contractor shall remove all spillage of excavated materials, debris or dust from public roads by methods approved by the Engineer.

3. Contractor shall sprinkle water at locations and in such quantities and at such frequencies as may be required by the Engineer to control dust and prevent it from becoming a nuisance to the surrounding area.

4. Dust control and cleaning measures shall be provided at no additional cost to the Owner.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 01590

FIELD OFFICE, EQUIPMENT AND SERVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. First Aid Cabinet shall conform to the OSHA requirements for an office of up to 15 persons or a construction site of up to 5 persons.

B. Contractor's Field Office

1. Each Contractor shall furnish, equip and maintain a field office at the site of a size required for his operations. Each Contractor shall provide his own telephone service and shall have readily accessible at the field office, copies of the Contract Documents, latest approved Shop Drawings and all field Project related correspondence, Change Order, etc.

C. Project Sign and Sign Panel

1. The General Contractor shall erect a sign at the Project site identifying the Project. **The sign shall be erected within twenty-one (21) days after the Notice to Proceed**, and shall be in accordance with the Specifications and details included in this Section. The project sign and sign panel shall be furnished, erected, and maintained by the Contractor at the location designated by the Engineer. Wording and colors shall be as shown on the detail after the end of this Section.

2. The project sign shall be fabricated, erected and maintained by the Contractor in accordance with the following specifications:

a) Sign Panel: The sign panel shall be constructed of 3/4 inch minimum thickness marine plywood rabetted into a 2 inch x 4 inch wood frame. All fasteners used in the construction of the sign shall be of a rustproof nature.

b) Painting: All supports, trim and back of the sign panel shall be painted with at least two (2) coats of the same paint used for the sign face. All paint used shall be exterior grade paint, suitable for use on wood signs.

c) Sign Supports: The supports for the project sign shall be at least two 4" by 4" treated wood posts. The sign panel shall be securely fastened to the sign supports with at least six (6) 3/8 ϕ galvanized bolts, nuts and washers. The positioning and alignment of the sign shall be as determined by the Engineer.

d) Maintenance: The project sign shall be maintained by the Contractor, in good condition, at all times, for the duration of construction.

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e) Removal of Sign from Project Site: The removal of the project sign from the construction site by the Contractor shall be at the completion of construction, when ordered by the Engineer.

f) Payment: The cost of the fabrication, erection, maintenance, and removal of the project sign, including all labor and materials, shall be included in the General Contractor's Lump Sum Bid. No extra payment will be made for obliterating certain names and offices and replacement thereof of others because of administrative changes during the course of this Contract.

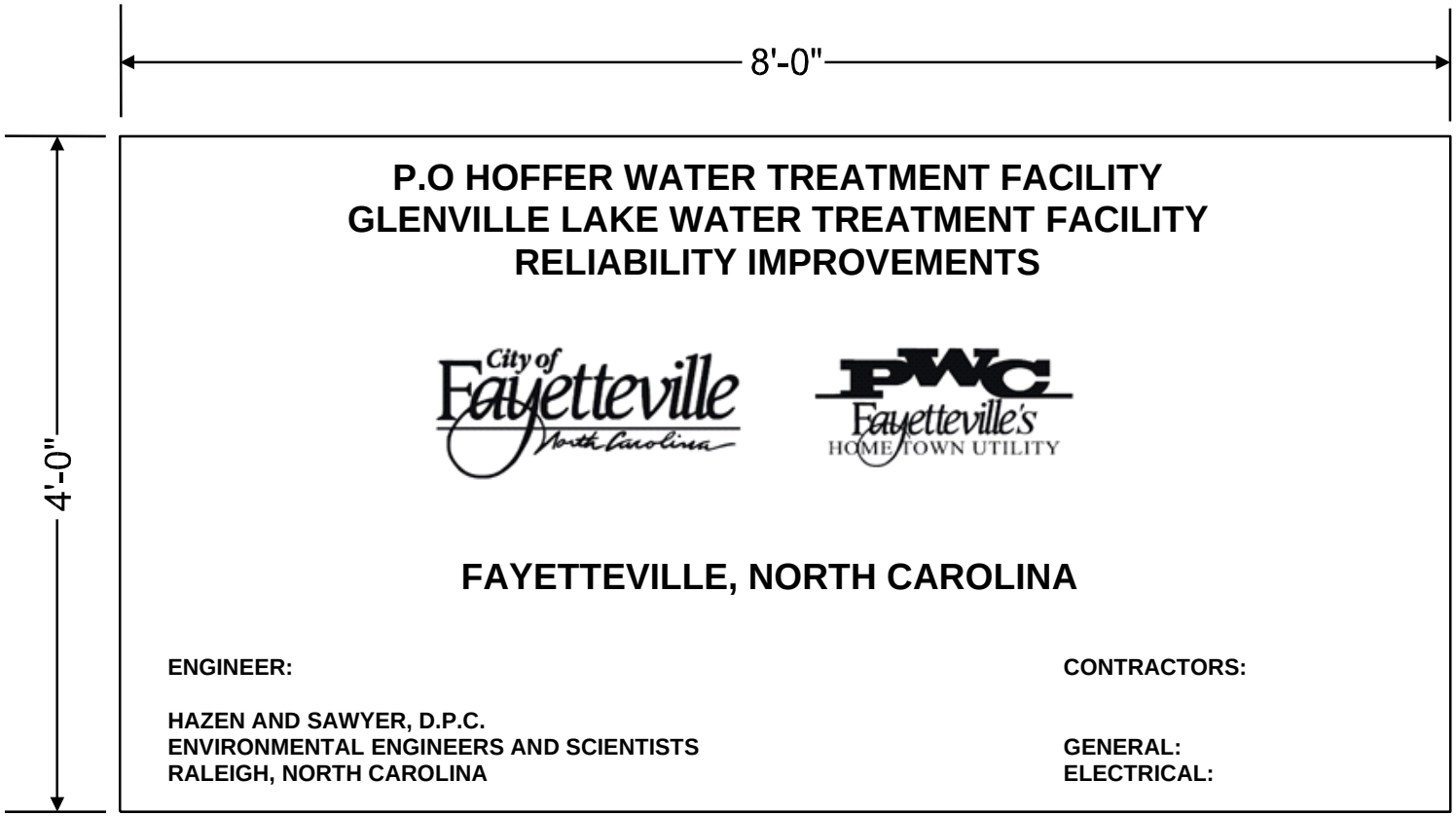
PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –



1. **Provide black letters on white background.**

2. **Use of ½" duraply signboard with vinyl lettering will be acceptable as an alternate to plywood and painted letters.**

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SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.

2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Foundations for Equipment

1. Each Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.

2. Anchor bolts and templates for equipment foundations shall be furnished under the respective Contracts for installation by the respective Contractor. The General Contractor shall cooperate with the respective Contractors to secure a satisfactory installation and to maintain the schedule of construction.

3. All concrete foundations for equipment shall be treated, by the respective Contractor, with an approved sealer to prevent oil from seeping into the concrete.

1.02 EQUIPMENT AND MATERIALS

A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.

B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage buildings as needed and as specified in Section 01550, Site Access and Storage. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. Storage areas shall be located sufficiently distant from all construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have

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become damaged or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

1.03 INSTALLATION OF EQUIPMENT

A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Supplemental Conditions and the respective Specification Sections.

B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.

C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.

D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.

E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.

F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.

G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

1.04 CONNECTIONS TO EQUIPMENT

A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop

Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.

B. The Electrical Contractor or General Contractor if no electrical contract exists shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

C. The HVAC Contractor or General Contractor if no HVAC Contract exists shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

D. The Plumbing Contractor or General Contractor if no plumbing contract exists shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

1.05 SUBSTITUTIONS

A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified.

1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where feasible, to enable the Owner and Engineer to determine if the proposed substitution is equal.

2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. A list of installations where the proposed substitution is equal.

4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.

B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.

C. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the Contractor by the Owner in accordance with the requirements of the General Conditions, and the Supplemental Conditions.

D. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed

substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.

E. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.

F. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01700

PROJECT CLOSEOUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Final Cleaning

1. At the completion of the work, the Contractor shall remove all rubbish from and about the site of the work, and all temporary structures, construction signs, tools, scaffolding, materials, supplies and equipment which he or any of his Subcontractors may have used in the performance of the work. Contractor shall broom clean paved surfaces and rake clean other surfaces of grounds.

2. Contractor shall thoroughly clean all materials, equipment and structures; all marred surfaces shall be touched up to match adjacent surfaces; dirty filters and burned out lights replaced as required; all glass surfaces cleaned and floors cleaned and polished so as to leave work in a clean and new appearing condition.

3. Contractor shall maintain cleaning until project, or portion thereof, is occupied by the Owner.

B. Lubrication Survey

1. A lubrication survey, made by a lubricant supply firm, subject to the approval of the Owner shall be provided and paid for by the Contractor.

2. The lubrication survey shall list all equipment, the equipment manufacturer's lubrication recommendations, and an interchangeable lubricants tabulation standardizing and consolidating lubricants whenever possible.

3. The Contractor shall supply all lubricants, applicators and labor for lubricating the equipment, in accordance with manufacturer's recommendations, for field testing and prior to final acceptance. A supply of required lubricants sufficient for start-up and one year of operation shall also be supplied by the Contractor.

4. An electronic copy of the approved lubrication survey shall be furnished to the Engineer prior to final acceptance.

C. Spare Parts and Special Tools

1. As soon as practicable after approval of the list of equipment, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply.

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2. Contractor shall also furnish a list of parts, and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified to be furnished as part of the Contract and a list of additional items recommended by the manufacturer to assure efficient operation for a period of one-hundred and twenty (120) days for the particular installation.

3. All parts shall be securely boxed and tagged, and clearly marked on the box and individually for identification as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten (10) years.

4. Contractor shall furnish at no additional cost to the Owner with each piece of equipment as a minimum, one (1) complete set, or the number of sets called for in the Technical Specifications, of suitably marked special tools and appliances which may be needed to adjust, operate, maintain, or repair the equipment.

5. Contractor shall submit, for approval by the Engineer, a complete list of the special tools and appliances to be furnished. Such tools and appliances shall be furnished in approved painted steel cases properly labeled and equipped with good grade cylinder locks and duplicate keys.

D. Equipment Start-Up Services

1. Equipment start-up period, for the training of plant personnel, shall begin after satisfactory completion and acceptance of the field tests and coincidentally with the certified date of substantial completion for the part of the work for which the equipment is included. If the equipment is not covered by a certificate of substantial completion for a part of the work, the period shall begin upon substantial completion of the project.

2. During the equipment start-up period the Contractor shall furnish, at no additional cost to the Owner the services of factory trained representatives of the equipment manufacturers for the equipment designated in the Specifications to:

   a. Assist in the start-up and operations of the equipment.

   b. Assist in the training of plant personnel, designated by the Owner in the proper operation and maintenance of the equipment.

3 The Owner shall:

   a. Provide the necessary plant personnel to be instructed in the operation and maintenance of the equipment. The Owner's personnel shall operate all equipment.

   b. Pay for all fuel, power and chemicals consumed beyond quantities specified in the Contract Documents. The Contractor shall pay for fuel, power, and chemicals consumed up to the date of "certified substantial completion" except as otherwise specified herein.

4. Contractor shall be available to promptly repair all work during the start-up period so as to cause minimum disruption to the total plant operation.

5. Upon completion of a minimum of ten (10) consecutive and continuous days of satisfactory operation, or the number of days called for in the Technical Specifications, the Owner will assume operation and operating cost of the equipment. If the equipment malfunctions during this start-up period, the start-up period will be repeated until satisfactory operation is achieved.

6. In the event a system, equipment or component proves defective or is unable to meet specified performance criteria, the Contractor shall replace the defective item and the minimum one (1) year guarantee period, or the guarantee period called for in the Technical Specifications for the item shall start after satisfactory replacement and testing of the item.

E. Final Cleanup; Site Rehabilitation

1. Before finally leaving the site, the Contractor shall wash and clean all exposed surfaces which have become soiled or marked, and shall remove from the site of work all accumulated debris and surplus materials of any kind which result from his operation, including construction equipment, tools, sheds, sanitary enclosures, etc. The Contractor shall leave all equipment, fixtures, and work, which he has installed, in a clean condition. The completed project shall be turned over to the Owner in a neat and orderly condition.

2. The site of the work shall be rehabilitated or developed in accordance with other sections of the Specifications and the Drawings. In the absence of any portion of these requirements, the Contractor shall completely rehabilitate the site to a condition and appearance equal or superior to that which existed just prior to construction, except for those items whose permanent removal or relocation was required in the Contract Documents or ordered by the Owner.

F. Final Inspection

1. Final cleaning and repairing shall be so arranged as to be finished upon completion of the construction work. The Contractor will make his final cleaning and repairing, and any portion of the work finally inspected and accepted by the Engineer shall be kept clean by the Contractor, until the final acceptance of the entire work.

2. When the Contractor has finally cleaned and repaired the whole or any portion of the work, he shall notify the Engineer that he is ready for final inspection of the whole or a portion of the work, and the Engineer will thereupon inspect the work. If the work is not found satisfactory, the Engineer will order further cleaning, repairs, or replacement.

3. When such further cleaning or repairing is completed, the Engineer, upon further notice, will again inspect the work. The "Final Payment" will not be processed until the Contractor has complied with the requirements set forth, and the Engineer has made his final inspection of the entire work and is satisfied that the entire work is

properly and satisfactorily constructed in accordance with the requirements of the Contract Documents.

G. Project Close Out

1. As construction of the project enters the final stages of completion, the Contractor shall, in concert with accomplishing the requirements set forth in the Contract Documents, attend to or have already completed the following items as they apply to his contract:

   a. Scheduling equipment manufacturers' visits to site.

   b. Required testing of project components.

   c. Scheduling start-up and initial operation.

   d. Scheduling and furnishing skilled personnel during initial operation.

   e. Correcting or replacing defective work, including completion of items previously overlooked or work which remains incomplete, all as evidenced by the Engineer's "Punch" Lists.

   f. Attend to any other items listed herein or brought to the Contractor's attention by the Engineer.

2. Just before the Engineer's Certificate of Substantial Completion is issued, the Contractor shall accomplish the cleaning and final adjustment of the various building components as specified in the Specifications and as follows:

   a. Clean all glass and adjust all windows and doors for proper operation.

   b. Clean all finish hardware after adjustment for proper operation.

   c. Touch up marks or defects in painted surfaces and touch up any similar defects in factory finished surfaces.

   d. Wax all resilient flooring materials.

   e. Remove bitumen from gravel stops, fascias, and other exposed surfaces.

   f. Remove all stains, marks, fingerprints, soil, spots, and blemishes from all finished surfaces, tile, stone, brick, and similar surfaces.

3. In addition, and before the Certificate of Substantial Completion is issued, the Contractor shall submit to the Engineer (or to the Owner if indicated) certain records, certifications, etc., which are specified elsewhere in the Contract Documents. A partial list of such items appears below, but it shall be the Contractor's responsibility to submit any other items which are required in the Contract Documents:

   a. Test results of project components.

b. Performance Affidavits for equipment.

c. Certification of equipment or materials in compliance with Contract Documents.

d. Operation and maintenance instructions or manuals for equipment.

e. One set of neatly marked-up record drawings showing as-built changes and additions to the work under his Contract.

f. Any special guarantees or bonds (Submit to Owner).

g. Licensed surveyor’s report showing elevations of weirs specified in the Contract Drawings and the final surveyed elevation.

4. The Contractor's attention is directed to the fact that required certifications and information under Item 3 above, must actually be submitted earlier in accordance with other Sections of the Specifications.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION –

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SECTION 02050

DEMOLITION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials and equipment in accordance with the requirements of Section 01520 - Maintenance of Utility Operations During Construction and Section 01540 - Demolition and Removal of Existing Structures and Equipment.

B. In addition, the Contractor shall demolish and remove all concrete and asphaltic paving, curbs, sidewalk, and miscellaneous yard structures as required and shown on the Contract Drawings during the construction work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01090 - Reference Standards

B. Section 01520 - Maintenance of Utility Operations During Construction

C. Section 01540 - Demolition and Removal of Existing Structures and Equipment

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References shall be in accordance with reference standards, codes, and specifications as set forth herein and in Section 02100 - Clearing, Grubbing, and Site Preparation.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:

1. Copies of all photographs and other records from the joint existing conditions surveys.

PART 2 -- EXECUTION

2.01 DEMOLITION

A. Existing concrete and asphaltic paving, curbs, sidewalk and miscellaneous yard structures within the areas designated for new construction work shall be completely demolished and all debris removed from the site.

B. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris.

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C. Work shall be performed in such manner as not to endanger the safety of the workmen or the public or cause damage to nearby structures.

D. Provide all barriers and precautionary measures in accordance with Owner's requirements and other authorities having jurisdiction.

E. Where parts of existing pavements or structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove asphalt, concrete, and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.

F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby pavements and structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims. Copies of all photographs and other records from the joint existing conditions survey shall be provided to the Owner/Engineer before construction activities begin.

2.02 DISPOSAL OF MATERIAL

A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of offsite by the Contractor at his expense.

B. Burning of any debris resulting from the demolition will not be permitted at the site.

- END OF SECTION -

SECTION 02100

CLEARING, GRUBBING, AND SITE PREPARATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.

2. Clearing the site within the Contract Limit Lines, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.

3. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved. Relocating trees and shrubs, so indicated on the Drawings, to designated areas.

4. Repairing all injury to trees, shrubs, and other plants caused by site preparation operations shall be repaired immediately. Work shall be done by qualified personnel in accordance with standard horticultural practice and as approved by the Engineer.

5. Removing topsoil to its full depth from designated areas and stockpiling on site where directed by the Engineer for future use.

6. Disposing from the site all debris resulting from work under this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. North Carolina Administrative Code, Title 15, Chapter 2.

1.04 STREET AND ROAD BLOCKAGE

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A. Closing of streets and roads during progress of the work shall be in compliance with the requirements of the Owner and other authorities having jurisdiction. Access shall be provided to all facilities remaining in operation.

1.05 PROTECTION OF PERSONS AND PROPERTY

A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.

B. All conduits, wires, cables and appurtenances above or below ground shall be protected from damage.

C. Provide warning and barrier fence where shown on the Drawings and as specified herein.

PART 2 -- EXECUTION

2.01 CLEARING OF SITE

A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.

B. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Prior to the start of construction, the Contractor shall survey the entire Contract site and shall prepare a plan which defines the areas to be cleared and grubbed, trees to be pruned, extent of tree pruning, and/or areas which are to be cleared but not grubbed. This plan shall be submitted to the Engineer for approval. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.

C. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02200, Earthwork.

D. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15 ft. wide along all permanent fence lines installed under this Contract.

E. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2.02 STRIPPING AND STOCKPILING EXISTING TOPSOIL

A. Existing topsoil and sod on the site within areas designated on the Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

B. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil.

C. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

2.03 GRUBBING

A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.

B. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

2.04 DISPOSAL OF MATERIAL

A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.

B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

2.05 WARNING AND TREE PROTECTION BARRIER FENCE

A. The fence shall be made of a visible, lightweight, flexible, high strength polyethylene material. The fence shall be Beacon Plus High Visibility Orange Safety Fence as manufactured by TENAX, or equal.

B. Physical Properties

Fence:

Color: International Orange
Roll Size: 4' x 100'
Roll weight: 12.5 lbs.
Mesh opening: 1-1/2" x 3-1/2"

Posts:

ASTM Designation: ASTM 702
Length: 5 feet long (T-Type)
Weight: 1.25 #/Foot (min)
Area of Anchor Plate: 14 Sq. In.

C. Drive posts 18 inches into ground every 8'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten

material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.

D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post, and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

- END OF SECTION -

SECTION 02140

DEWATERING

PART 1 -- GENERAL

1.01 WORK INCLUDED

A. Furnish all labor, materials, and equipment, perform all work necessary to lower and control the groundwater levels and hydrostatic pressures to permit all excavations and construction to be performed in dry conditions. The work shall include the following:

1. Testing, operation, maintenance, supervision, rewatering, and final dismantling and removal from the site of the dewatering system.

2. The cost of any replacement or rehabilitation of the subgrade or structures damaged due to dewatering system failures or Contractor negligence.

3. Compliance with all regulations relating to this work.

4. The diversion, collection, and removal of all ice, snow and surface runoff from the work areas, and removal of groundwater from new excavations to permit construction in the dry.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents to the extent that the provisions therein are not in conflict with the requirements of this Section.

1.	ASTM D1556	Density of soil in place by the Sand Cone Method.
2.	ASTM D2167	Density of soil in place by the Rubber Balloon Method.
3.	Bureau of Reclamation	Groundwater Manual Sediment Test by Imhoff Cone

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals:

1. Name of dewatering subcontractor, if applicable

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2. Shop Drawings indicating the following:

    a. Plans showing the methods and location of dewatering and discharge including a sufficient number of detailed sections to clearly illustrate the scope of work.

    b. Relationship of the dewatering system, observation wells, and discharge line to existing buildings, other structures, utilities, streets and new construction.

    c. Utility locations.

    d. Drawings shall bear the seal and signature of the qualified Registered Professional Engineer in charge of preparing the drawings.

    e. List of materials and equipment to be used.

    f. A sample of all well record forms to be maintained during construction.

3. Detailed description of the sequence of dewatering operations

4. Dewatering well installation records indicating an identification number, location, dimensions, and installation procedures and materials.

5. Observation well installation records indicating an identification number, location, dimensions, and installation procedures and materials.

6. Emergency observation plan to be put into operation during failure of the dewatering system

7. Monthly Dewatering System Monitoring Reports containing the following data on approved forms:

    a. For observation wells, daily piezometric levels shall be identified by date, time, well number and system (subsystem if multiple pumps are used) pumping rate. Piezometric levels shall be noted in feet of drawdown and groundwater elevation.

    b. For dewatering wells, suspended material test results shall be identified by date, time, well number, well pumping rate (if monitored) and system (subsystem if multiple pumps are used) pumping rate.

    c. Installation records for new wells.

8. Schedule and records of all maintenance tests for primary and standby dewatering systems including the following:

    a. Maintenance tests and water quality tests for suspended matter at the discharge point including date, time of day, elapsed times of tests

procedures, components tested, suspended particles, resultant observations and well readings.

b. Daily discharge rates.

c. Installation and removal of wells.

d. General observations of the system such as equipment running times, and failures.

9. Dewatering well removal records

10. Observation well removal records

1.05 QUALITY ASSURANCE

A. The Contractor shall be solely responsible for the arrangement, location, and depths of the dewatering system necessary to accomplish the work described herein.

B. Dewatering shall prevent the loss of fines, seepage, boils, quick conditions or softening of the foundation strata while maintaining stability of the sides and bottom of the excavation, and providing dry conditions for construction operations.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Materials, especially the well screen, shall be carefully chosen to be compatible with the environment to prevent erosion, deteriorization, and clogging.

B. Surging of the natural formation to form a "gravel pack" is strictly prohibited.

PART 3 -- EXECUTION

3.01 EXAMINATION OF THE SITE

A. Become familiar with the surface and subsurface site conditions.

B. Obtain the data required to analyze the water and soil environment at the site in order to assure that the materials used for the dewatering systems will not erode, deteriorate, clog or otherwise hinder the system's performance during the period of the dewatering.

C. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.02 DESIGN

A. The dewatering system shall be capable of relieving all hydrostatic pressure against the height of the excavation walls and of lowering the hydrostatic level below the bottom of the base slab a minimum of four (4) feet in the work areas both prior to excavation, and during excavation and construction.

B. The dewatering system shall be segmented so that if the operation of any one segment is disrupted, the remaining segment plus activated redundant components are capable of maintaining the groundwater at the stated levels.

C. Provide, operate and maintain all ditches, berms, site grading, sumps and pumping facilities to divert, collect and remove all surface water from work areas. All collected water shall be discharged into the outfall pipe.

D. Provide pipe and pumps of sufficient size and quantity to be able to flood the excavation within 12 hours in an emergency situation. Restoration of the working area shall be carried out by the Contractor at no additional cost to the Owner.

E. Carry the dewatering system discharge through pipes out of the area of the excavation into the outfall junction manhole shown on the Drawings. Provide meters to measure the discharge flow.

F. Place a portion of the header and discharge system underground to provide vehicle crossings or access to existing structure as required.

G. Provide a standby dewatering system that meets the following requirements:

1. Provide 100 percent standby power.

2. Provide a 15 percent minimum increase in the number of wells and related equipment required to operate the dewatering system installed and ready to operate.

3. Provide a minimum of three separate power units for the standby power system and one installed auxiliary unit for each individually powered pump.

4. Provide separate discharge lines from each well or common lines with valves such that any well or wells that malfunction or are damaged can be isolated form the others.

5. The systems shall be laid out and designed in such a way that portions of the system may be isolated for routine maintenance or repair in case of accidental damage without affecting the normal operation of the system.

H. Provide sufficient fuel to maintain a five day supply on site for fuel power systems.

I. Provide observation wells to determine compliance with dewatering requirements as indicated on the Drawings, Shop Drawings, and the Engineer.

J. Designate certain observation wells as emergency observation wells.

3.03 INSPECTION

A. All tests and inspections require the witnessing and written approval of the Owner and Engineer.

B. Provide safe access for the owner and Engineer to perform testing and inspection.

C. The Owner and Engineer will provide oral and written notice to the Contractor for all tests and inspections that do not meet approval.

3.04 INSTALLATION AND TESTING

A. Install the dewatering system from the existing ground surface or from the bottom of an excavation which is located above the natural groundwater level.

B. Pump each well individually at its maximum or design flow and take a water sample using the following procedures:

1. Obtain samples from stopcocks located along the discharge lines at points of high turbulence or between 4 and 8 o'clock on the perimeter of straight sections of pipe.

2. Flush the stopcock for a few seconds before taking a sample.

3. Take a 1 liter sample with the stopcock fully open.

C. Test the sample following the Sediment Test by Imhoff Cone for two to three minutes and measure the volume of settled materials to the nearest 0.01 milliliters (0.01 milliliters = 10 ppm).

D. All wells shall be evaluated as follows:

1. Wells producing 10 ppm or less shall be accepted.

2. Wells producing between 10 and 20 ppm may be accepted by the Engineer based on the evaluation of average ppm for all wells, ppm of adjacent wells, and total quantity of water which is actually pumped to dewater the excavation.

3. Well producing more than 20 ppm shall be abandoned and backfilled.

E. Observation wells shall consist of a standpipe or riser of minimum 1.0-inch inside diameter and a minimum three (3) foot long well-point screen or slotted PVC section at the bottom. Observation wells shall be installed as follows:

1. Employ the jetting method for all observation wells except those within ten feet of existing structures, piping or utilities.

2. Employ Case Boring Techniques for all observation wells within ten feet of existing structures, piping, or utilities and backfill the annulus between the well point or riser and the natural soil with a free flowing granular material similar to Ottawa Sand.

F. Test observation wells by adding or removing water from the riser to demonstrate their proper functioning.

3.05 DEWATERING PROCEDURE

A. Following soldier pile installation and dewatering system installation and testing and prior to excavation, place the dewatering system into operation and lower the water level.

B. Schedule the dewatering work to coordinate with all the other related work such as excavation, sheeting and tiebacks, pouring of concrete walls and slabs, and any other operations by other Contractors that might be affected by this work.

C. Test the standby dewatering system with the following procedures:

1. Shut off the primary power source and demonstrate that the standby power can be activated prior to the groundwater level rising to within one (1) foot of the bottom of base slab elevation and that the standby power source is adequate to draw the groundwater level back down to the Contractor's design depth or to the minimum required depths.

2. Shut off one segment of the system and show that redundant components can be activated prior to the groundwater level rising to within one (1) foot of the bottom of base slab elevation and that the system is adequate to draw the groundwater level back down to the Contractor's design depth or to the minimum required depths.

3. If the dewatering system fails to meet either performance requirement, the Contractor shall draw the groundwater level to a greater depth, add wells, or modify the system such that it will be in conformance with these requirements when retested.

D. Operate the dewatering system continuously twenty-four (24) hours per day, seven (7) days per week until all structures have been satisfactorily constructed, including placement of fill materials, and no longer require dewatering.

3.06 MONITORING

A. Measure the piezometric water levels to the nearest one-tenth foot in all observation wells and submit the readings daily.

B. Measure the concentration of suspended material in the discharge water of each well once every two days. Wells which exceed the acceptable level of solids concentration shall be replaced.

C. Test the performance of the standby system and all components by demonstrating that the system is operational at least every two weeks.

D. Test the observation wells every two weeks by adding and removing water from the risers to demonstrate their proper functioning.

E. Observation wells that become inoperable shall be immediately replaced while construction is halted if the Engineer determines that the observation well is critical.

F. Remove and add riser pipe of each observation well located within the excavation as construction progresses until the well conflicts with the structure. When the conflict occurs, abandon the observation well, fill it with grout, and cut the riser off at grade.

G. In the event of a dewatering system failure, take the following steps:

1. Conduct in situ density tests conforming to ASTM D1556 or ASTM D2167 immediately above an at the structure founding grades.

2. Remove all soils that show unacceptable density and replace them with compacted fill as indicated in Section 02200, Earthwork.

3. Test the repaired soils as required by the Owner and Engineer to verify that they have been returned to their original in situ state or better.

4. Repair or replace damaged structures.

3.07 REWATERING AND REMOVAL OF DEWATERING SYSTEM

A. Obtain written approval from the Owner and Engineer to being rewatering operations.

B. Provide an adequate weight of fill to prevent buoyancy.

C. Pump water into the excavation such that the water level inside the excavation is always at a higher level than the rising groundwater on the outside until the groundwater level has reached its static level.

D. Remove all dewatering wells, buried and surface piping, cables, pump foundations, structural supports and all other support facilities.

E. Backfill as specified in Section 02200, Earthwork, all trenches and excavations below final grades or in fill areas.

F. Provide documentation of dewatering and observation well removal including the date of removal, well number, location, procedures, and materials used.

- END OF SECTION -

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SECTION 02200

EARTHWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, providing a Materials Testing Consultant for the testing of soils and compaction, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

D. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the North Carolina Department of Transportation Standard Specifications for Roads and Structures and the North Carolina Erosion and Sediment Control Planning and Design Manual;

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Department of Transportation Standard Specifications for Roads and Structures, latest edition.

2. American Society for Testing and Materials (ASTM):

ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.

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ASTM C 136	Test for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 422	Particle Size Analysis of Soils.
ASTM D 423	Test for Liquid Limit of Soils.
ASTM D 424	Test for Plastic Limit and Plasticity Index of Soils.
ASTM C 535	Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D 698	Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
ASTM D1556	Test for Density of Soil in Place by the Sand-Cone Method.
ASTM D1557	Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop.
ASTM D2049	Test Method for Relative Density of Cohesionless Soils.
ASTM D2167	Test for Density of Soil in Place by the Rubber-Balloon Method.
ASTM D2216	Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures.
ASTM D2487	Test for Classification of Soils for Engineering Purposes.
ASTM D2922	Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 SUBSURFACE CONDITIONS

A. Information on subsurface conditions is referenced under Division 1, General Requirements.

B. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Perform all repairs to same in the event that excavation activities disrupt service.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. Results of soils testing for topsoil supplied for project meeting requirements of 2.02 TOPSOIL, of this specification.

4. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

5. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.

6. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.

7. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer in the State of North Carolina.

8. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems and near areas where dewatering is required to facilitate construction.

9. Dewatering procedures.

1.06 PRODUCT HANDLING

A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

PART 2 -- PRODUCTS

2.01 SELECT FILL

A. Soils from the excavations meeting requirements stipulated herein with the exceptions of topsoil and organic material may be used as select fill for backfilling, constructing embankments, reconstructing existing embankments, and as structural subgrade support.

B. Select fill used for embankment construction shall be a silty or clayey sand or low plasticity silts and clay having Unified Soil Classification of SM, SC, ML or L. Select Fill shall have a Maximum Liquid Limit (LL) of 50 and a Plasticity Index (PI) between 7 and 20.

C. Select fill used for backfilling shall either be material as described in Paragraph B above or a granular soil material with a Maximum Plasticity Index (PI) of 6.

D. Regardless of material used as select fill, materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 2% below nor more than 2% above the optimum moisture content for the particular material tested in accordance with the ASTM D698.

E. Select fill used as subgrade support shall be a coarse aggregate material meeting the gradation requirements of #57 or #78 aggregates in accordance with ASTM C-33, or Aggregate Base Course (ABC) as defined in Section 02207 – Aggregate Materials.

F. Where excavated material does not meet requirements for select fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein. Determination of whether the borrow material will be paid for as an extra cost will be made based on Article 4 of the General Conditions, as amended by the Supplementary Conditions. When the excavated material from required excavations is suitable for use as backfill, bedding, or embankments, but is replaced with off-site borrow material for the Contractor's convenience, the costs associated with such work and material shall be borne by the Contractor.

2.02 TOPSOIL

A. Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

B. Contractor shall submit test results performed ed by a soils laboratory or soil cooperative service indicating topsoil supplied for the project has the following characteristics:

a. **Texture** - Loam, sandy loam, and silt loam are best; sandy clay loam, silty clay loam, clay loam, and loamy sand are fair. Do not use heavy clay and organic soils such as peat or muck as topsoil

b. **Organic matter content** - Greater than 1.5% by weight.

c. **Acidity -** pH should be greater than 3.6 before liming, and liming is required if it is less than 6.0.

d. **Soluble salts** - Shall be less than 500 ppm.

e. **Sodium** - Sodium adsorption ratio shall be less than 12

2.03 GEOTEXTILES

A. The Contractor shall provide geotextiles as indicated on the Drawings and specified herein. The materials and placement shall be as indicated under Section 02274 - Geotextiles.

PART 3 -- EXECUTION

3.01 STRIPPING OF TOPSOIL

A. In all areas to be excavated, filled, paved, or graveled the topsoil shall be stripped to its full depth and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials.

3.02 EXCAVATION

A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, all other obstacles encountered, and all other obstacles shown to be removed within the limits of excavation shown on the Contract Drawings or specified herein. The cost of excavation shall be included in the Lump Sum Bid Price and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein.

B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER AND/OR MATERIALS TESTING CONSULTANT WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer and/or materials testing consultant such measures are necessary to provide proper construction.

C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.

D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation

shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Engineer before approval is given to proceed.

E. It is the intent of these Specifications that all structures shall bear on an aggregate base, crushed stone or screened gravel bedding placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as specified in Section 15000 - Basic Mechanical Requirements, or as shown on the Drawings.

F. The bottom of all excavations for structures and pipes shall be examined by the Engineer and/or materials testing consultant for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer and/or materials testing consultant, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by the Engineer shall be made as an extra by a Change Order in accordance with the General Conditions and Division 1. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.

G. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.

H. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Engineer at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.

I. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Engineer for this purpose.

3.03 EXCAVATION SUPPORT

A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect pipes and structures from possible damage and to provide safe working conditions. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.

B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations on

proposed systems sealed by a Professional Engineer currently registered in the State of North Carolina.

C. The Contractor shall exercise caution in the installation and removal of supports to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.

D. Contractor shall monitor movement in the excavation support systems as well as movement at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Engineer shall be notified immediately. Contractor shall be exclusively responsible for repair of any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.

E. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and expense of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 1. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

3.04 PROTECTION OF SUBGRADE

A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:

1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.

2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.

3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

3.05 PROOFROLLING

A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material.

3.06 DEWATERING

A. See specification section 02140 – Dewatering.

3.07 EMBANKMENTS

A. The Contractor shall perform the construction of embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment

in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.

B. Surfaces upon which embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing embankment material, the Contractor shall compact the top 12-inches of in place soil as specified under Paragraph 3.09, COMPACTION.

C. Any soft or unsuitable materials revealed before or during the in place compaction shall be removed as indicated by the Engineer and/or materials testing consultant and replaced with select fill.

D. Ground surfaces on which embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.09, COMPACTION.

E. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.

F. Where embankments are to be placed and compacted on hillsides, or when new embankment is to be compacted against embankments, or when embankment is built in part widths, the slopes that are steeper than 4:1 shall be loosened or plowed to a minimum depth of 6 inches or, if in the opinion of the Engineer, the nature of the ground is such that greater precautions should be taken to bind the fill to the original ground then benches shall be cut in the existing ground as indicated by Engineer.

G. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the final grade. Stones, fragmentary rock, or boulders larger than 12-inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be

exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

3.08 BACKFILLING

A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.09, COMPACTION.

B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

3.09 COMPACTION

A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

	Density % Std. Proctor (D698)	Density % Mod. Proctor (D1557)	Max. Lift Thickness as Compacted Inches
Embankments Beneath Structures, Roadways, and Sidewalks*	98	95	8
Other Embankments	95	92	8
Backfill Around Structures	95	92	8
Backfill in Pipe Trenches	95	92	8
Crushed Stone Beneath Structures	**	**	12
Select Sand	--	98	8
Aggregate Base Course (ABC) Beneath Pavements and Structures	--	98	8
Crushed Stone Backfill	**	**	12

	Density % Std. Proctor (D698)	Density % Mod. Proctor (D1557)	Max. Lift Thickness as Compacted Inches
Crushed Stone Pipe Bedding	**	**	12
In place Subgrade Beneath Structures	98	95	Top 12-inches

* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope.

** The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

B. Field density tests will be made by the materials testing consultant to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The Engineer in conjunction with the materials testing consultant will be the judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.

C. Testing will be performed as frequently as deemed necessary by the Engineer and/or materials testing consultant. As a minimum, one in-place density test shall be performed for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either.

3.10 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.

B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.

C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.

D. All excess and unsuitable materials shall be hauled in trucks of sufficient capacity and tight construction to prevent spillage. Trucks shall be covered to prevent the propagation of dust.

E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

3.11 BORROW EXCAVATION

A. Description

The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfill and incorporated into the embankments.

B. Coordination with Seeding Operations

The Contractor shall coordinate the work covered by this section with the construction of embankments so that the requirements of Section 02200 are met.

C. Materials

All material shall meet the requirements of Division 2 shown below:

Borrow Material .....Section 02200, Subsection 2.01 - Select Fill

D. Construction Methods

1. General

The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 02100.

Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control measures as may be approved by the Engineer.

The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.

Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct his hauling operations in such a manner as to not interfere with the normal flow of traffic and shall keep the traffic lanes free from spillage at all times.

2. Owner Furnished Sources

Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.

The Owner will furnish the necessary haul road right-of-way at locations designated by the Engineer. All haul roads required shall be built, maintained, and when directed by the Engineer, obliterated, at no cost to the Owner. Where the haul road is to be reclaimed for cultivation the Contractor shall plow or scarify the area to a minimum depth of 8 inches.

The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided.

All sources shall be seeded and mulched in accordance with Section 02910.

3. Contractor Furnished Sources

Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Engineer prior to performing any work on the proposed borrow source.

The approval of borrow sources furnished by the Contractor shall be subject to the following conditions:

a. The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.

Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

b. Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Engineer for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Contractor's plan shall address the following:

(1) Drainage

The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate.

(2) Slopes

The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.

(3) Erosion Control

The plan shall address the temporary and permanent measures that the Contractor intends to employ during use of the source and as a part of the reclamation. The Contractor's plan shall provide for the use of staged permanent seeding and mulching on a continual basis while the source is in use and the immediate total reclamation of the source when no longer needed.

4. Maintenance

During construction and until final acceptance the Contractor shall use any methods approved by the Engineer which are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

- END OF SECTION -

SECTION 02207

AGGREGATE MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and materials required to complete all work associated with the installation of aggregate material beneath foundations, as backfill and as roadway subgrades and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01090 - Reference Standards

B. Section 02200 - Earthwork

C. Section 02276 - Erosion and Sedimentation Control

D. Section 02510 - Paving and Surfacing

E. Section 02910 - Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures

2. ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.

3. ASTM C 136 Test for Sieve Analysis of Fine and Coarse Aggregates.

4. ASTM C 535 Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Materials gradation and certification.

082905BR

2. ASTM C127, ASTM C136, and ASTM C535 test results

PART 2 -- PRODUCTS

2.01 CRUSHED STONE, SCREENED GRAVEL and AGGREGATE BASE COURSE (ABC)

A. Crushed stone or screened gravel shall meet the requirements of Aggregate Standard Size No. 57 or No. 67 as defined by NCDOT Standard Specifications.

B. ABC shall meet the requirements of ABC as defined by NCDOT Standard Specifications.

2.02 SELECT SAND

A. Select sand shall meet the requirements of Sections 1005 and 1014 of the NCDOT Standard Specifications for materials and gradation. The size used shall be Standard Size No. 2S or 2MS as listed and defined in Table 1005-2, "Aggregate Gradation", of the NCDOT Standard Specifications.

PART 3 -- EXECUTION

3.01 CRUSHED STONE, SCREENED GRAVEL AND AGGREGATE BASE COURSE (ABC)

A. Contractor shall install crushed stone, screened gravel and ABC in accordance with the NCDOT Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.

1. Unless otherwise stated herein or shown on the Drawings, all mat foundations (bottom slabs) for the proposed structures shall have a blanket of crushed stone or ABC 6-inches thick minimum placed directly beneath the proposed mat. The blanket shall extend a minimum of 12 inches beyond the extremities of the mat.

2. For subgrade preparation at structures and structural fill, the foundation material shall be ABC where specifically specified on Drawings, otherwise, crushed stone or screened gravel shall be used.

3. For ground under drains, pipe bedding, and drainage layers beneath structures the coarse aggregate shall meet the requirements of aggregate standard Size No. 57 or No. 67, as defined by NCDOT Standard Specifications.

3.02 SELECT SAND

A. Contractor shall install select sand in accordance with the NCDOT Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.

- END OF SECTION -

SECTION 02274

GEOTEXTILES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all Geotextiles, including all necessary and incidental items, as detailed or required for the Contractor to complete the installation in accordance with the Drawings and these Specifications.

B. For the location of each type of Geotextile see the Drawings.

1.02 REFERENCES

A. ASTM Standards

1. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles

2. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

3. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles

4. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

B. AASHTO Standards

1. AASHTO M 288-06 (2011) Geotextile Specification for Highway Applications

1.03 SUBMITTALS

A. Prior to shipping to the site, the Contractor shall submit to the Engineer two copies of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile. The Supplier shall also submit three Geotextile samples of each product, 1 yard square each, seamed and unseamed as appropriate, with the mill certificate for each Geotextile type supplied. The mill certificate or affidavit shall attest that the Geotextile meets the chemical, physical and manufacturing requirements stated in the specifications. The samples shall be labeled with the manufacturer's lot number, machine direction, date of sampling, project number, specifications, manufacturer and product name.

B. The Engineer shall be furnished copies of the delivery tickets or other acceptable receipts as evidence for materials received that will be incorporated into construction.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Filter Geotextile shall be a minimum 6-ounce per square yard (nominal) nonwoven needle punched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10. The Geotextiles shall have a minimum threshold water head of 0.25-inches in the "as received" condition.

1. Filter Geotextile shall have a Survivability Class of Class 1 or 2 in accordance with AASHTO M288, unless otherwise specified herein.

B. Cushion Geotextile shall be a minimum 16-ounce per square yard nonwoven needle punched synthetic fabric consisting of continuous filament or staple polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Cushion Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288.

C. Type I Separator Geotextile shall be a minimum 8-ounce per square yard (nominal) nonwoven neddle-punched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Type I Separator Geotextile shall have a Survivability Class of Class 1 or 2 in accordance with AASHTO M288, unless otherwise specified herein.

D. Type II Separator Geotextile shall be a woven slit film or monofilament synthetic fabric consisting of polyester or polypropylene in a manner approved by the Engineer. Geotextile shall be treated to resist degradation due to exposure to ultraviolet light.

1. Type II Separator Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288, unless otherwise specified herein.

E. All Geotextiles shall conform to the properties listed using the test methods listed in Table 1. The Contractor shall be responsible for timely submittals of all confirmation test data for Geotextiles.

PART 3 -- EXECUTION

3.01 SHIPPING, HANDLING AND STORAGE

A. During all periods of shipment and storage, all Geotextiles shall be protected from direct sunlight, temperature greater than 140°F water, mud, dirt, dust, and debris.

B. To the extent possible, the Geotextile shall be maintained wrapped in heavy-duty protective covering until use. Geotextile delivered to the project site without protective covering shall be rejected. After the protective covering has been removed, the Geotextile shall not be left uncovered for longer than fourteen (14) days, under any circumstances.

C. The Owner shall approve the shipping and delivery schedule prior to shipment. The Owner shall designate the on-site storage area for the Geotextiles. Unloading and storage of Geotextiles shall be the responsibility of the Contractor.

D. Geotextiles that are damaged during shipping or storage shall be rejected and replaced at Contractor expense.

3.02 QUALITY ASSURANCE CONFORMANCE TESTING

A. At the option of the Engineer representative samples of Geotextiles shall be obtained and tested by the Engineer to assure that the material properties conform to these Specifications. Conformance testing shall be conducted by the Engineer and paid for by the Owner.

B. Conformance testing shall be completed at a minimum frequency of one sample per 100,000 square feet of Geotextile delivered to the project site. Sampling and testing shall be as directed by the Engineer.

C. Conformance testing of the Geotextiles shall include but not be limited to the following properties:

1. Trapezoidal Tear (ASTM D4533)
2. Grab Tensile Strength (ASTM D4632)
3. Mass Per Unit Area (ASTM D5261)
4. Puncture Resistance (ASTM D6241)

D. The Engineer may add to, remove or revise the test methods used for determination of conformance properties to allow for use of improved methods.

E. All Geotextile conformance test data shall meet or exceed requirements outlined in Table 1 of these Specifications for the particular category of Geotextile prior to installation. Any materials that do not conform to these requirements shall be retested or rejected at the direction of the Engineer.

F. Each roll of Geotextile will be visually inspected by the Engineer or his representative. The Engineer reserves the right to sample and test at any time and reject, if necessary, any material based on visual inspection or verification tests.

G. A Geotextile that is rejected shall be removed from the project site and replaced at the Contractor's expense. Sampling and conformance testing of the Geotextile supplied as replacement for rejected material shall be performed by the Engineer at Contractor's expense.

3.03 INSTALLATION

A. Geotextiles shall be placed to the lines and grades shown on the Drawings. At the time of installation, the Geotextile shall be rejected by the Engineer if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.

B. It is the intent of these Specifications that Geotextiles used to protect natural drainage media be placed the same day as the drainage media to prevent soil, sediment or windblown soils to make contact with the drainage media.

C. The Geotextiles shall be placed smooth and free of excessive wrinkles. Geotextiles shall conform to and be in contact with the approved subgrade.

D. When the Geotextiles are placed on slopes, the upslope fabric portion shall be lapped such that it is the upper or exposed Geotextile.

E. Geotextiles shall be temporarily secured in a manner accepted by the Engineer prior to placement of overlying materials.

F. In the absence of specific requirements shown on the Drawings, the following shall be used for overlaps of adjacent rolls of Geotextile:

GEOTEXTILE TYPE/ APPLICATION	OVERLAP OF ADJACENT ROLLS[(1)] (INCHES)	TRANSVERSE END OVERLAP (INCHES)
Filter Geotextile	6 min	12 min
Cushion Geotextile	12 min	12 min
Separator-Roadway Applications	12 min	24 min
Separator-Slope Protection	18 min	24 min
Separator Geotextile	12 min	18 min

[(1)] Overlaps may be reduced if adjacent panels are sewn or heat bonded where approved by the Engineer.

G. Any Geotextile that is torn or punctured shall be repaired or replaced as directed by the Engineer by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap the existing Geotextile a minimum of 12-inches from any point of the rupture.

H. Any Geotextile that is subjected to excessive sediment buildup on its surface during construction shall be replaced by the Contractor prior to placement of overlying material.

TABLE 1 - MINIMUM REQUIRED GEOTEXTILE PROPERTIES*

GEOTEXTILE PROPERTY	FILTER GEOTEXTILE	CUSHION GEOTEXTILE	TYPE I SEPARATOR GEOTEXTILE	TYPE II SEPARATOR GEOTEXTILE
Geotextile Construction	Nonwoven Needlepunched	Nonwoven Needlepunched	Nonwoven Neddlepunched	Woven
Ultraviolet Resistance, (500 hrs.) ASTM D7238, Average % Strength Retention	70	70	70	70
Grab Tensile Strength (lbs.), ASTM D4632	120	340	160	315
Grab Tensile elongation (%) ASTM D4632	50	50	50	50
Trapezoid Tear Strength (lbs) ASTM D4533	50	155	60	120
Apparent Opening Size (AOS), (mm), ASTM D4751	0.212	N/A	0.212	0.425
Permittivity at 50 mm constant head (sec^{-1}), ASTM D4491	0.5	N/A	1.5	0.1
CBR Puncture Resistance, ASTM D6241 (lb)	340	1100	410	900

*** MINIMUM AVERAGE ROLL VALUE (MARV)**

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SECTION 02276

EROSION AND SEDIMENTATION CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. The Contractor is responsible for implementing Stormwater Control Measures (SCMs) to prevent and minimize erosion and resultant sedimentation in all cleared and grubbed areas during and after construction. This item covers the work necessary for the installation of structures and measures for the prevention of soil erosion and control of sedimentation. The Contractor shall furnish all material, labor and equipment necessary for the proper installation, maintenance, inspection, monitoring, reporting, and removal (where applicable) of erosion prevention and sediment control measures and, if applicable, to cause compliance with all local permits and the State of North Carolina Department of Environmental Quality Construction Stormwater Program General Permit – NCG 010000 to Discharge Stormwater under the National Pollution Discharge Elimination System for Construction Activities, for any land disturbance or construction activity of one (1) acre or more, under this Section 02276.

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B. Any land disturbance as the result of modifications to a site's drainage features or topography requires protection from erosion and sedimentation.

C. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Contract Drawings or established by the Engineer.

D. It is the intent of this Specification that the Contractor conducts the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

E. All work under this Contract shall be done in conformance with and subject to the limitations of the North Carolina Rules and Regulations for Erosion and Sedimentation Control as adopted by the North Carolina Sedimentation Control Commission (15A NCAC, Chapter 4, latest edition).

F. The following excerpts from the regulations are particularly important:

1. Pursuant to North Carolina G.S. 113A-57(2), the angle of graded slopes and fills shall be no greater than the angle that can be retained by vegetative cover or other adequate erosion-control devices or structures.

2. As per North Carolina DEQ Construction Stormwater Program General Permit NCG01, perimeter dikes, swales, ditches and slopes, disturbed areas within High Quality Water (HWQ) Zones, and slopes steeper than 3H:1V following completion of any phase of grading, shall be planted or otherwise provided with temporary or permanent ground cover, devices, or structures sufficient to restrain erosion **within 7 calendar days**.

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3. All other slopes of 3H : 1V or flatter, except those with slopes greater than 50 feet in length or within HWQ Zones, following completion of any phase of grading, shall be planted or otherwise provided with temporary or permanent ground cover, devices, or structures sufficient to restrain erosion **within 14 calendar days**.

G. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sediment control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Contract Drawings shall have the prior acceptance of the Engineer and shall be completed at no additional cost to the Owner.

H. Erosion and sedimentation controls applicable to this project shall be as shown on the Contract Drawings, as specified herein, as indicated by the Engineer and as detailed in the North Carolina Erosion and Sediment Control Planning and Design Manual.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 02100 – Clearing, Grubbing, and Site Preparation

C. Section 02140 – Dewatering

D. Section 02200 – Earthwork

E. Section 02274 – Geotextiles

F. Section 02500 – Surface Restoration

G. Section 02910 – Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. 15A NCAC, Chapter 4

2. North Carolina Erosion and Sediment Control Planning and Design Manual, latest edition

3. North Carolina Department of Environmental Quality Construction Stormwater Program General Permit NCG 010000 to Discharge Stormwater under the National Pollution Discharge Elimination System for Construction Activities, for any land disturbance or construction activity of one (1) acre or more

4. North Carolina Department of Transportation Standard Specifications for Roads and Structures, latest edition

5. North Carolina Department of Environmental Quality Stormwater Design Manual, latest edition

B. See Specification Section 01090 - Reference Standards.

1.04 REGULATORY COMPLIANCE

A. Land disturbance activities are not authorized to begin until after all required erosion and sediment control permits are obtained from the United States, the State of North Carolina and local authorities, as necessary. Contractor is the Co-Primary Permittee and Operator under the provisions of the NPDES Permit. As such, the Contractor will be required to sign certain certifications as described in the NPDES Permit. Contractor shall comply with requirements specified in the Contract Documents, on the approved Erosion Control Plan, and by the Engineer. Contractor shall also comply with all other laws, rules, regulations, ordinances and requirements concerning soil erosion and sediment control established in the United States, the State of North Carolina and local authorities as applicable. The following documents and the documents referenced therein define the regulatory requirements for this Section 02276.

1. NPDES PERMIT: The North Carolina Department of Environmental Quality General Permit NCG 010000 to Discharge Stormwater under the National Pollution Discharge Elimination System for Construction Activities (NPDES permit) governs land disturbance or construction activities of one (1) acre or more. On applicable sites, Contractor is responsible for complying with terms and conditions of this permit.

2. Manual for Erosion and Sediment Control: Contractor shall follow Practices and Standards of the North Carolina Erosion and Sediment Control Planning and Design Manual (NC ESCPDM), latest edition.

B. During the period beginning on the effective date of the permit and lasting until expiration, the Permittee is authorized to discharge stormwater associated with construction activity including clearing, grading and excavation activities resulting in the disturbance of land and related support activities. Such discharges shall be controlled, limited and monitored as specified below.

1. The Contractor, as Co-Primary Permittee and Operator under the provisions of the NPDES Permit, shall submit a plan for compliance with the Owner-provided approved erosion and sedimentation control plan to the Engineer for approval. Plans must include designation of where 7 and 14-day ground stabilization requirements and where basins which comply with surface-withdrawal requirements of the NPDES permit, if applicable, are located. Land disturbing activity shall not commence until the plan is approved by the Engineer. Maintain

an up-to-date copy of the approved plan on the site.

2. Implement the approved plan. Deviation from the plan is allowed only to correct emergency situations of sediment discharge offsite or when minor modifications are made to improve performance of the measures and the approval authority has been notified. Note allowed deviations on the plan maintained on the site.

3. Manage onsite activities such that no adverse impacts to water quality occur from site activities or allowed discharges. The following activities, and others on a site-specific basis, require oversight throughout the construction and development process to assure that all water quality standards are protected.

    a. Equipment Operation and Maintenance: Equipment utilized during the construction activity on a site must be operated and maintained in such a manner as to prevent the potential or actual pollution of the surface or ground waters of the State. Fuels, lubricants, coolants, and hydraulic fluids, or any other petroleum products, shall not be discharged onto the ground or into surface waters. Spent fluids shall be disposed of in a manner so as not to enter the waters, surface or ground, of the State and in accordance with applicable state and federal disposal regulations. Any spilled fluids shall be cleaned up to the extent practicable and disposed of in a manner so as not to allow their entry into the waters, surface or ground, of the State.

    b. Material Handling: Herbicide, pesticide, and fertilizer usage during the construction activity shall be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act and shall be in accordance with label restrictions.

c. Building Material Waste Handling: All wastes composed of building materials shall be disposed of in accordance with North Carolina General Statutes, Chapter 130A, Article 9 - Solid Waste Management, and rules governing the disposal of solid waste (North Carolina Administrative Code Section 15A NCAC 13B). In particular, the following guidelines shall be followed:

i. No paint or liquid wastes in streams or storm drains.

ii. Dedicated area for demolition, construction, and other wastes must be located a minimum of 50' from storm drains and streams unless no reasonable alternatives are available.

iii. Earthen-material stockpiles must be located a minimum of 50' from storm drains and streams unless no reasonable alternatives are available.

iv. Concrete materials onsite, including excess concrete, must be controlled to avoid contact with surface waters, wetlands, or buffers. (Note discharges from onsite concrete plants may require coverage under a separate NPDES permit – NCG140000).

d. Litter and Sanitary Waste: The Permittee shall control the management and disposal of litter and sanitary waste from the site.

C. Violations and Fines

1. Contractor shall be responsible for reimbursing the Owner for any fines incurred as a result of violations to the NC Sedimentation Pollution Control Act, the NPDES General Permit for Stormwater Discharges on Construction Sites, and any applicable delegated local program's sediment control regulations until construction activities are complete and the project is accepted by the Owner. These include fines levied by the NC DEMLR Division of Land Quality, NCDEQ Division of Water Quality and delegated local programs.

2. If violations result in the issuance of a Notice of Violation, the Contractor shall comply with the requirements of the Notice within the specified time period for compliance. Failure to comply could result in the assessment of a penalty for each day of the continuing violation, beginning with the date of the violation.

3. Violations may result in civil and/or criminal penalties which include fines and imprisonment.

1.05 SUBMITTALS

A. Prior to the start of the work, the Contractor shall prepare and submit a plan for implementing the temporary and permanent erosion and sedimentation control measures as shown on the Erosion and Sediment Control Plan approved by the appropriate regulatory authority. Construction work shall not commence until the schedule of work and the methods of operations have been reviewed and approved.

B. The Contractor shall perform inspections of erosion and sedimentation control measures and stormwater discharge outfalls and prepare inspection reports as described in Part 3 of this Section. Copies of the inspection reports shall be submitted to the Engineer on a monthly basis.

C. In accordance with the procedures and requirements set forth in the General Conditions Division 1 and Section 01300 - Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. List of disposal sites for waste and unsuitable materials and evidence of all required permits for use of those sites.

1.06 GUARANTEE

A. All restoration and re-vegetation work shall be subject to the one-year guarantee period of the Contract as specified in the General Conditions.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Materials for use in erosion and sedimentation control devices shall be in accordance with the NC ESCPDM.

B. All erosion and sediment control bid prices shall include all excavation, grading, maintenance, legal sediment disposal, permits and all other work and appurtenances necessary to design, install and maintain the sediment and erosion control measures as detailed herein and in accordance with the NC ESCPDM.

2.02 SILT FENCE

A. Silt (or sediment) fence shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Section 6.62 of the NC ESCPDM. Silt fences shall be installed below small disturbed areas that are less than ¼ acre disturbed per 100-feet of fence when slopes are less than 2%. Contractor shall refer to Table 6.62a in the NC ESCPDM for criteria. Silt fence shall not be installed across streams, ditches, or waterways or other areas of concentrated flows.

B. Silt fence shall be designed, installed and maintained in accordance with Part 3 of this Section and Section 6.62 of the NC ESCPDM. Silt fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalines and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be C-50NW as manufactured by Contech Earth Stabilization Solutions, GT 142 as manufactured by SKAPS Industries, Soiltex ST 120N as manufactured by Geo-

Synthetics, Inc., or approved equal. The cost of silt fence shall include the materials, excavation, backfill, aggregate, etc. and all maintenance and restoration activities required.

C. Silt fence shall be stable for the 10-year peak storm runoff. Fabric shall meet the following specifications:

Temporary Silt Fence Material Property Requirements					
	Test Material	**Units**	**Supported[1] Silt Fence**	**Un-Supported[1] Silt Fence**	**Type of Value**
Grab Strength	ASTM D 4632	N (lbs)			
Machine Direction			400	550	MARV
			(90)	(90)	
x-Machine Direction			400	450	MARV
			(90)	(90)	
Permittivity[2]	ASTM D 4491	sec-1	0.05	0.05	MARV
Apparent Opening Size[2]	ASTM D 4751	mm	0.60	0.60	Max. ARV[3]
		(US Sieve #)	(30)	(30)	
Ultraviolet Stability	ASTM D 4355	% Retained Strength	70% after 500 hours exposure	70% after 500 hours exposure	Typical

[1] Silt Fence support shall consist of 14 gage steel wire with a mesh spacing of 150 mm (6 inches), or prefabricated polymer mesh of equivalent strength.

[2] These default values are based on empirical evidence with a variety of sediment. For environmentally sensitive areas, a review of previous experience and/or site or regionally specific geotextile tests in accordance with Test Method D 5141 should be performed by the agency to confirm suitability of these requirements.

[3] As measured in accordance with Test Method D 4632.

D. The synthetic filter fabric shall consist of at least 95% by weight of polyolefins or polyester, certified by the manufacturer, and as specified by Section 6.62 of the NC ESCPDM.

E. The posts for silt fences shall be 1.33 lb/linear feet steel with a minimum length of 5 feet; posts shall have projections to facilitate fastening of the fabric.

F. For reinforcement of standard strength filter fabric use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.

2.03 STONE FOR EROSION CONTROL

A. The Contractor shall place stone for erosion control as shown on the Contract Drawings, as specified herein, as specified in Section 1610 of the NCDOT Standard Specifications, and as detailed in Section 6.15 of the NC ESCPDM. The stone for erosion control shall consist of field stone or rough un-hewn quarry stone. The stone shall be sound, tough, dense, and resistant to the action of air and water. The stone for erosion control shall be

Class (A) or Class (B) as specified in the NCDOT Standard Specifications, Section 1610, unless otherwise shown on the Contract Drawings.

B. Stone for erosion control shall be designed, installed and maintained in accordance with Part 3 of this Section, Section 1610 of the NCDOT Standard Specifications, and Section 6.15 of the NC ESCPDM. The cost for stone for erosion control shall include furnishing, weighing, stockpiling, re-handling, placing and maintaining stone; disposal of any stone not incorporated into the project if directed by the Engineer; and any other incidentals necessary to complete the work.

2.04 RIP RAP

A. The Contractor shall place rip rap as shown on the Contract Drawings, as specified in Section 1042 of the NCDOT Standard specifications for plain rip rap, and as detailed in Section 6.15 of the NC ESCPDM. The stone for rip rap shall consist of field stone or rough un-hewn quarry stone. The rip rap shall be sound, tough, dense, and resistant to the action of air and water. Neither the width nor thickness of individual stones shall be less than one third their length. The rip rap shall be Class 1 or Class 2 as specified in the NCDOT Standard Specifications, Section 1042, unless otherwise shown on the Contract Drawings.

B. Rip rap shall be designed, installed and maintained in accordance with Part 3 of this Section, Section 1042 of the NCDOT Standard Specifications, and Section 6.15 of the NC ESCPDM. The cost for rip rap shall include furnishing, weighing, stockpiling, rehandling, placing and maintaining rip rap; disposal of any rip rap not incorporated into the project if directed by the Engineer; and any other incidentals necessary to complete the work.

2.05 ROLLED EROSION CONTROL MATTING (RECMs)

A. RECMs, including Turf Reinforcement Mat (TRM), shall be installed as shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Section 6.17 of the NC ESCPDM. RECMs should be utilized to aid stabilization of slopes greater than 2:1 and with more than 10 feet of vertical relief. RECMs should also be used when mulch cannot be adequately tacked and where immediate ground cover is required to prevent erosion damage. Examples of RECMs are blankets, nets and matting.

B. RECMs shall be designed, installed and maintained in accordance with Part 3 of this Section and Section 6.17 of the NC ESCPDM. The cost for RECMs shall include all excavation, grading, and materials, and all maintenance activities.

C. RECMs shall be used to aid in permanent stabilization of vegetated channels where runoff velocity will exceed 2 feet/second on bare earth during the 2-year rainfall event that produces peak runoff.

D. RECMs shall be chosen based on the Design Criteria detailed in Section 6.17 of the NC ESCPDM. Typically, nets shall be used in conjunction with mulch; the use of mulch is typically not required with excelsior, woven straw blankets and coir blankets.

E. The recommended anchoring devices are 12-inch minimum length wooden stakes, 11-gauge staples that are at least 6 inches long by 1 inch wide, or rigid, biodegradable stakes of a minimum of 6 inches in length. If Manufacturer's recommendations are more stringent, they shall supersede.

F. The minimum bare soil shear stress values for specific RECMs are as follows:

1. Straw with net temporary RECM shall be North American Green S150, American Excelsior Co. Curlex I, Contech SFB1, or equal with a minimum bare soil shear stress value of 1.5 lb/ft^2.

2 Curled wood or coconut fiber RECM shall be American Excelsior Curlex II, North American Green C125, Contech EFB4 or equal matting with a minimum bare soil shear stress value of 2.0 lb/ft^2.

3. Synthetic Turf Reinforcement Mat (TRM) shall be Enkamat 7020 as manufactured by Colbond Geosynthetics, Synthetic Industries Landlock Erosion Mat TRM 1060, TH8 as manufactured by TC Mirafi, or equal matting with a minimum long-term vegetated shear stress value of 5.0 lb/ft^2.

2.06 TEMPORARY AND PERMANENT DIVERSIONS

A. Temporary diversions shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Sections 6.20 and 8.05 of the NC ESCPDM. Permanent diversions shall be constructed as shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Section 6.21 and 8.05 of the NC ESCPDM. Temporary diversions shall be constructed adjacent to disturbed areas to collect surface runoff from disturbed areas and direct the runoff to sediment basins or to divert non-sediment laden runoff away from undisturbed areas and/or sediment basins. All temporary diversions transporting sediment-laden runoff shall terminate in a sediment trapping device. Permanent diversions should be planned as a part of initial site development and should be coordinated with temporary diversions. All temporary and permanent diversions shall be stabilized with vegetation or other means within 7 days of installation. Permanent diversions shall be used to divert water to locations where it can be used or released without erosion or flood damage. Dimensions shall be as shown on the Contract Drawings.

B. Temporary diversions shall be designed, installed and maintained in accordance with Part 3 of this Section and Sections 6.20 and 8.05 of the NC ESCPDM, to the satisfaction of the Engineer, until the site has been stabilized. Permanent diversions shall be designed, installed and maintained in accordance with Part 3 of this Section and Sections 6.21 and 8.05 of the NC ESCPDM. The cost of temporary and permanent diversions shall include the excavation, grading, materials, etc. and all maintenance and restoration activities required.

2.07 TEMPORARY GRAVEL CONSTRUCTION ENTRANCES/EXITS

A. Temporary gravel construction entrances/exits shall be located at points where vehicles enter and leave a construction site, at other locations indicated by the Engineer, as specified herein, and as detailed in Section 6.06 of the NC ESCPDM.

B. Temporary gravel construction entrances/exits shall be constructed with a minimum 6 inch layer of 2 – 3 inch washed stone placed over a stable foundation and shall be a minimum of 100 feet in length and 25 feet in width. Geotextile fabric shall be used under stone as shown on the Contract Drawings.

C. Temporary gravel construction entrances/exits shall be designed, installed and maintained in accordance with Part 3 of this Section and Section 6.06 of the NC ESCPDM, to the satisfaction of the Engineer, until the site has been stabilized. The cost of temporary gravel construction entrances/exits shall include the materials and all maintenance activities required, including additional tire washing as may be necessary.

2.08 TEMPORARY AND PERMANENT STABILIZATION OF DISTURBED AREAS

A. Temporary and permanent stabilization of disturbed areas will be provided at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Sections 6.10, 6.11, 6.12 and 6.14 of the NC ESCPDM. The Contractor shall provide ground cover adequate to restrain erosion on disturbed areas that will be left un-worked for periods exceeding 7 to 14 days, as noted in Section 1.01. F. of this specification.

B. Soil amendments, including lime and fertilizer, shall be as detailed in Sections 6.10, 6.11 and 6.12 of the NC ESCPDM.

C. Seed mixtures shall be selected based on site location and seasonal recommendations outlined in Sections 6.10 and 6.11 of the NC ESCPDM. Sod shall be selected based on site location and intended use as outlined in Section 6.12 of the NC ESCPDM.

D. Mulch shall be as detailed in Section 6.14 of the NC ESCPDM. RECMs shall be as detailed in 2.05 herein and in Section 6.17 of the NC ESCPDM.

E. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "MA-60 Soil Stabilizer" by Enviroseal Corporation, "BIND | ATLAS SUPERDUTY" by Quattro Environmental, Inc., or "VERTEX" by LSC Environmental Products, Inc., and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

F. Temporary and permanent stabilization of disturbed areas shall be achieved in accordance with Part 3 of this Section and Sections 6.10, 6.11, 6.12, 6.14 and 6.17 of the NC ESCPDM. The cost of temporary and permanent stabilization of disturbed areas shall include all grading, excavation and materials as well as all reseeding and other maintenance activities required until stabilization is achieved.

2.09 INLET EROSION CONTROL MEASURES

A. Yard, Curb and other Inlet Erosion Control Measures shall be constructed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Sections 6.50 through 6.55 of the NC ESCPDM. Inlet erosion control measures shall be used to prevent or limit the introduction of sediment to storm drain systems and allow early use of the of the storm drainage system. Maximum drainage areas for inlet erosion control measures vary from 1 acre for excavated drop inlet protection, hardware & cloth gravel inlet protection, and block and gravel inlet protection to more than 5 acres for rock pipe inlet protection. In addition to the inlet protection measures described in the NC ESCPDM, other measures may be specified by the Engineer. For measures not detailed in the NC ESCPDM, the materials will be as specified by the Engineer's and Manufacturer's instructions, with more stringent specifications superseding.

B. Materials for Inlet Erosion Control Measures consist of silt fence, riprap, stone (gravel), hardware wire, sod, concrete blocks, and sediment logs. Riprap and stone for erosion control shall be as specified herein. Hardware wire shall be as specified in Section 6.51 of the NC ESCPDM. Sod shall conform to the specifications set forth in Section 6.12 of the NC ESCPDM. Concrete blocks shall be as specified in Section 6.52 of the NC ESCPDM. Material specifications for sediment logs appear within. If Manufacturer's recommendations are more stringent, they shall supersede.

C. Inlet Erosion Control Measures shall be designed, installed and maintained in accordance with Part 3 of this Section and Sections 6.50 through 6.55 of the NC ESCPDM. Measures not described in the NC ESCPDM shall be designed, installed, and maintained in accordance with the Engineer's and Manufacturer's instructions, with more stringent instructions superseding. The cost of inlet erosion control measures shall include all excavation, grading and materials as well as all maintenance activities required.

2.10 FIBER FILTRATION TUBES (FFTs) AND SEDIMENT LOGS

A. FFTs and sediment logs shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, and as specified herein.

B. FFTs shall consist of composite wood fibers and man-made fibers, with or without performance-enhancing polymers, encased with cylindrical tubes composed of a heavy-duty, knitted, high density polyethylene mesh. The photodegradable mesh shall be oriented in a diamond or hexagonal pattern and shall move freely at all knitted yarn intersections.

C. Sediment logs shall consist of natural fibers (wood, coconut, etc.) inside heavy duty knitted cylindrical tubing.

D. FFTs and sediment logs shall be designed, installed and maintained as specified herein. If Manufacturer's recommendations are more stringent, they shall supersede. The cost of FFTs shall include all excavation, grading and materials as well as all maintenance activities required.

2.11 TEMPORARY AND PERMANENT CHANNELS

A. Temporary and permanent channels shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Sections 6.30, 6.31 and 8.05 of the NC ESCPDM. Temporary and permanent channels shall be used to convey concentrated runoff without damage from erosion, deposition or flooding.

B. Temporary and permanent channels shall be designed, installed and maintained in accordance with Part 3 of this Section and Sections 6.30, 6.31 and 8.05 of the NC ESCPDM. The cost of all temporary and permanent channels shall include all excavation, grading and materials as well as all maintenance activities required.

2.12 TREE PROTECTION FENCE

A. Tree protection fence shall be installed at the locations shown on the Contract Drawings, at other locations indicated by the Engineer, as specified herein, and as detailed in Section 6.05 of the NC ESCPDM.

B. Tree protection fence shall used to protect trees and their root zones during construction. Tree protection fence shall be brightly colored, UV-resistant poly barricade fabric. Signs designating the area as protected shall be installed on all sides of the fence. Wording and spacing of the signage shall be as indicated on the Contract Drawings.

C. Tree protection fence shall be installed and maintained in accordance with Part 3 of this Section and Section 6.05 of the NC ESCPDM. The cost of tree protection fence shall include all materials as well as all maintenance activities required.

2.13 FILTER BAGS

A. Temporary filter bag sediment control bags for use in dewatering and retaining sediment pumped out of active 'dirty' project areas, such as stream restoration projects, where water is pumped from work area, sent through the bag and flow is then released from the bag to discharge on a stable flood plain or other secure area.

B. The filter bag shall be a nonwoven bag which is sewn with a double needle matching using a high strength thread. The dewatering bag must be made of non-woven geotextile with a minimum surface area of 225 square feet per side. Each sack is required to have a fill spout large enough to accommodate a 4-inch discharge hose. Straps are to be attached such that the hose is secure, and the hose prevents pumped water from escaping without being filtered.

C. The geotextile fabric shall be non-woven and shall meet the following properties:

Properties	Test Method	Units	Value
Weight	ASTM D-3776	Oz/yd	12
Grab Tensile	ASTM D-4632	lbs	300
Puncture	ASTM D-4833	lbs	180
Flow Rate	ASTM D-4491	gal/min/ft^2	75
Permittivity	ASTM D-4491	sec^{-1}	1.1
Mullen Burst	ASTM D-3786	psi	550
UV Resistant	ASTM D-4355	%	70
AOS% Retained	ASTM D-4751	%	100

PART 3 -- EXECUTION

3.01 INSTALLATION AND MAINTENANCE

A. All installation and maintenance shall be conducted in accordance with this specification and the NC ESCPDM. In the event of a discrepancy between this specification, Manufacturer's recommendations and the NC ESCPDM, the more stringent requirements shall take precedence.

B. If applicable, all requirements of the NPDES Permit shall be followed. In the event of a discrepancy between this specification and the NPDES Permit requirements, the more stringent requirements shall take precedence.

C. If possible, erosion and sedimentation control devices shall be established prior to clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established concurrent with the clearing operations or immediately following completion of the clearing operations.

D. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. At a minimum, maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Note that specific maintenance intervals for various measures and practices are specified within the NC ESCPDM. Of the maintenance requirements specified herein and in the NC ESCPDM, the more stringent shall take precedence for each and every sediment and erosion control measure utilized on the site. Maintenance shall include but not be limited to 1) the removal and satisfactory, legal disposal of accumulated sediment from traps or silt barriers and 2) replacement of filter fabrics used for silt fences and stone impaired by sediment in stone filters, gravel construction entrances, etc. Maintenance as noted in items 1) and 2) above shall be performed as required, and at least once every 3 months for the duration

of construction activities. Sediment removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in off-site sedimentation as acceptable to the Engineer, at no additional cost to the Owner. If no suitable on site locations are available, all such sediment will be legally disposed of off site, at no additional cost to the Owner.

3.02 SILT FENCE

A. Silt Fence shall be designed, installed and maintained in accordance with the requirements of Section 6.62 of the NC ESCPDM. Silt fence shall be erected at the locations shown on the Contract Drawings and at all other locations as may be directed by the Engineer. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Replacement of the filter fabric and its associated appurtenances, if required by the Engineer, will be at the Contractor's expense.

B. Silt fence shall not be installed across streams, ditches, waterways or other areas of concentrated flow. Silt fence shall be placed at least 6 feet beyond the toe of slope of any embankment or stockpile area to allow space for ponding and maintenance access.

C. Dig a trench approximately 8 inches deep and 4 inches wide and place the fabric in the bottom of the excavated ditch or use the slicing method to insert the fabric into a cut sliced in the ground with a disc. Ensure that the height of the sediment fence does not exceed 24 inches above the ground surface.

D. Install posts 4 feet apart in critical areas and 6 feet apart on standard applications when extra strength filter fabric is used. When wire mesh support is used, posts shall be installed a maximum of 8 feet apart. Install posts 2 feet deep on the downstream side of the silt fence, as close as possible to the fabric.

E. Joints should be avoided along the fencing. When joints are necessary, securely fasten the filter cloth only at a support post with 4 feet minimum overlap to the next post.

F. Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of 4 trips.

G. Stabilized outlets for silt fence shall be provided at locations shown on the Contract Drawings. The outlet section shall have a maximum width of 4 feet. The height of silt fence at the outlet shall be a maximum of 1 foot. A 5 foot x 5 foot (minimum) apron of #57 washed stone shall be provided on the downstream side of the silt fence outlet.

H. Silt fence shall be erected around all catch basins which are located downstream from any construction work unless other inlet protection is specified. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins. Upon completion of the modification, the area shall be rough graded, as shown on the Contract Drawings, until the end of the project, at which time final grading shall occur.

I. Inspect silt fence at least once a week and after each rainfall event. Make any required repairs immediately.

J. Should the fabric of any silt fence collapse, tear, decompose or become ineffective, replace it promptly. All fabric shall be replaced after the first 6 months of construction activity and every 6 months thereafter until construction activities are complete, unless otherwise directed by the Engineer..

K. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.

L. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized. Removal of any silt fence shall be permitted only with the prior approval of the Engineer or the local governing agency.

3.03 STONE FOR EROSION CONTROL

A. Stone for erosion control shall be designed, installed, and maintained in accordance with the requirements of Section 6.15 of the ESCPDM. Stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above, to protect structures from damage when rock material is placed against the structures, or to protect the underlying Separator Geotextile from damage during installation.

B. Inspect at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Remove accumulated sediment and replace stone impaired by sediment as necessary.

3.04 RIPRAP

A. Riprap shall be designed, installed and maintained in accordance with the requirements of Section 6.15 of the NC ESCPDM. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone. The placed riprap shall have a minimum depth of 24 inches unless otherwise specified by the Engineer. Type II Separator Geotextile, as specified in Section 02274 – Geotextiles, shall be used under all riprap unless otherwise noted.

B. Inspect periodically for scour or dislodged stones. Control of weed and brush growth may be needed.

3.05 ROLLED EROSION CONTROL MATTING (RECM)

A. RECMs shall be designed, installed and maintained in accordance with the requirements of Section 6.17 of the NC ESCPDM. The Engineer may direct the Contractor to place

RECMs in permanent channels or on slopes at other locations in addition to those shown on the Contract Drawings. If Manufacturer's instructions are more stringent, they shall supersede.

B. The Contractor shall place the RECMs where directed immediately after the channel or slope has been properly graded and, if applicable, prepared, fertilized, and seeded.

C. Grade the surface of the installation area so that the ground is smooth and loose. When seeding prior to installation, follow the steps in Section 6.10 (Temporary Seeding) and 6.11 (Permanent Seeding) of the NC ESCPDM as applicable. Remove all large rocks, debris, etc. so as to ensure that good contact between the RECM and the ground is maintained so that no erosion occurs beneath the RECM. Terminal anchor trenches are required at RECM ends and intermittent trenches must be constructed across channels at 25-foot intervals. Terminal anchor trenches should be a minimum of 12 inches in depth and 6 inches in width, while intermittent trenches should be a minimum of 6 inches deep and 6 inches wide. Take care to maintain direct contact between the soil and the RECM.

D. For slope installation, place RECM 2-3 feet over top of slope and into an approximately 12 inch deep by 6 inch wide excavated end trench. Using staples, stakes, or pins, anchor the RECM at 1 foot intervals along the bottom of the trench, backfill, and compact. Along the slope, pin the RECM in a 3 foot center-to-center pattern; provide a minimum 3 inch overlap for adjacent rolls.

E. For channel installations, excavate 12 inch deep by 6 inch wide terminal trenches across the upper and lower end of the lined channel. Anchor the RECM at a minimum of 25 foot intervals utilizing either two rows of anchors or 6 inch by 6 inch cross trenches. Bury outside RECM edges in longitudinal trenches 6 inches deep and wide along the channel edges. Pin the RECM in at 1 foot intervals along the bottom of terminal trenches, backfill, and compact. Overlap adjacent rolls a minimum of 3 inches and pin at 1 foot intervals. Place the first RECM at the downstream end of the channel and unroll upstream. When starting installation of a new roll, begin in a trench or shingle-lap ends of rolls a minimum of 1 foot with upstream RECM on top to prevent uplifting.

F. Staples, stakes, and pins shall be driven so that the top is flush with the ground.

G. During the establishment period, check RECMs at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Immediately make repairs. Good contact with the ground must be maintained. Monitor and repair the RECM as necessary until ground cover is established.

3.06 TEMPORARY AND PERMANENT DIVERSIONS

A. Temporary diversions shall be designed, installed and maintained in accordance with the requirements of Sections 6.20 and 8.05 of the NC ESCPDM. Permanent diversions shall be designed, installed, and maintained in accordance with the requirements of Sections 6.21 and 8.05 of the NC ESCPDM. The Contractor shall provide temporary and permanent diversions at all locations noted on the Contract Drawings and at all other locations as may be directed by the Engineer.

B. Remove and properly dispose of all trees, debris, etc. Fill and compact all ditches, swales, etc. that will be crossed to natural ground level or above.

C. Excavate, shape and stabilize diversions as shown on the Contract Drawings and described herein. Unless otherwise noted, provide vegetative stabilization immediately after installation of permanent diversions. Temporary diversions that are to serve longer than 7 working days shall be seeded and mulched as soon as they are constructed to preserve dike height and reduce maintenance. Seed and mulch disturbed areas draining into the diversions within 14 calendar days of completing any phase of grading.

D. For temporary diversions, ensure that the top of the dike is not lower at any point than the design elevation plus the specified settlement. Provide sufficient room around temporary diversions to permit machine re-grading and cleanout. Vegetate the ridge of temporary diversions immediately after construction unless they will remain in place less than 7 working days.

E. Provide outlet protection adequate to accept flow from diversion plus any other contributing runoff. Sediment-laden runoff shall be routed through a sediment-trapping device.

F. Inspect temporary diversions once a week and after every rainfall event. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it. Inspect permanent diversions weekly and after every rainfall event during construction operations until permanent vegetation is established. After vegetation is established, inspect after major storms. Immediately remove any debris and make repairs as needed in a timely manner. Maintain healthy vegetation at all times.

3.07 TEMPORARY GRAVEL CONSTRUCTION ENTRANCES/EXITS

A. Temporary gravel construction entrances/exits shall be designed, installed and maintained in accordance with the requirements of Section 6.06 of the NC ESCPDM. The Contractor shall provide temporary gravel construction entrances/exits at all locations noted on the Contract Drawings and at all other locations as may be directed by the Engineer.

B. Maintain the gravel pad as specified in Section 6.06 of the NC ESCPDM and in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2 – 3 inch stone. Inspect each construction entrance at least weekly and after each rainfall event and replace stone impaired by sediment as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.

C. If, despite the use of a gravel construction entrance/exit, most of the mud and sediment are not removed from vehicle tires, tire washing may be necessary as detailed in Section 6.06 of the NC ESCPDM. If necessary this shall be done at no additional cost to the Owner.

3.08 TEMPORARY AND PERMANENT STABILIZATION OF DISTURBED AREAS

A. The Contractor shall temporarily stabilize disturbed areas that will not be brought to final grade within 14 calendar days unless as noted in 1.01 F. of this Section. Temporary seeding shall be applied on areas that include diversions, dams, temporary sediment basins, temporary road banks and topsoil stockpiles. Areas to be stabilized with permanent vegetation must be seeded or planted within 14 working days after final grade is reached, unless temporary stabilization is applied. Temporary seeding provides protection for no more than 1 year, after which permanent stabilization should be initiated.

B. Complete grading before preparing seedbeds, and install all necessary erosion control measures. Minimize steep slopes. If soils become compacted during grading, loosen to a depth of 6-8 inches.

C. Reseed and mulch temporary seeding areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.

D. Refer to Section 6.10 of the NC ESCPDM for additional information and specifications regarding seedbed requirements, plant selection, seeding and mulching for temporary seeding applications.

E. The operation of equipment is restricted on slopes steeper than 3:1. Provisions for vegetation establishment can be made during final grading. Vegetation chosen for these sites must not require mowing or other intensive maintenance. Good mulching practices are critical for protecting against erosion on steep slopes.

F. Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect seeded areas for failure and make necessary repairs and reseedings within the same season, if possible.

G. Reseeding – If a stand has inadequate cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary, annual species if the time of year is not appropriate for permanent seeding.

H. If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.

I. Fertilization - On the typical disturbed site, full establishment usually requires re-fertilization in the second growing season. Fine turf requires annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixture.

J. Refer to Section 6.11 of the NC ESCPDM for additional information and specifications regarding seedbed requirements, plant selection, seeding and mulching for permanent seeding applications.

K. Refer to Section 6.12 of the NC ESCPDM for additional information and specifications regarding soil preparation, sod selection, installation, and maintenance for sodding.

L. Inspect all seeded areas weekly and after heavy rains until permanent cover is established. Inspect within 6 weeks of planting to see if stands are adequate. Fertilize, reseed and mulch damaged and sparse areas immediately.

3.09 INLET EROSION CONTROL MEASURES

A. Inlet erosion control measures shall be designed, installed and maintained in accordance with the applicable requirements of Sections 6.50 through 6.55 of the NC ESCPDM. If inlet erosion control measures shown on the Contract Drawings are not included in the NC ESCPDM, Engineer's and Manufacturer's instructions for design, installation, and maintenance shall be followed, with more stringent instructions superseding. The Contractor shall provide inlet erosion control measures at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.

B. Excavated drop inlet protection shall be installed and maintained in accordance with Section 6.50 of the NC ESCPDM. Drainage area is limited to 1 acre. The minimum volume of excavated area around the drop inlet is 1800 ft^3/acre disturbed. Minimum depth of the excavated area shall be 1 foot and maximum depth shall be 2 feet as measured from the crest of the inlet structure. Weep holes shall be protected by gravel. Inspect the excavated basin at least weekly and after every storm event until the contributing drainage area has been permanently stabilized. Remove sediment when the storage volume has been reduced by one-half.

C. Block and gravel inlet protection shall be installed and maintained in accordance with Section 6.52 of the NC ESCPDM. Drainage area shall be limited to 1 acre unless site conditions allow for frequent removal of accumulated sediment. The height of the block barrier shall be no more than 12 inches and no less than 24 inches. On the bottom row, place some of the blocks on their side to allow for dewatering. Place wire mesh over all block openings to hold gravel in place. Lateral support may be provided by placement of 2 x 4 wood studs through block openings. Place gravel 2 inches below the top of the block barrier. The top elevation of the structure must be at least 6 inches below the ground elevation downslope from the inlet to ensure that all stormwater flows over the structure and enters the storm drain instead of bypassing the structure. Block and gravel inlet protection shall not be used near the edge of fill material and shall not divert water away from the storm drain. Inspect at least weekly and after every storm event until the contributing drainage area has been permanently stabilized. Remove sediment as necessary to provide adequate storage volume for subsequent rains. Replace stone as needed.

D. Rock pipe inlet protection shall be installed and maintained in accordance with Section 6.55 of the NC ESCPDM. Rock pipe inlet protection may be used at pipes with a maximum diameter of 36 inches. It shall not be installed in intermittent or perennial streams. The minimum crest width of the riprap berm shall be 3 feet, with a minimum bottom width of 11 feet and minimum height of 2 feet. The top of the riprap shall be 1 foot lower than the shoulder of the embankment or diversions. The outside face of the riprap should be covered with a 12-inch thick layer of #5 or #57 washed stone. The

sediment storage area should be excavated upstream of the rock pipe inlet protection, with a minimum depth of 18 inches below grade. The rock pipe inlet protection shall be inspected at least weekly and after any storm event of greater than 1 inch of rain per 24-hour period. Repairs shall be made immediately. Remove sediment when the volume of the sediment storage area has been decreased by one-half and replace the contaminated part of the gravel facing.

3.10 FIBER FILTRATION TUBES (FFTs) AND SEDIMENT LOGS

A. FFTs and sediment logs shall be placed along slopes to function as slope breaks and to minimize sediment transport and in diversions/channels to serve as check dams. The Contractor shall provide FFTs and sediment logs at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.

B. FFTs and sediment logs shall be installed to maintain contact with the soil surface. Install prior to seeding. May be installed before or after installation of RECMs.

C. Anchor the upstream/upslope side of the FFTs using wire staples or approved devices at 1-foot intervals. Drive wooden stakes through downstream/downslope side of the FFTs at 2-foot intervals. Take care not to compress the FFTs. Backfill and compact loose soil against the upstream/upslope side. Overlap adjacent FFT ends by a minimum of 1 foot.

D. For channel installation, construct anchor trench 3 inches deep by FFT diameter and place loose soil against upstream side of FFT. For channel gradients of 2%, install trenches on 25-foot intervals. Decrease interval distance with steeper channel gradients or more highly erosive soils.

E. Any sediment accumulation at the base of the FFT must be removed when it reaches one-third of the height of the tube. FFT may need to be removed if fully loaded with captured sediment for maximum product performance. FFTs are to be left in place or removed from the site as directed by the Engineer.

F. Sediment logs do not require installation trenches. Wood stakes shall be placed at least every 2 feet along the length of the sediment log. Stakes shall only penetrate the netting around the log. They shall not be driven through the center of the log. Sediment logs are to be left in place or removed from the site as directed by the Engineer.

G. The FFTs and sediment logs shall be shall be inspected at least weekly and within 24 hours after any storm event of greater than 1 inch of rain per 24-hour period. Look for signs of flow undercutting the logs. Re-anchor and replace as necessary.

3.11 TEMPORARY AND PERMANENT CHANNELS

A. Temporary and permanent channels shall be designed, installed and maintained in accordance with the requirements of Sections 6.30, 6.31 and 8.05 of the NC ESCPDM. The Contractor shall provide temporary and/or permanent channels at all locations noted on the Contract Drawings, and at all other locations as may be directed by the Engineer.

B. Remove all trees, brush, stumps, etc. from the channel area and dispose of properly.

C. Excavate the channel to the dimensions shown on the plans, over-excavating to allow for liner thickness. Remove and properly dispose of all excess soil so that surface water may enter the channel freely.

D. Armor the channel as specified on the Contract Drawings. If the specified channel lining requires an establishment period, protect the channel with mulch or a temporary liner sufficient to withstand anticipated velocities during this period.

E. During the establishment period, inspect channels weekly and after every rainfall. After lining has been fully established, inspect channels after any storm event of greater than 1 inch of rain per 24-hour period. Immediately make repairs.

F. Perform all channel construction to keep erosion and water pollution to a minimum. Immediately upon completion of the channel, vegetate all disturbed areas or otherwise protect them against soil erosion. Where channel construction will take longer than 7 days, stabilize channels by reaches.

G. Inspect the channel outlet and all road crossings for bank stability and evidence of piping or scour holes. Give special attention to outlets and points where concentrated flow enters the channel.

H. Maintain all vegetation adjacent to and in the channel in a healthy, vigorous condition to protect the area from erosion.

I. Remove all significant sediment accumulations to maintain the designed carrying capacity.

3.12 TREE PROTECTION FENCE

A. Tree protection fence shall be installed and maintained in accordance with the requirements of Section 6.05 of the NC ESCPDM. If Manufacturer's recommendations are more stringent, they shall supersede.

B. Install tree protection fence around all designated tree protection areas prior to clearing, deliveries, and other construction activities onsite. Post signs designating area as protected on all sides of the fencing.

C. Inspect tree protection fence weekly. Repair and replace as needed.

3.13 ADDITIONAL REQUIREMENTS

A. All storm sewer piping shall be blocked at the end of every working day until the inlet is constructed above grade.

B. All streets around the construction area shall be scraped as necessary to prevent accumulation of dirt and debris.

C. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains, curb inlets (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed

upstream of any trench or other excavation to prevent sedimentation of offsite areas. Silt fence will be provided, at no additional cost to the Owner, around excavation materials if deemed necessary by the Engineer. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.

D. The Engineer may direct the Contractor to place any additional sediment and erosion control devices at other locations not shown on the Drawings.

3.14 INSPECTIONS AND MAINTENANCE

A. The Contractor shall designate an Authorized Representative to perform inspections and maintenance as described herein. Contractor shall perform regular inspections and maintain records as follows:

1. Inspections shall be performed, at a minimum, once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24 hour period.

2. A rain gauge shall be maintained in good working order on the site and all rainfall amounts recorded throughout the duration of construction activities.

3. Inspection reports must be available on-site during business hours unless a site-specific exemption is approved.

4. Inspection records must be kept for 3 years following completion of construction and be available upon request.

5. Electronically-available records may be substituted under certain conditions as approved by Land Quality and DEQ.

B. During inspections the following will be observed and appropriate maintenance activities shall be performed:

1. The conformance to specifications and current condition of all erosion and sediment control structures.

2. The effectiveness and operational success of all erosion and sediment control measures.

3. The presence of sediments or other pollutants in storm water runoff at all runoff discharge points.

4. The presence of sediments or other pollutants in receiving waters.

1. Evidence of off-site tracking at all locations where vehicles enter or exit the site.

6. Evidence of impacts to water quality due to site activities pertaining to equipment operation and maintenance, material handling, and material storage and construction laydown areas exposed to precipitation.

C. Immediate action shall be taken to repair/maintain erosion and sediment control measures that are not performing as designed. The State reserves the right to stop all construction activities not related to these measures until such deficiencies are repaired.

D. In areas that have undergone final stabilization, inspections and, if necessary, maintenance by Contractor will occur at least once per month for the duration of the contract or project, whichever is longer.

3.15 MONITORING AND REPORTING

A. Monitoring: The Contractor shall be responsible for the implementation of the Inspections and Maintenance Procedures as included in the approved erosion and sediment control plan. The implementation must comply with guidelines as set forth in the NPDES General Permit NCG 010000 (Part I Section B: Minimum Monitoring and Reporting Requirements), as well as those of any local regulatory authorities. Minimum monitoring requirements are as follows:

1. A rain gauge shall be maintained in good working order on the site.

2. A written record of the daily rainfall amounts shall be retained. (Note: if no rainfall occurred the Contractor must record “zero”).

3. The control measures shall be inspected to ensure that they are operating correctly. Inspection records must be maintained for each inspection event and for each measure. All erosion and sedimentation control measures must be inspected by the Contractor at least once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24 hour period unless otherwise noted herein. Some measures require inspection following each rainfall event.

4. Once land disturbance has begun on the site, stormwater runoff discharge outfalls shall be inspected by observation for erosion, sedimentation and other stormwater discharge characteristics such as clarity, floating solids, and oil sheens. Inspections of the outfalls shall be made at least once every seven calendar days and within 24 hours after any storm event of greater than 1 inch of rain per 24 hour period. Inspection records must be maintained for each inspection event and for each discharge location.

5. If any visible sedimentation is leaving the site or entering waters of the State,

corrective action shall be taken immediately to control the discharge of sediments. **Where visible deposition of sediment has occurred in surface waters or wetlands, the Contractor must verbally contact the Engineer and the Division of Water Quality within 24 hours of becoming aware of the deposition. Written notification shall be made to the Engineer and the Division of Water Quality within 5 days of becoming aware of the deposition.**

B. Reporting: The Contractor must keep a record of inspections onsite with a copy of the approved erosion and sediment control plan. Inspection records shall be made available to DEQ or its authorized agent upon request. Copies of inspection records shall be sent to the Engineer on a monthly basis. The records must provide the details of each inspection including observations and corrective actions taken as described below. The required rainfall and monitoring observations shall be recorded on an "Inspection Record for Activities Under Stormwater General Permit NCG010000" form provided by DEQ or a similar inspection form that is inclusive of all of the elements contained in the Division's form. A sample inspection form can be found at the end of this Section.

1. Control Measure Inspections: Inspection records must include at a minimum: 1) identification of the measures inspected, 2) date and time of the inspection, 3) name of the person performing the inspection, 4) indication of whether the measures were operating properly, 5) description of maintenance needs for the measure, 6) corrective actions taken and 7) date of actions taken.

2. Stormwater Discharge Inspections: Inspection records must include at a minimum: 1) identification of the discharge outfall inspected, 2) date and time of the inspection, 3) name of the person performing the inspection, 4) evidence of indicators of stormwater pollution such as oil sheen, floating or suspended solids or discoloration, 5) indication of visible sediment leaving the site, 6) actions taken to correct/prevent sedimentation and 7) date of actions taken.

3. Visible Sedimentation Found Outside the Site Limits: Inspection records must include 1) an explanation as to the actions taken to control future releases, 2) actions taken to clean up or stabilize the sediment that has left the site limits and 3) the date of actions taken.

4. Visible Sedimentation Found in Streams or Wetlands: All inspections should include evaluation of streams or wetlands onsite or offsite (where accessible) to determine if visible sedimentation has occurred.

5. Visible Stream Turbidity – If the discharge from a site results in visible stream turbidity, inspection records must record that evidence and actions taken to reduce sediment contributions.

C. The State reserves the right to use its own resources to duplicate monitoring and verify the work required by the Contractor in this section.

1. The Sedimentation Pollution Control Act requires persons responsible for land-disturbing activities to inspect a project after each phase of the project to make sure that the approved erosion and sedimentation control plan is being followed.

2. The self-inspection program is separate from the weekly self-monitoring program of the NPDES Stormwater Permit for Construction Activities. The focus of the self-inspection report is the installation and maintenance of erosion and sedimentation control measures according to the approved plan. The inspections should be conducted after each phase of the project and continued until permanent ground cover is established.

3. The Self-Inspection Report form may be found at the end of this section and is also available as an Excel spreadsheet from the Land Quality web site, http://www.dlr.enr.state.nc.us/pages/sedimentation_new.html

D. Sites discharging to streams named on the state's 303(d) list as impaired for sediment-related causes may be required to perform additional monitoring, inspections or application of more stringent management practices if it is determined that the additional requirements are needed to assure compliance with the federal or state impaired-waters conditions. Inspection records must be maintained for each inspection event and for each discharge location. If a discharge covered by this permit enters a stream segment that is listed on the Impaired Stream List for sediment-related causes, and a Total Maximum Daily Load (TMDL) has been prepared for those pollutants, the Permittee must implement measures to ensure that the discharge of pollutants from the site is consistent with the assumptions and meets the requirements of the approved TMDL. The DWQ 303(d) list can be found at: http://h2o.enr.state.nc.us/tmdl/General_303d.htm/.

3.16 REMOVAL OF TEMPORARY SEDIMENT CONTROL STRUCTURES

A. At such time that temporary erosion and sediment control structures are no longer required under this item, the Contractor shall notify the Engineer of its intent and schedule for the removal of the temporary structures. The Contractor shall obtain the Engineer's approval in writing prior to removal. Once the Contractor has received such written approval from the Engineer, the Contractor shall remove, as approved, the temporary structures and all sediments accumulated at the removed structure shall be returned upgrade and stabilized so they do not re-erode. In areas where temporary control structures are removed, the site shall be left in a condition that will restore original drainage. Such areas shall be evenly graded and seeded as specified in Section 02910 - Final Grading and Landscaping.

-- END OF SECTION –

INSPECTION AND MONITORING RECORDS FOR ACTIVITIES UNDER STORMWATER GENERAL PERMIT NCG010000 AND SELF-INSPECTION RECORDS FOR LAND DISTURBING ACTIVITIES PER G.S. 113A-54.1

Project Name				**Land Quality or Local Program Project/Permit #**	
Approving Authority		**Date of Plan Approval**		**Expiration Date, if applicable**	
NCG010000 Certificate of Coverage Number				**Date of COC Issuance**	
Coverage under the NCG010000 permit must be renewed annually, if issued after April 1, 2019 until Notice of Termination is filed and approved.					

PART 1A: Rainfall Data

	Rain Amount (inches) Daily Rainfall Required. If no rain, indicate with a "zero"
M	
T	
W	
Th	
F	
Sat (Inspection Optional)	
Sun (Inspection Optional)	

PART 1B: Phase(s) of the Plan

Check ALL applicable box(es) that apply to completed & current phases	**X**
Initial installation of erosion and sediment control measures	
Clearing and grubbing of existing ground cover	
Completion of any grading that requires ground cover	
Completion of all land-disturbing activity, construction or development	
Permanent ground cover sufficient to restrain erosion has been established	

Are there any site or project conditions that limit completion of inspection? If yes, explain conditions and areas of site that were inaccessible.	

PART 2: STORMWATER PLANS AND CONTROLS: For each question below, mark the corresponding box as Yes, No or N/A. For all items marked "No", note in Part 3A the Reference letter and provide the Corrective Action and location of the deficiency, the original date noted, and the date it was noted as being corrected. NOTE: Reference letters may be used multiple times.

Reference	Part 2A: Storm Water Plans and Related Documents	Yes	No	N/A
A	Is the approval letter or certificate, COC and a copy of the NPDES Construction General Permit (CGP) on site? (Readily available electronic copy of CGP is acceptable)			
B	Is the approved plan on site and current?			
Reference	**Part 2B: Stormwater Pollutant Controls**	**Yes**	**No**	**N/A**
C	Are erosion and sediment controls that are shown on the approved plan installed and operating properly with no repairs needed?			
D	Are stormwater controls that are shown on the approved plan installed and operating properly with no repairs needed?			
E	Vehicle Tracking: Are construction entrances operating properly with no repairs needed?			
F	Soil Stabilization: Are areas of the site where construction activities have ceased been properly stabilized within the required timeframes?			
G	Are earthen stockpiles stabilized or otherwise protected from sediment loss, and located at least 50 feet away or downhill from drain inlets and surface waters?			
Reference	**Part 2C: Non-Storm Water Pollutant Controls**	**Yes**	**No**	**N/A**
H	Concrete, stucco, paint, etc. washouts: Are washouts installed, properly located, posted and operating with no repairs needed?			
I	Solid & hazardous wastes: Are trash, debris, and hazardous materials properly managed?			
J	Sanitary waste: Are portable toilets properly located and operating with no visible repairs needed?			
K	Equipment and stored fluids: Are fuels, lubricants, hydraulic fluids, etc. contained so as not to enter surface and ground waters?			

Report oil spills and the release of hazardous substances to the appropriate DEQ Regional Office via phone call or email within 24 hours of discovery. https://deq.nc.gov/contact/regional-offices

For any items listed in the section below, a full description of sedimentation is required in Part 3A. This includes, but may not be limited to: location, estimated amount of sediment that has left the site and/or entered waters, apparent causes of the sediment loss, and what corrective actions need to be taken to prevent this from recurring.

Reference	Part 2D: Sedimentation	Yes	No	N/A
L	Are sediment or other pollutants noted beyond the approved or permitted limits of disturbance?			

M	Are BMPs detected as releasing sediment or other pollutants into receiving waters?			
Report visible sedimentation into streams or wetlands to the appropriate DEQ Regional Office via phone call or email within 24 hours of discovery. https://deq.nc.gov/contact/regional-offices				

PART 3A: EROSION AND SEDIMENTATION CONTROL MEASURES: Measures must be inspected at least ONCE PER 7 CALENDAR DAYS AND WITHIN 24 HOURS OF A RAINFALL EVENT EQUAL TO OR GREATER THAN 1.0 INCH PER 24 HOUR PERIOD. *Add rows as needed.*

Erosion and Sedimentation Control Measures Inspected			**Inspection Date**	**Describe Actions Needed** Corrective actions should be performed as soon as possible and before the next storm event	**Date Previous Action(s) Observed as Corrected**
Measure ID **or** Location and Description	Reference(s)	Operating Properly? (Y/N)			
Report unanticipated bypasses, or non-compliance conditions that may endanger health or the environment, to the appropriate DEQ Regional Office via phone call or email within 24 hours of discovery. https://deq.nc.gov/contact/regional-offices					

PART 3B: STORMWATER DISCHARGE OUTFALLS (SDOs): SDOs must be inspected at least ONCE PER 7 CALENDAR DAYS AND WITHIN 24 HOURS OF A RAINFALL EVENT EQUAL TO OR GREATER THAN 1.0 INCH PER 24 HOUR PERIOD. *Add rows as needed.*

Stormwater Discharge Outfalls Inspected					**Inspection Date**	**Describe Actions Needed** Corrective actions should be performed as soon as possible and before the next storm event	**Date Previous Action(s) Observed as Corrected**
Stormwater Discharge Outfall ID or Location	Any Visible Sedimentation in Streams, Wetlands or Outside Site Limits? (Y/N)	Any Increase in Stream Turbidity from Discharge? (Y/N)	Any Visible Erosion below SDO? (Y/N)	Any visible oil sheen, floating or suspended solids or discoloration? (Y/N)			

PART 3C: GROUND STABILIZATION: Must be recorded, at a minimum, after each phase. *Add rows as needed.*

Site area description and location where construction activities have temporarily or permanently ceased	Time Limit for Ground Cover (see table below)	Have stabilization measures been installed? (Y/N)	Temporary or Permanent Stabilization (T/P)	Is Ground Cover Sufficient to Restrain Erosion? (Y/N)	**Original Inspection Date**	**Describe Actions Needed** **Corrective actions should be performed as soon as possible and before the next storm event**	**Date Previous Action(s) Observed as Corrected**

GROUND STABILIZATION TIMEFRAMES		
Site Area Description	**Stabilization**	**Timeframe Variations**
Perimeter dikes, swales and slopes	7 Days	None
High Quality Water (HQW) Zones	7 Days	None
Slopes Steeper than 3:1	7 Days	7 days for perimeter dikes, swales, slopes and HWQ zones 14 days for slopes 10 ft or less in length and not steeper than 2:1 10 days for Falls Lake Watershed
Slopes 3:1 to 4:1	14 Days	7 days for perimeter dikes, swales, slopes and HWQ zones 7 days for slopes greater than 50 ft in length 10 days for Falls Lake Watershed
All other areas with slopes flatter than 4:1	14 Days	7 days for perimeter dikes, swales, slopes and HWQ zones 10 days for Falls Lake Watershed

PART 3D: NEW OR REVISED MEASURES: Erosion and sedimentation control measures omitted or installed, at a minimum since the last inspection, shall be documented here or by initialing and dating each measure or practice shown on a copy of the approved erosion and sedimentation control plan. Alterations and relocations of measures shall also be documented if they significantly deviate from the approved plan. The removal of measures should also be documented. List dimensions of measures such as Sediment Basins and Dissipator Pads. Add rows as needed. Corrective actions should be included in Part 3A.

Measure ID **or** Location and Description	Proposed Dimensions (ft.)	Actual Dimensions (ft.)	Significant Deviation* from Plan? (Y/N)	Date measure observed as installed, altered, relocated or removed	Installed (I) Altered (A) Relocated (R) Removed (X)

*Significant deviation means any omission, alteration or relocation of an erosion or sedimentation control measure that prevents it from performing as intended.

PART 4: Signature of Inspector

Financially Responsible Party (FRP) / Permittee			**County**	
INSPECTOR		Name	Employer	
Inspector Type (Mark)	**X**	Address		
FRP/Permittee				
Agent/Designee		Phone Number	Email Address	

By this signature, I certify in accordance with the NCG010000 permit & G.S. 113A-54.1 that this report is accurate and complete to the best of my knowledge.	
Financially Responsible Party / Permittee or Agent / Designee	Date & Time of Inspection

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SECTION 02500

SURFACE RESTORATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 02276 - Erosion and Sedimentation Control

C. Section 02910 - Final Grading and Landscaping

PART 2 -- MATERIALS

2.01 TOPSOIL

A. Topsoil shall meet the requirements of Section 02200 – Earthwork.

PART 3 -- EXECUTION

3.01 FINAL GRADING

A. Following approval of rough grading the subgrade shall be prepared as follows:

1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.

2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped.

B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.

C. Topsoil shall not be placed in a frozen or muddy condition.

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D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.

E. All stones and roots over 4-inches and rubbish and other deleterious materials shall be removed and disposed of.

- END OF SECTION -

SECTION 02510

PAVING AND SURFACING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and materials and perform all operations in connection with the construction of asphalt concrete pavement, asphalt concrete overlay, reinforced concrete pavement, gravel roads, concrete curb and gutter, repair and reconstruction of existing asphalt concrete pavement, repair of existing gravel roads, and pavement markings complete as specified herein and as detailed on the Drawings.

B. All new roads including the replacement of portions of the existing roads shall be to the limits, grades, thicknesses and types as shown on the Drawings. Patches for pipe crossings and areas damaged during the construction work shall be asphalt and/or gravel, depending upon the material encountered, unless otherwise indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1, Division 2 and Division 3 of these Specifications.

1.03 RELATED SECTIONS

A. Section 02200 - Earthwork

B. Section 03300 - Cast-In-Place Concrete

1.04 STANDARD SPECIFICATIONS

A. Except as otherwise provided in the Specifications or on the plans, all work shall be in accordance with the North Carolina Department of Transportation Standard Specifications for Roads and Structures, 2002 except that any reference to "NCDOT", "Department" or "Unit" shall mean the "Owner". When reference to these Specifications is intended, the description will be NCDOT Section _____ or NCDOT Specifications.

B. Except with the approval of the Engineer, the placing of concrete or asphalt concrete surface paving shall be subject to the Seasonal and Weather Restrictions set forth in NCDOT Specifications.

PART 2 -- MATERIALS

2.01 SELECT FILL

A. The Contractor shall place select fill as necessary to complete the embankments, shoulders, subgrade foundation and replacement for removed unsuitable material in accordance with NCDOT Section 235, and Section 02200 - Earthwork.

2.02 GRAVEL

A. All work, including materials, associated with gravel shall be in accordance with NCDOT Section 545, Incidental Stone Base, except that Articles 545-6 and 545-7, shall be deleted.

2.03 AGGREGATE STABILIZATION

A. All work, including materials, associated with Aggregate Stabilization shall be in accordance with NCDOT Section 510, Aggregate Stabilization, except that Articles 510-6 and 510-7, shall be deleted.

2.04 AGGREGATE BASE COURSE (ABC)

A. All work, including materials, associated with Aggregate Base Course shall be in accordance with NCDOT Section 520, Aggregate Base Course, except that Articles 520-11 and 520-12 shall be deleted. Type "A" or "B" aggregate will be acceptable for this project.

2.05 ASPHALT BINDER FOR PLANT MIX

A. All work, including materials, associated with asphalt binder shall be in accordance with Section 620, Asphalt Binder for Plant Mix, Grade PG 64-22, of the NCDOT Standard Specifications for Roads and Structures, except Articles 620-4 and 620-5 shall be deleted.

2.06 ASPHALT PAVEMENTS

A. All work, including materials, associated with asphalt pavement shall be in accordance with Section 610, Asphalt Concrete Plant Mix Pavements, of the NCDOT Standard Specifications for Roads and Structures, except Articles 610-15 and 610-16 shall deleted. Surface Course shall be Superpave S-9.5B, Intermediate Course shall be Superpave I-19.0B, and Base Course shall be Superpave B-25.0C. Asphalt pavement mix designs shall be in accordance with TABLE 610-2 of the NCDOT.

B. The job mix formulas (JMF) shall be delivered to the Engineer at least two (2) weeks prior to beginning paving operations. The JMF submitted for asphalt concrete pavement shall be dated to within 12 months of asphalt placement.

2.07 RIGID PORTLAND CEMENT CONCRETE PAVEMENT

A. All work, including materials associated with rigid concrete pavement shall be in accordance with Section 03300, Cast-In-Place Concrete. Class A concrete shall be used. Placement shall be in accordance with Section 03300 and NCDOT Section 700, General Requirements for Portland Cement Concrete Pavement and Section 710, Concrete Pavement, except that Articles 700-2, 700-15, 710-3, 710-4, 710-8, 710-9, 710-10, and 710-11 shall be deleted.

2.08 RIGID CONCRETE PAVEMENT REINFORCING

A. Reinforcing, if specified, shall be as shown on the Structural Drawings and as specified under Section 03200, Reinforcing Steel.

2.09 CONCRETE CURB AND GUTTERS

A. Concrete shall be Class B in accordance with the requirements of Section 03300, Cast-In-Place Concrete, except that concrete shall be air-entrained to provide an air content of 6% ± 1.5%.

B. Premolded expansion joint filler for expansion joints shall conform to ASTM D 1751 and shall be 1/2-inch thick, minimum.

2.10 ASPHALT TACK COAT

A. All work, including materials, associated with asphalt tack coat shall be in accordance with Section 605, Asphalt Tack Coat, of the NCDOT Standard Specifications for Roads and Structures, except that Article 605-10 shall be deleted.

PART 3 -- EXECUTION

3.01 EMBANKMENT

A. The embankment shall be constructed in accordance with Section 02200 - Earthwork.

3.02 SUBGRADE

A. The subgrade, where shown on the Drawings, shall be aggregate stabilized by the addition and mixing of coarse aggregate with the top 3-inches of subgrade in accordance with NCDOT Section 510-4. Aggregate stabilization shall be applied to the subgrade at a rate of 300-pounds per square yard. Following the application of stabilizer aggregate, the subgrade shall be formed true to crown and grade, and shall be compacted with a minimum of four (4) passes of a 15-ton vibratory roller to conform to the maximum densities determined by AASHTO T99 Standard Specifications.

3.03 BASE COURSE

A. The finished base course of all paving shall be ABC and shall be of the thickness shown on the Drawings, formed true to crown and grade. Gravel roads, including repair to existing gravel roads shall be ABC and shall be of the thicknesses shown on the Drawings, formed true to crown and grade. No fill material except new ABC shall be placed on top of existing gravel.

3.04 ASPHALT BASE COURSE (OR INTERMEDIATE COURSE)

A. Asphalt Concrete Base (or Intermediate) Course shall be placed in accordance with NCDOT Standard Specifications for Roads and Structures 610-8, Spreading and Finishing. Asphalt Concrete Base (or Intermediate) Course shall be compacted in

accordance with NCDOT Standard Specifications for Roads and Structures 610-9, Compaction. Thicknesses shall be as shown on the Drawings.

3.05 ASPHALT CONCRETE SURFACE COURSE

A. Prior to placement of the asphalt concrete surface course, the base/intermediate course shall be inspected for damage or defects and repaired to the satisfaction of the Engineer. The surface of the base/intermediate course shall be approved by the Engineer.

B. The asphalt tack coat shall be applied to the surface of the approved base/binder course as described in NCDOT Section 605. Equipment for applying the tack coat shall be power-oriented pressure spraying or distributing equipment suitable for the materials to be applied and approved by the Engineer.

C. The Asphalt Concrete Surface Course shall be placed and compacted on the base/intermediate course in layers not to exceed 2-inches and at the rate of 110-pounds per square yard per inch. Surface Course shall be compacted in accordance with NCDOT Standard Specification for Roads and Structures, Article 610-9. Thicknesses shall be as shown on the Drawings.

3.06 ASPHALT CONCRETE PAVEMENT COMPACTION

A. Asphalt concrete pavement compaction shall be performed as per NCDOT Standard Specification for Roads and Structures, Article 610-9.

B. Contractor shall provide Quality Control (QC) for proper asphalt concrete pavement placement and compaction using equipment in good working order which has been properly calibrated at the start of each round of testing. Quality Assurance (QA) of paving operations will be performed by an independent third party representative hired by Owner.

C. Immediately after the asphalt mixture has been spread, struck off and surface and edge irregularities adjusted, thoroughly and uniformly compact the pavement. Compact the mix to the required degree of compaction for the type of mixture being placed, as noted in Table 610-6 of the 2012 NCDOT Standard Specification for Road and Structures, or latest edition, and reproduced below in Table 3-1.

TABLE 3-1
SUPERPAVE DENSITY REQUIREMENTS

Superpave Mix Type	Minimum % Gmm (Maximum Specific Gravity
SF9.5A	90.0
S9.5X, S12.5X, I19.0X, B25.0X	92.0

3.07 ASPHALT CONRETE PAVEMENT PHASING

A. Contractor shall be responsibilefor phasing the placement of asphalt concrete pavement sections and courses to account for individual construction activities, the construction

traffic volume, and vehicle loading expected throughout construction activities. The placement of asphalt concrete pavement shall also be phased so the aggregate base course, once installed, is not be exposed to freeze/thaw cycles.

3.08 RIGID PORTLAND CEMENT CONCRETE

A. The subgrade and base course beneath portland cement concrete pavement shall be prepared in accordance with the applicable Sections of these Specifications and referenced Standard Specifications, except that the Contractor shall use an approved automatically controlled fine grading machine to produce final subgrade and base surfaces meeting the lines, grades, and cross sections (thicknesses) shown on the Drawings or established by the Engineer.

B. The surface of the base shall be damp at the time the concrete is placed. The Contractor shall sprinkle the base when necessary to provide a damp surface. The Contractor shall satisfactorily correct all soft areas in the subgrade or base prior to placing concrete.

C. Hauling over the base course shall not be allowed except where specifically permitted by and in writing by the Engineer. The Engineer may allow equipment dumping concrete to operate on the base to the extent and under the conditions the Engineer deems necessary to facilitate placing and spreading the concrete.

D. Installation of the rigid concrete pavement shall be in accordance with the details shown on the Drawings and Division 3 - Concrete. The rigid concrete pavement shall cure a minimum of ten (10) calendar days and until the concrete has attained a minimum flexural strength of 550 psi as indicated by flexural strength testing. The Contractor shall coordinate and pay for all flexural strength testing with a minimum of four (4) 6-inch by 6-inch by 20-inch beams for every fifty (50) cubic yards of pavement concrete installed.

E. Transverse and longitudinal joints shall be spaced at intervals as shown on the Drawings and installed as per the requirements of NCDOT Standard Specification for Road and Structures Section 610-11. Transverse contraction joints shall be formed by an approved joint insert. Longitudinal joints shall be formed by allowing the paver to deposit the mixture adjacent to the joint to such depth that maximum compaction can be obtained along the joint. Pinch the joint by rolling immediately behind the paver. Expansion joints shall be placed when the pavement abuts a structure using 1-inch expansion joint material (filler) and sealant as specified herein.

3.09 ASPHALT CONCRETE DENSITY ACCEPTANCE

A. The Engineer will evaluate the asphalt pavement for density acceptance after the asphalt mix has been placed and compacted using the Contractor's QC test results, the Owner’s QA test results (including verification samples) and by observation of the Contractor's density QC process conducted in accordance with NCDOT Standard Specification for Roads and Structures, Section 609.

B. Minimum density requirements for all mixes will be as specified in Table 3-1. Density acceptance will be as provided herein. Core sample shall be obtained and tested by the Owner’s representative at the same frequency and location as the Contractor’s QC testing,

if possible, and densities will be determined by use of the requirements as outlined in NCDOT Standard Specification for Roads and Structures, Section 610-14.

C. A failing lot for density acceptance purposes is defined as a lot for which the average of all test sections, and portions thereof, fails to meet the minimum specification requirement. A lot will consist of one day's production of a given JMF, for each layer of asphalt concrete placed. If additional density sampling and testing, beyond the minimum requirement, is performed and additional test sections are thereby created, then all test results shall be included in the lot average.

D. Any lot or portion of a lot deemed obviously unacceptable by the Owner or Engineer will be rejected for use in the work. If the Engineer determines that a given lot of mix does not meet the minimum specification requirements but the work is reasonably acceptable, the lot will be accepted at a reduced pay factor in accordance with the following formula. The reduced pay factor will apply only to the contractor's schedule of values.

$$\text{Reduced Pay Factor} = 100 + \frac{[(\text{Actual Density} - \text{Specified Density}) \times 30]}{2}$$

Where: Actual Density = the lot average density, not to exceed 2.0% of the specified density
Specified Density = the density in Table 3-1 or as specified in the contract

3.10 CONCRETE CURB AND GUTTER

A. The expansion joint filler for concrete curb and gutters shall be cut to conform with the cross section of the curb. Expansion joints shall be spaced at intervals of not more than 30-feet. Formed control joints shall be installed at intervals not exceeding 10 feet, or 15 feet if a machine is used for installation. Depth of joint shall be 1/3 the thickness. Curved forms shall be used where radii are indicated; straight segments shall not be permitted. Upon removal of the forms, exposed curb faces shall be immediately rubbed down to a smooth and uniform surface. No plastering shall be permitted.

3.11 UNDERGROUND UTILITY LINES

A. Where an underground utility line is beneath the new roadway, the backfilling shall be carried out with special care, and the final consolidation shall be accomplished by a vibratory roller. Construction of the roadway over the trench shall be deferred as long as practicable.

3.12 JUNCTION WITH OTHER PAVING

A. Where new asphalt concrete pavement abuts existing asphalt concrete pavement, the existing pavement shall be cut back to insure obtaining the specified compaction of the new pavement courses and interlocking adjoining courses. Existing subbase courses shall be cut back from the subgrade level of the new pavement on a one-on-one slope into the existing pavement, and the asphalt courses of the existing pavement shall be removed for an additional 6-inches back from the slope. The edge of the existing asphalt courses

shall be saw cut straight and true. The faces between new and existing asphalt courses shall receive an application of tack coat.

B. Where new rigid concrete pavement abuts existing rigid concrete or asphalt concrete paving, the existing paving shall be saw cut straight and true. An expansion joint of a 1/2-inch minimum thickness with filler material and sealant shall be placed between the new concrete pavement and the existing rigid concrete or asphalt concrete paving.

3.13 MILLING ASPHALT CONCRETE

A. Milling asphalt concrete shall be in accordance with NCDOT Section 607, Milling Asphalt Pavement, of the NCDOT Standard Specifications for Roads and Structures.

3.14 ASPHALT CONCRETE OVERLAY

A. Where asphalt concrete is proposed to be placed over an existing asphalt or rigid concrete surface, the surfaces shall be thoroughly cleaned by power brooming and a tack coat shall be applied in accordance with NCDOT Section 605, Asphalt Tack Coat, of the NCDOT Standard Specifications for Roads and Structures, prior to installing the overlay. The overlay shall be applied in accordance with Subsections 2.06 and 3.05 and Standard Details shown on the Drawings.

-END OF SECTION-

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SECTION 02604

UTILITY STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

B. Section 03200 – Reinforcing Steel

C. Section 03250 – Concrete Accessories

D. Section 03300 – Cast-in-Place Concrete

E. Section 03400 – Precast Concrete

F. Section 05540 – Castings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections

2. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

3. ASTM C990 - Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

1.04 SUBMITTALS

A. Submit samples and/or Shop Drawings in accordance with Section 01300, Submittals.

B. In addition to items listed in Section 03400, Precast Concrete, Shop Drawings shall include, but not be limited to:

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1. Complete layout and installation Drawings and schedules with clearly marked dimensions.

2. Material certificates on all piping materials.

3. Structural design calculations sealed by a P.E. registered in the State of North Carolina. Design calculations for precast manholes and vaults shall include confirmation structures are adequately sized for diameter and number of pipes entering structure, and structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure.

4. Results of leakage tests.

PART 2 -- PRODUCTS

2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

A. Precast utility structures shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast utility structures shall be watertight and conform to the requirements of ASTM C 478 and ASTM C857 with the following modifications there to:

1. Materials shall conform to Section 03400, Precast Concrete.

2. Manholes shall meet the following:

   a. Manhole section shall have an internal diameter of 4'-0", unless noted otherwise.

   b. Minimum manhole wall thicknesses shall be 5 inches for 4 foot and 5 foot diameter manholes, 6 inches for 6 foot diameter manholes and 7 inches for 7 foot diameter manholes.

   c. Manholes and utility structures shall include ballast concrete and/or other means necessary to insure manholes resist flotation when empty and subjected to groundwater full height of structure.

   d. Precast manholes and utility structures shall be as manufactured by NC Products/Oldcastle, Tindall Products, or equal.

3. The date and name of manufacturer shall be marked inside each precast section.

4. No more than two lift holes may be cast or drilled in each section.

5. Dimensions shall be as shown on the Drawings.

6. Covers and frames shall be as specified in Section 2.13.

7. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.

B. Joints between manhole and utility structures riser sections and at base slabs shall be groove type.

2.02 BRICK

A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.

2.03 MORTAR

A. Mortar shall conform to Section 04100 Mortar and Masonry Grout.

2.04 CONCRETE

A. Concrete shall conform to Section 03300, Cast-in-Place Concrete.

2.05 REINFORCING

A. Reinforcing shall conform to Section 03200, Reinforcing Steel.

2.06 PRECAST CONCRETE

A. Precast concrete shall conform to Section 03400, Precast Concrete.

2.07 CONCRETE BLOCK

A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.

2.08 CASTINGS

A. Castings shall conform to Section 05540, Castings. Casting shall be of the type and size indicated on the Drawings.

2.09 STEPS

A. Steps shall be constructed of Grade 60 steel reinforcing rod (min. 1/2-inch) and completely encapsulated with a wear resistant and chemical resistant rubber.

B. Each step shall have a minimum vertical load resistance of 800 pounds and a minimum pull-out resistance of 400 pounds.

C. The steps shall have 11-inch minimum tread width and shall be placed at 16-inches on center, as shown on the Drawings.

D. Steps shall be cast in place with the concrete.

E. Steps shall only be installed as shown on the Drawings or required in the Specifications.

2.10 JOINT SEALANT

A. Joint sealant shall be a preformed flexible sealant conforming to the requirements of ASTM C990, paragraph 6.2, Butyl Rubber Sealant. Joint sealant shall be Pro-Stik Butyl Sealant by Press-Seal, Butyl-Nek Join Sealant by Henry ,CS-102 Butyl Rubber Sealant for all Precast Structures by ConSeal, or equal.

2.11 FLEXIBLE RUBBER SLEEVE

A. The spring set type shall have a stainless steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal assembly by National Pollution Control Systems, or Lock Joint Flexible Manhole Sleeve by Interpace Corp.

B. The cast-in-place type shall conform to ASTM C923 and shall include stainless steel take up clamps.

C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

2.12 RUBBER BLADDER

A The rubber bladder seal shall conform to ASTM C923 suitable for pressure testing at 10 psi minimum, with a 3/8 inch minimum wall thickness.

B. The rubber bladder seal shall contain an environmentally safe, anti-bacterial compound which turns into a high viscosity gel when in contact with pressurized water.

C. The rubber bladder seal shall be NPC Contour Seal by Kor-N-Seal, or equal.

2.13 COVERS AND FRAMES

A. Covers and frames shall comply with Section 05540, Castings and shall be provided by the utility structure manufacturer.

B. Manhole covers and frames shall meet the following requirements:

1. Locate so that there is ready access to the manhole steps

2. Clear opening shall be a minimum of 22 inches, unless otherwise indicated on the Drawings.

3. Watertight manhole frames and covers shall be suitable for 20 psi internal pressure and shall be Neenah Model R-1915, Type P or L or equal cast in place.

4. Non-watertight manhole covers shall be perforated and shall be Neenah Model R-1668, or equal.

5. Storm drain grated inlet frames and grates shall be Neenah R-1878-B7G, East Jordan Iron Works V5660, or equal.

6. Curb inlet frames and grates shall be Neenah R-3067, East Jordan Iron Works EJ 7030, or equal, and shall include frame, grate, and hood.

C. Vault covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05050, Metal Fastening.

D. All frames and covers shall be given one shop coat of asphalt or coal tar varnish, unless otherwise specified.

DE. Frames and covers shall be identical throughout the Contract.

2.14 GRATES

A. Grates shall comply with Section 05540, Castings.

2.15 CONCRETE BALLAST

A. Concrete ballast shall be Class B concrete in conformance with Section 03300, Cast-in-Place Concrete. Ballast shall be provided as necessary to ensure manhole resists flotation when empty and subjected to full height groundwater conditions.

2.16 FLEXIBLE JOINT SEALER

A. Flexible joint sealer shall be a rubber ring waterstop as manufactured by Fernco Joint Sealer Co., or equal.

2.17 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to Section 03250, Concrete Accessories.

PART 3 -- EXECUTION

3.01 DESIGN CRITERIA

A. Minimum structural design loading for underground precast concrete vaults shall be as indicated in ASTM C857, unless otherwise noted herein. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.

B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.

C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole/vault.

3.02 FABRICATION AND CASTING

A. Fabrication and casting shall conform to Section 03400, Precast Concrete, and to Section 03300, Cast-in-Place Concrete.

B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.

C. Utility structures built around existing pipe shall have a cast-in-place base slab.

3.03 HANDLING, TRANSPORTING, AND STORING

A. Handling, transporting and storing of precast items shall comply with Section 03400, Precast Concrete.

3.04 INSTALLATION

A. Installation shall conform with Section 03400, Precast Concrete and with the manufacturer's recommendations or to Section 03300, Cast-in-Place Concrete.

B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.

C. Joints between riser sections shall be sealed with joint sealant.

D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.

E. Openings that are too large for flexible rubber sleeves shall utilize rubber bladder seals which are expanded by water injected using a pressure pump.

F. All units shall be installed plumb and level.

G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03600, grout inside and out.

H. The manhole frames shall be set to their required elevations either with grade rings or with two or three courses of brick masonry laid around the top of the upper wall section. Such brick work shall be given a 1-inch mortar coat on the inside and out.

I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.

J. Brick or Concrete Block

Brick or concrete block shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. Outside of walls shall be plastered with a minimum 1-inch thick coat of cement-sand mortar troweled smooth.

K. Connection to Existing Pipe

1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.

2. Provide adequate protection to prevent damage to the existing pipe.

3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.

4. Cut off the existing pipe sufficiently for connection to the new structure and remove.

5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.

6. Install a flexible joint sealer around the pipe.

7. Grout inside and outside of wall penetration with nonshrink grout.

L. Backfill structures in accordance with Section 02200, Earthwork.

M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.

N. Excavation shall conform to Section 02200, Earthwork.

O. Structure bases shall bear on a minimum of 8 inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.

2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.

3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

A. Adjust structures as indicated on the Drawings using concrete or cast-iron adjustment rings by approved methods.

B. Clean covers and inlet castings of all foreign material and paint with one coat of coal tar epoxy.

3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

A. Adjusting collars shall be as shown on the Drawings. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

3.07 LEAKAGE TESTING FOR MANHOLES

A. All manholes shall be vacuum tested as specified below. Refer to Section 22 14 00 – Storm Drains and Roof Drains for storm water pipe testing methods and requirements and Section 45 05 00 – Basic Mechanical Requirements for sanitary pipe testing methods and requirements.

B. Manhole vacuum testing shall include the following minimum requirements:

1. Testing shall be done in accordance with ASTM C1244-05 (or latest revision).

2. Prior to testing all pipes, holes, and vents entering manhole shall be plugged and braced.

3. Contractor shall have an approved test head and copy of instructions for use by the manufacturer.

4. Contractor shall furnish two (2) certified and calibrated vacuum test gauges for the test.

   A vacuum of 10-inch hg shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time for the vacuum pressure to drop to 9-inch hg shall be measured. If the test time meets or exceeds the test time as specified in Table 1, the manhole is acceptable; otherwise, the test has failed and the manhole should be checked for leaks, repaired, and re-tested.

Table 1
Minimum Vacuum Test Times (Seconds) for Various Manhole Diameters and Depths

	Manholes Ø (inches)						
epth (ft)	**48**	**60**	**72**	**84**	**96**	**108**	**120**
6'	15	20	25	29	34	38	43
8	20	26	33	38	45	51	57
10	25	33	41	48	56	63	71

12	30	39	49	57	67	76	85
14	35	46	57	67	78	89	00
16	40	52	67	76	89	01	14
18	45	59	73	86	00	14	28
20	50	65	81	95	11	26	42
22	55	72	89	105	22	39	56
24	59	78	97	114	33	52	70
26	64	85	05	124	44	64	85
28	69	91	13	133	55	77	99
30	74	98	21	143	66	89	213
d. VF	2.5	3.25	4.0	4.75	5.5	6.5	7.0

3.08 FLUSHING AND TESTING OF SEWERS

A. Obstruction – After backfilling, all sewers shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Engineer. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Contractor shall provide a means acceptable to the Engineer for removal of debris flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Contractor's expense.

B. Visual Inspection – Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet these qualifications. Any visual water infiltration of water into the manhole shall be repaired using hydraulic cement or other approved materials.

C. Leakage – Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Engineer and the Contractor. The Contractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Contractor shall, at his own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.

D. Leakage Test Procedure – Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be reestablished and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.

1. If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir or other measuring device approved by the Engineer. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.

2. Where the actual leakage exceeds the allowable, the Contractor shall discover the cause and correct it before the sewer will be accepted. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stub-outs for future connections.

E. Low Pressure Compressed Air Test – If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.

F. Deflection Test – No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflectometer or a rigid "GoNoGo" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

1. Where the actual deflection exceeds the allowable, the Contractor shall discover the cause and correct it before the pipe will be acceptable. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

G. Cost of Testing and Repairs – Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Contractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Contractor.

1. The Contractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the sewers.

- END OF SECTION -

SECTION 02710

STORM DRAINS AND ROOF DRAINS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment and materials in connection with the installation and testing of exterior underground Storm drains and Roof drains as shown on the Contract Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

1. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

2. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe

3. ASTM C443 - Standard Specification for Joints in Concrete Pipe and Manholes, Using Rubber Gaskets

4. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections

5. ASTM C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

6. ASTM C969 - Standard Practices for Infiltration and Exfiltration Testing of Installed Precast Concrete Pipe Sewer Lines

7. ASTM C990 – Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

8 ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

9.. ASTM C1619 – Standard Specification for Elastomeric Seals for Joining Concrete Structures

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10. ASTM C1628 – Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets

11. ASTM D 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.

12. ASTM D 3350 – Standard Specifications for Polyethylene Plastic Pipe and Fitting Material.

13. AWWA C 110 – Standard Specification for Ductile Iron Pipe & Fittings for Water and Other Liquids.

14. ASTM C 150 – Standard Specification for Portland Cement

15. AWWA C 151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

16. ASTM F 447 – Standard Specifications for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

17. AASHTO R82-17

18. AASHTO M 198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

19. AASHTO M 294 – Standard Specifications for Corrugated Polyethylene Pipe (12" to 36").

20. AASHTO Section 30 – Thermoplastic Pipe.

1.04 SUBMITTALS

A. Furnish and submit shop drawings and certificates for the piping work as outlined in the General Conditions and Division 1.

B. Special care shall be exercised during delivery, distribution and storage of the pipe and fittings to prevent damage. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Storage of pipe and fittings, prior to use, shall be in such a manner as to keep the materials clean and dry.

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE (RCP) – STORM DRAINS AND CULVERTS

A. Pipe and Joints

1. Reinforced concrete pipe for storm drains and culverts shall conform to ASTM Standard C76, Class III, Wall thickness B, unless otherwise noted on the Contract Drawings. Elliptical reinforcement will not be permitted. All pipe shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site. All pipe shall be of the sizes indicated on the drawings

2. Pipe shall be provided with bell and spigot or tongue and grooved ends meeting the physical, design, and performance requirements of ASTM C-990 or C-443 as appropriate. Pipe joints shall be sealed with pre-formed flexible joint sealants of an approved type and manufacture meeting the physical requirements of ASTM C-990, unless otherwise noted. If water-tight joints are specified, pipe joints shall be sealed with rubber gaskets seals meeting the physical requirements of ASTM Standard C-443.

C. Joint Lubricant

1. Joint lubricant shall be of the type recommended by the manufacturer. Use of petroleum-based lubricants is not permitted.

2.02 Ductile Iron Pipe (DIP) – ROOF DRAINS

A. Pipe

1. Shall be centrifugally cast in metal molds or sand lined molds in accordance with ANSI A21.51 (AWWA C151) of grade 70-50-05 ductile iron. The above standard covers ductile iron pipe with nominal pipe sizes from three (3) inches up to and including fifty-four (54) inches in diameter.

2. Shall have a rated working pressure of 150 psi.

3. Shall be a minimum PC 150.

B. Fittings

1. Shall be manufactured in accordance with ANSI A21.10 (AWWA C110).

2. Shall be manufactured of grade 70 - 50 - 05 ductile iron.

3. Shall have a rated working pressure of 250 psi.

4. Grey iron fittings which conform to the specifications contained herein may be used with ductile iron pipe providing the piping systems minimum working pressure is met or exceeded, and only where ductile iron fittings are not manufactured for a specific fitting.

C. Coatings and Linings for Pipe and Fittings

1. The standard asphaltic coating shall be applied to the exterior wall of the pipe and fittings in accordance with ANSI A21.51 (AWWA C151).

2. The pipe and fittings shall be cement mortar lined to twice the standard thickness in accordance with ANSI A21.4 (AWWA C104) except as specified in the pipe schedule. A seal coat of asphaltic material shall be applied to the mortar lining.

D. Joints

1. Joints shall be push on type in accordance with ANSI A21.11 (AWWA CIII).

2.03 SMOOTH LINED CORRUGATED HIGH-DENSITY (HDPE) POLYETHYLENE PIPE - STORM DRAINS AND CULVERTS

A. General

1. Smooth lined corrugated high-density polyethylene (HDPE) pipe shall be used for storm drains and shall be BLUE SEAL watertight HDPE pipe as manufactured by Hancor, Inc., N-12 WT IB (Watertight) Pipe by ADS, Inc., or approved equal.

B. Pipe and Fittings

1. Smooth lined HDPE pipe and fittings shall conform to AASHTO M252-TYPE S for 4" to 10"φ and AASHTO M294 - TYPE S for 12" to 36"φ. All pipes shall be of the sizes indicated on the drawings.

C. Joints

1. Joints shall be watertight bell and spigot type; Hancor, Inc. BLUE SEAL, ADS, Inc. N-12 WT IB, or equal.

D. Foundation Drains

1. Foundation drains shall conform to AASHTO M252-TYPE C. Drains shall have drilled perforations and be Heavy Duty-AASHTO Pipe as manufactured by Hancor, Inc., Single Wall Corrugate Pipe by ADS, Inc., or approved equal.

2.04 BACKFILL MATERIAL

A. The material obtained from excavation of the pipe trench or elsewhere on site with a particle size not greater than 3 inches shall be used for pipe backfill if they conform with the soil classes given in Table 1. Imported materials meeting the criteria of Table 1 may also be used.

TABLE 1 – ACCEPTABLE BACKFILL MATERIAL AND COMPACTION REQUIREMENTS

SOIL CLASSIFICATIONS				
DESCRIPTION	ASTM D 2321	ASTM D 2487	AASHTO M 43	Minimum Standard Proctor Density %
Graded or crushed, crushed stone, gravel	Class I	--	5 56	Dumped
Well-graded sand, gravels and gravel/sand mixtures, poorly graded sand, gravels and gravel/sand mixtures; little or no fines	Class II	GW GP SW SP	57 6	95%
Silty or clayey gravels, gravel/sand/silt or gravel and clay mixtures; silty or clayey sands, sand/clay or sand/silt mixtures	Class III	GM GC SM SC	Gravel and Sand (<10% fines)	95%

PART 3 – EXECUTION

3.01 INSPECTION

A. Each length of pipe and fittings delivered to the property shall be inspected by the Contractor, in the presence of the Engineer, for flaws, cracks, dimensional tolerances and compliance with the referenced Standards. The Contractor shall provide the Engineer with suitable templates or calipers for checking pipe dimensions. Only lengths of pipe and fittings accepted by the Engineer and so marked may be installed in the work.

3.02 INSTALLATION

A. Trenching, bedding and backfilling shall be as specified in Section 02200 - Earthwork of these Specifications and Section 2.04 Backfill Material of this Specification. Under no condition shall pipe be laid in water or when trench conditions or weather are unsuitable for such work.

B. All pipes and fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists or lowered on skidways in such a manner as to avoid shock. Derricks, ropes or other suitable equipment shall be used for lowering the pipe into the trench. Pipe and fittings shall not be dropped or dumped.

C. Each pipe and fitting shall be inspected before it is lowered into the trench. The interior of the pipe and all joint surfaces shall be thoroughly cleaned and shall thereafter be maintained clean. The open ends of pipe shall be securely plugged whenever pipe laying is not in progress.

D. Pipe and fittings shall be selected so there will be as small a deviation as possible at the joints and so inverts present a smooth surface. All joints shall be installed, made up, and

inspected in accordance with approved printed instructions of the manufacturer. Pipe and fittings which do not fit together to form a tight joint will be rejected.

E. Cutting of reinforced concrete pipe will be permitted only at connections to structures and be accomplished by abrasive saws. Cutting of other pipe materials shall be done only with mechanical cutters and in accordance with the manufacturer's recommendations.

F. Pipe shall be laid accurately to the lines and grades shown on the drawings or as directed by the Engineer.

G. If an adequate foundation for the pipe is not available at the desired depth, additional excavation shall be required, and the foundation brought to desired grade with suitable granular material.

H. Rock outcroppings, very soft soils such as muck, and other similar materials not providing proper foundation support shall be removed/replaced with suitable granular material.

I. Bedding material directly under the pipe invert shall be left in native condition and not compacted. Pipe shall be placed on the bedding, then backfilled under the pipe haunches before further backfill is placed.

J. Class I materials may be dumped around pipe. Voids shall be eliminated by knifing under and around the pipe or by other approved technique.

L. Inorganic silts, and gravelly, sandy, or silty clays, and other Class IV materials (not shown in Table 1) shall not be used for pipe backfill.

M. Any section of the pipe found defective in material, alignment, grade, joints, or otherwise, shall be satisfactorily corrected by the Contractor at no additional cost to the Owner.

3.03 COMPACTION

A. General

1. Place and assure backfill and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.

2. In no case shall degree of compaction below “Minimum Compactions” specified be accepted.

B. Compaction Requirements: Unless noted otherwise on the Drawings or more stringently by other sections of these Specifications, comply with following trench compaction criteria:

TABLE 2 – - MINIMUM COMPACTIONS

LOCATION	SOIL TYPE	DENSITY
1. Compacted select backfill:		

All applicable areas	Cohesive soil	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254
2. Common trench backfill:		
Under pavements roadways surfaces, D698 within highway right-of-ways, adjacent to retaining walls	Cohesive soils	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254
Under turfed, sodded plant seeded, non-traffic areas	Cohesive soils	95 percent of maximum dry density by ASTM D698
	Cohensionless soils	75 percent of maximum relative density by ASTM D4253 and ASTM D4254

C. Ensure backfill materials have moisture content within three (3) percent of optimum moisture content at the time of placement.

3..04 INSPECTION AND TESTING

A. General

1. The Contractor shall provide at his own expense, all labor, material, video and measuring devices, water, plugs, or other equipment necessary to perform the required tests. All tests shall be performed in the presence of the Engineer. Disposal of water shall be in accordance with Section 01010 – Summary of Work.

B. Tests by Manufacturer

1. Reinforced Concrete Storm Drains and Culverts - An infiltration and exfiltration test for the pipe shall be made at the place of manufacture. Certified test results shall be submitted. The infiltration or exfiltration allowance shall not exceed the limits as set in the “Performance requirements for Joints” paragraph in ASTM C443 – 12 (2017) or ASTM C990-09 (2014), depending on the type of gasket specified.

2. DIP and HDPE - An infiltration and exfiltration test for the pipe shall be made at the place of manufacture. Certified test results shall be submitted. The infiltration or exfiltration allowance shall not exceed 250 gallons per inch of pipe diameter per mile per day. One joint test for each two hundred feet of pipe to be furnished.

C. Field Test - Visual Inspection

1. Examine structures and pipes for:

   a. Physical damage.

   b. Indication of displacement of pipes or structures, reinforcement, forms, or bedding.

   c. Porous areas or voids.

   d. Proper placement of seals, gaskets, and embedments.

   e. Visible infiltration.

2. Verify structures and pipes are set to proper line, grade as per the Contract Drawings, and are plumb.

3. Verify structure and pipe dimensions and thickness match Contract Drawings.

4. Measure inside dimensions of all flexible (HDPE) pipe prior to installation. Use these dimensions when sizing the mandrel should deflection testing be required.

   a. Using light to inspect pipe shall be done following pipe trench backfill is compacted and brought to grade or pavement subgrade.

   b. Full pipe diameter shall be visible for entire length of each section between structures.

   c. No less than half pipe diameter shall be visible for horizontal alignment.

5. The Contractor shall be responsible to provide video recording of the all installed storm sewer systems at least 30 days after completion of backfill and one month before Owner or Engineer gives final acceptance for the two-year warranty. The recording shall be made using a color camera, self-propelled or other, having sufficient light to show detail of problem areas and joints. Camera speed shall not exceed 3 feet per second. If problems or concerns are seen by the operator, then the camera shall be reversed and an extended look at the area will be recorded. All recordings will have time, date, and footage displayed. Supplement the video recording with a written log or orally recorded tape log noting observations, findings, and deficiencies shown on the video tape.

   a. The video recording inspection shall be performed by an outside independent testing agency acceptable to the Owner or Engineer.

   b. The video tape and log will be given to the Engineer for review. If the Engineer finds any problems with the storm sewer, the Contractor will

repair the problem and re-camera the repaired area before final acceptance will be given, at no added cost to the Owner.

c. Video recording of storm sewer may be waived if pipe diameter is sufficient for human access, as determined by the Engineer. A log shall be developed for such inspection.

d. One copy of the video tape and log will become permanent property of the Engineer and Owner as record.

D. Field Test - Manhole Testing

1. The finished manholes shall be as watertight as the pipe system of which it is part. See Specification 02604 – Utility Structures for manhole testing criteria.

2. Observed leaks (infiltration or exfiltration) at any time within the warranty period shall be cause for rejection.

E. Deflection Test – Flexible Pipe

1. If after the visual or video inspection of the storm trunk or lateral lines, the Inspector finds there is “egging or deflection” of a section of pipe, a deflection test shall be performed on the defective section of pipe installed. Test shall be performed using an odd-legged mandrel pulled through the pipe without mechanical assistance or by laser profiling. The mandrel size shall be the measured inside diameter of the subject pipe minus 5% of the measured diameter. The mandrel shall have no less than nine legs.

2. Any pipe failing any deflection test shall be removed, replaced, and retested.

3. At the end of the two-year warranty period, the flexible storm pipe will be visually inspected for “egging or deflection”. If excess deflection is observed, the Owner/Warranty Holder will, at his/her expense, retest questionable portions per this section.

F. Repair

1. Repair or replace any unacceptable work at no additional cost to the Owner.

2. Repair all visible leaks.

3. Remove any concrete webs or protrusions.

4. Remove form ties and repair tie holes.

END OF SECTION

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SECTION 02910

FINAL GRADING AND LANDSCAPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment, and materials necessary for final grading, topsoiling, seeding, and miscellaneous site work not included under other Sections, but required to complete the work as shown on the Drawings and specified herein. Under this Section, all areas of the project site disturbed by excavation, materials storage, temporary roads, etc., shall be reseeded as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02276 - Erosion and Sedimentation Control.

B. Section 02500 - Surface Restoration.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Product Data
2. Certification of all materials
3. Three (3) copies of composition and germination certification and of test results for grass seed.

PART 2 -- PRODUCTS

2.01 CONTRACTOR'S RESPONSIBILITIES

A. Furnish and submit certification for the materials used as specified in the General Conditions, Division 1 and Division 2.

2.02 TOPSOIL

A. Upon completion and approval of the rough grading, the Contractor shall place the topsoil over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped. Topsoil shall not be placed in a frozen or muddy condition and shall contain no toxic materials harmful to grass growth. Topsoil shall be as defined under Section 02200 - Earthwork.

2.03 WATER

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A. Water shall be furnished to the Contractor by the Owner from existing facilities as directed by the Engineer.

B. The Contractor shall furnish all hoses and connections necessary to complete the landscaping work.

2.04 FERTILIZER

A. Fertilizer shall be a complete commercial fertilizer with components derived from commercial sources. Fertilizer analysis shall be determined from field soil sampling in appropriate number taken by the Contractor and analyzed by the N.C. Department of Agriculture or other independent laboratory. Contractor shall furnish fertilizer in accordance with the recommendations of the N.C. Department of Agriculture.

B. One-quarter of the Nitrogen shall be in the form of nitrates, one-quarter in the form of ammonia salts, and one-half in the form of natural organic Nitrogen. Available Phosphoric Acid shall be free from superphosphate, bone, or tankage. Potash shall be Sulphate of Potash. Elements shall conform to the standards of Association of Official Agricultural Chemists.

C. Fertilizer shall be delivered in standard size bags marked with the weight, analysis of contents, and the name of the manufacturer. Fertilizer shall be stored in weatherproof storage areas and in such a manner that its effectiveness will not be impaired.

2.05 LIME

A. At least 50% shall pass a No. 200 U.S.S. mesh sieve. At least 90% shall pass a No. 100 U.S.S. mesh sieve and 100% shall pass a No. 10 U.S.S. mesh sieve. Total carbonates shall not be less than 80% or 44.8% Calcium Oxide equivalent. For the purpose of calculation, total carbonates shall be considered as Calcium Carbonate.

2.06 GRASS SEED

A. The Contractor shall furnish the kinds and amounts of seed to be seeded in all areas disturbed by the construction work. All seed shall be labeled to show that it meets the requirements of the North Carolina Seed Law. All seed must have been tested within six (6) months immediately preceding the planting of such material on the job.

B. The inoculant for treating legume seed shall be a pure culture of nitrogen-fixing bacteria prepared specifically for the species. Inoculants shall not be used later than the date indicated on the container. The quality of the seed shall conform to the following:

Type	Minimum Seed Purity (%)	Minimum Germination (%)	Maximum Weed Seed (%)
Bermuda	98	85	0.15
Hybrid Rye	98	85	0.10
Sudan Grass	98	85	0.25

Millet	98	85	0.50

C. All seed shall be in conformance with N.C. Seed Law restrictions for restricted noxious weeds.

D. Seed mixtures to be used on the project shall be as follows:

P - 100#/acre Bermuda, add 10#/acre German Millet (May 1st – August 15), add 40#/acre Hybrid Rye (Before May 1st and After August 15th)

TW - 120#/acre Hybrid Rye

TS - 40#/acre German Millet or 50#/acre Sudan grass

TF - 120#/acre Hybrid Rye

Note: P - Permanent Seeding
TW - Temporary Winter Seeding
TS - Temporary Summer Seeding
TF – Temporary Fall Seeding

E. On cut and fill slopes 2:1 or steeper add 10#/acre of German Millet or Browntop Millet the P seed mixture.

2.07 WOOD CELLULOSE FIBER MULCH

A. For use in hydroseeding grass seed in combination with fertilizers and other approved additions, shall consist of especially prepared wood cellulose fibers such as "Wood-Lok 300" manufactured by Applegate Mulch, "Enviro-Mix" manufactured by Profile, or equal, and have no growth or germination inhibiting factors, and be dyed green.

B. The wood cellulose fiber shall have the additional characteristic of dispersing rapidly in water to form a homogeneous slurry and remain in such state when agitated in the hydraulic mulching unit, or adequate equal, with the specified materials.

C. When applied, the wood cellulose fiber with additives will form an absorptive mat but not a plant inhibiting membrane, which will allow moisture, natural or mechanical, to percolate into underlying soil.

D. The mulch shall be supplied, compressed in packages containing 50 pounds of material having an equilibrium air dry moisture content at time of manufacture of 12% plus or minus 3%. Wood cellulose fiber mulch shall be stored in a weatherproof storage area and in such a manner that effectiveness will not be impaired.

2.08 STRAW MULCH

A. Straw mulch shall spread manually or by use of a straw blower. Straw used for mulch shall be small grain hay. Hay shall be undamaged, air dry, threshed straw, free of undesirable

weed seed. Straw mulch is not required for seeded areas treated by hydroseeding or with a temporary soil stabilizer.

2.09 TEMPORARY SOIL STABILIZER

A. Temporary soil stabilizers may be used in place of temporary seeding, as approved by the Owner or Engineer. The temporary agent for soil erosion control shall consist of an especially prepared plant-based or cementitious highly concentrated powder which, when mixed with water, forms a thick liquid such as "DustOut" manufactured by DustOut™, "Stabilizer" manufactured by Stabilizer Solutions, or "SoiLok™" as manufactured by Prime Resins, or equal, and having no growth or germination inhibiting factors. The agent shall be used for bare soil stabilization or hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a wind and rain resistant crust.

2.10 ROLLED EROSION CONTROL MATTING

A. The rolled erosion control products (RECMs) and Turf Reinforcement Mats (TRMs) shall be as specified in Section 02276 - Erosion and Sedimentation Control.

2.11 RIPRAP AND HERBICIDES

A. Furnish and install sufficient quantity of landscape gravel or riprap to cover over the ground to a minimum 4-inch depth for gravel and 24-inch depth for riprap, unless otherwise noted, or indicated on the Drawings. Also furnish and apply an approved herbicide to the subgrade surface just prior to installing the landscape gravel or riprap.

B. During placing, the stone shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone.

C. All topsoil and vegetative matter shall be removed from the subgrade surfaces below areas to receive non-vegetative permanent cover prior to the application of the weed killer (herbicide) and to the placement of landscape gravel, riprap, or other hardscaping. Apply commercial-type herbicide as preemergence control of miscellaneous grasses and broadleaf weeds in granular or liquid form such as "Treflan", "Dymid", or equal. Methods and rates of application shall be in strict compliance to manufacturer's directions and acceptable to the Engineer.

D. The herbicide selected shall be safe for use around ornamental plantings, have long-lasting weed control, and shall be resistant to leaching away under excessive rainfall.

E. A second application of the herbicide shall be made on the surface of the landscape gravel, riprap, or other hardscapes sometime after the first six (6) months, but not later than 12-months. Same methods and rates apply as specified previously.

PART 3 -- EXECUTION

3.01 GRADING

A. After approval of the rough grading, the Contractor shall commence his preparations of the subgrade for the various major conditions of the work as follows:

1. Bare soil for riprap area at subgrade (24-inches below final grade, or as directed by the Engineer).

2. Topsoil for lawn and road shoulder seed area - scarify 2-inch depth of subgrade (4-inches below final grade) prior to placing topsoil.

B. Final surface grading of the topsoiled, landscape graveled, and riprapped areas shall be mechanically raked or hand raked to an even finished surface alignment.

3.02 TOPSOIL

A. Topsoil shall be spread in place for quantity required for lawn and road shoulder seed areas at 4-inch consolidated depth, and sufficient quantity for certain plant beds and backfill for shrubs and trees as specified.

3.03 SEEDBED PREPARATION

A. Contractor shall prepare all areas to receive temporary or permanent seeding measures prior to planting.

B. Topsoil shall be placed in areas to be seeded and roughened with tracked equipment or other suitable measures. Slopes steeper than 3:1 may be roughened by grooving, furrowing, tracking, or stairstep grading. Slopes flatter than 3:1 should be grooved by disking, harrowing, raking, operating planting equipment on the contour.

C. Soil amendments including, but not limited to, lime and fertilizer shall be spread as necessary, and at the rates specified in this Section. Seeding shall be as per the type and rates specified in this Section. Seed shall be broadcast as soon as possible following roughening, before surface has been sealed by rainfall.

3.04 HYDROSEEDING AND GRASS

A. The Contractor shall grow a stand of temporary or permanent grass by hydroseeding method on all disturbed areas. The Contractor shall be responsible for the satisfactory growth of grass throughout the period of the one-year guarantee.

B. The Contractor's work shall include the preparation of the topsoil and bare soil seed bed, application of fertilizer, limestone, mulching, inoculant, temporary soil stabilizer, watering, and all other operations necessary to provide a satisfactory growth of sod at the end of the one-year maintenance period. Areas without satisfactory sod at the end of one (1) year shall be replanted until satisfactory growth is obtained and acceptable to the Engineer.

C. All areas to be seeded shall be done by the hydraulic seeding method including all additives and amendments required. A "Reinco", "Finn", or "Bowie" type hydromulcher with adjustable

nozzles and extension hoses, or equal, shall be utilized. General capacity of tank should range from 500 to 2,500 gallons, or as approved by the Engineer.

D. Hydraulic seeding shall be carried out in three steps. Step one shall consist of the application of lime. In step two the seed mixture shall be mixed with the fertilizer, wood cellulose fiber mulch, and any required inoculants and applied to the seed bed. Step three shall consist of application of top dressing during the first spring or fall, whichever comes first, after step two.

E. Top dressing shall consist of a commercial grade fertilizer plus Nitrogen or other analysis as may be recommended by soil testing. Types and application rates of seed mixtures, lime, fertilizer, and wood cellulose fiber mulch, shall be as shown in the Seeding Schedule.

F. Ingredients for the mixture and steps should be dumped into a tank of water and thoroughly mixed to a homogeneous slurry and sprayed out under a minimum of 300-350 pounds pressure, in suitable proportions to accommodate the type and capacity of the hydraulic machine to be used. Applications shall be evenly sprayed over the ground surface. The Contractor shall free the topsoil of stones, roots, rubbish, and other deleterious materials and dispose of same off the site. The bare soil, except existing steep embankment area, shall be rough raked to remove stones, roots, and rubbish over 4-inches in size, and other deleterious materials and dispose of same off the site.

G. No seeding should be undertaken in windy or unfavorable weather, when the ground is too wet to rake easily, when it is in a frozen condition, or too dry. Any bare spots shown in two to three weeks shall be recultivated, fertilized at half the rate, raked, seeded, and mulched again by mechanical or hand broadcast method acceptable to the Engineer.

H. Areas that have been manually seeded or hydroseeded with a temporary seed mixture shall be mowed to a height of less than 2-inches and scarified prior to hydroseeding with the permanent seed mixture.

I. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.

J. The Contractor shall water newly seeded areas of the lawn and road shoulder mix once a week until the grasses have germinated sufficiently to produce a healthy turf, or unless otherwise directed by the Engineer. Each watering shall provide three (3) gallons per square yard. The Contractor shall furnish all necessary hoses, sprinklers, and connections.

K. The first and second cutting of the lawn grasses only shall be done by the Contractor. All subsequent cuttings will be done by the Owner's forces in a manner specified by the Contractor.

3.05 DITCH AND SWALE EROSION PROTECTION

A. All ditches and swales indicated on the Drawings shall be lined with a rolled erosion control matting (RECM) or Turf Reinforcement Mat (TRM). The area to be covered shall be

properly graded and hydroseeded before the RECM or TRM is installed. Installation shall be in accordance with Section 02276 - Erosion and Sedimentation Control.

3.06 MAINTENANCE

A. The Contractor shall be responsible for maintaining all seeded areas through the end of a 1-year warranty period, beginning from the date of acceptance of final seeding and landscaping as determined by the Engineer. Maintenance shall include but not be limited to, annual fertilization, initial mowing, repair of seeded areas, irrigation to establish growth, and weed control. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.

B. Annual fertilization shall consist of an application of 500#/acre of 10-10-10 commercial grade fertilizer, or its equivalent and 60#/acre of nitrogen in early fall, or other analysis as may be determined by soil test. Annual fertilization shall be in addition to top dressing and shall be performed by the Contractor each fall season after planting until the work is substantially complete.

C. Mowing shall be scheduled so as to maintain a minimum stand height of 4-inches or as directed by the Engineer or Owner. Stand height shall be allowed to reach 8 to 10-inches prior to initial mowing, or as appropriate for type of vegetation planted.

D. All seeded areas shall be inspected on a regular basis and any necessary repairs or reseedings made within the planting season, if possible. If the stand should be over 60% damaged, it shall be re-established following the original seeding recommendations.

E. Weed growth shall be maintained mechanically and/or with herbicides. When chemicals are used, the Contractor shall follow the current North Carolina Agricultural Experiment Stations' weed control recommendations and adhere strictly to the instructions on the label of the herbicide. No herbicide shall be used without prior approval of the Engineer or Owner.

3.07 CLEANUP

A. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.

B. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

3.08 SEEDING SCHEDULE

A. All seeding and mulching to be completed by the Contractor shall conform to the following schedule. No permanent seeding shall be performed from May 1 - August 31 and November 1 - February 14. Temporary seed mixtures will be used during these times if seeding is necessary. Areas seeded with temporary seed mixtures shall be reseeded by the Contractor at no additional cost to the Owner with permanent seed as directed by the Engineer.

B. Application rates of seed mixtures, lime, fertilizer, mulch and top dressing are shown in the schedule.

SEEDING SCHEDULE

Application Rates (Pounds/Acre)

Seed Mixture	Planting Season	Lime[a]	Seed	Fertilizer	Straw[b] Mulch	Topdressing[a]	Annual Fertilizer	Comments
P	April 15 – June 30	4000	100	1000	4000	500 of 10-10-10 60 of Nitrogen	Same as Topdressing	Preferred planting season is April 15 – June30.
TW	Jan. 1-May 1	2000	120	750	4000	-	-	Over seed with Type P seed mixture during next planting season.
TS	May 1-Aug. 15	2000	40	750	4000	-	-	Over seed with Type P seed mixture during next planting season.
TF	Aug. 15-Dec. 30	2000	120	1000	4000	-	-	Over seed with Type P seed mixture during next planting season.

Footnotes:

a. Contractor shall confirm application rates and/or chemical analysis or established by soil test.

b. On cut and fill slopes 2:1 or steeper, add 10#/acre German or Browntop Millet to Type P seed mixture. Use scarified seed for spring plantings and unscarified for fall plantings.

c. Apply tackifier at rate of 0.10 gallon per square yard (10 gal/1000 ft^2), or as specified by manufacturer, to tack straw mulch.

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SECTION 03100
CONCRETE FORMWORK

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03200 – Reinforcing Steel

B. Section 03250 – Concrete Accessories

C. Section 03290 – Joints in Concrete

D. Section 03300 – Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Building Code for the State or Commonwealth in which the project is located.

2. ACI 318 – Building Code Requirements for Structural Concrete

3. ACI 301 – Specifications for Structural Concrete

4. ACI 347 – Recommended Practice for Concrete Formwork

5. U.S. Product Standard for Concrete Forms, Class I, PS 1

6. ACI 117 – Specification for Tolerances for Concrete Construction and Materials and Commentary

1.04 SUBMITTALS

093022

A. Submit the following in accordance with Section 01300 – Submittals.

1. Manufacturer's data on proposed form release agent

2. Manufacturer's data on proposed formwork system including form ties

1.05 QUALITY ASSURANCE

A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 – PRODUCTS

2.01 FORMS AND FALSEWORK

A. All forms shall be smooth surface forms unless otherwise specified.

B. Wood materials for concrete forms and falsework shall conform to the following requirements:

1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.

C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Sika Corporation or approved equal. Friction fit plugs shall not be used.

C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

PART 3 – EXECUTION

3.01 FORM DESIGN

A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.

B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.

B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.

C. Forms shall be true to line and grade and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.

D. Forms shall be mortar tight to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form.

E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.

G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.

H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.

I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.

J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts

shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.

B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.

C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and benchmarks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

D. Regardless of the tolerances specified, no portion of the structure shall extend beyond the legal boundary of the structure.

3.04 FORM ACCESSORIES

A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.

B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to water or enclosed surfaces above the water surface, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 – Concrete Finishes. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending

through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION – FORM RELEASE AGENT

A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

Ambient Temperature (°F.) During Concrete Placement

	Over 95°	70°-95°	60°-70°	50°-60°	Below 50°
Edge Forms for Slabs on Grade	1 day	1 day	1 day	1 day	
Walls	5 days	2 days	2 days	3 days	Do not remove until directed by Engineer (7 days minimum)
Columns	7 days	2 days	3 days	4 days	
Beam Soffits	10 days	7 days	7 days	7 days	
Elevated Slabs	12 days	7 days	7 days	7 days	

C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.

D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall always be available for inspection at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

3.09 RESHORING

A. When reshoring is permitted or required the operations shall be planned and subjected to approval by the Engineer.

B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.

D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall have a capacity sufficient to resist the anticipated loads and, in all cases, shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.

E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

END OF SECTION

SECTION 03200

REINFORCING STEEL

PART 1 – GENERAL

1.01 THE REQUIREMENTS

A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.

B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03250 – Concrete Accessories

C. Section 03300 – Cast-in-Place Concrete

D. Section 03400 – Precast Concrete

E. Section 04200 – Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Building Code for the State or Commonwealth in which the project is located.

2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice

3. ACI SP66 - ACI Detailing Manual

4. ACI 315 - Details and Detailing of Concrete Reinforcing

5. ACI 318 - Building Code Requirements for Structural Concrete

6. WRI - Manual of Standard Practice for Welded Wire Fabric

7. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

072122

8. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

9. ASTM E 3121 – Standard Test Methods for Field Testing of Anchors in Concrete or Masonry

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.

2. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all deformed bar reinforcing used in masonry. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, locations, spacing and splicing of the bars.

3. Mill test certificates - 3 copies of each.

4. Description of the reinforcing steel manufacturer's marking pattern.

5. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.

6. Proposed supports for each type of reinforcing.

7. Request to use splices not shown on the Drawings.

8. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.

9. Request for placement of column dowels without the use of templates.

10. Request and procedure to field bend or straighten partially embedded reinforcing.

11. International Code Council–Evaluation Services Report (ICC-ES ESR) for dowel adhesives.

12. Certification that all installers of dowel adhesive systems in horizontal to vertically overhead applications are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.

13. Adhesive dowel testing plan.

1.05 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

B. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information.

C. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards, or equivalent, for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.

D. Special inspections for adhesive dowels shall be conducted in accordance with the manufacturer's instructions and Specification Section 01450 – Special Inspections. Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

PART 2 – PRODUCTS

2.01 REINFORCING STEEL

A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 deformed billet-steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type, and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.

B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.

C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.

D. Field welding of reinforcing steel will not be allowed.

E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcing during concrete placement. Wire bar supports shall be plastic protected (CRSI Class 1).

B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall develop a tensile strength which exceeds 100 percent of the ultimate tensile strength and 125 percent of the yield strength of the reinforcing bars being spliced. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

C. Hot forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio, or approved equal. Mechanical couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

D. Where the threaded rebar to be inserted into the coupler reduces the diameter of the bar, the threaded rebar piece shall be provided by the coupler manufacturer.

2.04 DOWEL ADHESIVE SYSTEM

A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions.

B. All holes shall be drilled in accordance with the manufacturer’s instructions except that core drilled holes shall not be permitted unless specifically allowed by the Engineer. Cored holes, if allowed by the manufacturer and approved by the Engineer, shall be roughened in accordance with manufacturer’s requirements.

C. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with manufacturer’s instructions prior to installation of adhesive and reinforcing bar.

D. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be dry, or water saturated unless

otherwise permitted by the engineer. If water saturated installation is approved, appropriate reduction factors in accordance with manufacturer's design requirements should be considered. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer.

E. Injection of adhesive into the hole shall be performed in a manner to minimize the formation of air pockets in accordance with the manufacturer's instructions.

F. Embedment Depth:

1. The embedment depth of the bar shall be as shown on the Drawings. Although all manufacturers listed below are permitted, the embedment depth shown on the Drawings is based on "HIT-HY 200 Adhesive Anchoring System" by Hilti. If the Contractor submits one of the other named dowel adhesives from the list below, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

2. Where the embedment depth is not shown on the Drawings, the embedment depth shall be determined to provide the minimum allowable bond strength equal to the tensile strength of the rebar according to the manufacturer's ICC-ES ESR.

3. The embedment depth shall be determined using design parameters listed below. In no case shall the embedment depth be less than the minimum, or more than the maximum, embedment depths stated in the manufacturer's ICC-ES ESR.

4. Design of adhesive anchor system shall be based on the following parameters:

a. Actual compressive strength of concrete.

b. Cracked concrete state.

c. Dry or water saturated condition for installation.

d. Base material temperature between 40- and 104-degrees Fahrenheit.

e. Installation with either a hammer drill with carbide bit or hollow-drill bit system drilling methods.

f. Minimum age of concrete 21 days at time of installation.

G. Engineer's approval is required for use of this system in locations other than those shown on the Drawings.

H. The adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories and shall be "HIT-HY 200 Adhesive Anchoring

System" as manufactured by Hilti, Inc. “SET-3G Epoxy Adhesive Anchors” as manufactured by Simpson Strong-Tie Co. or “Pure 110+ Epoxy Adhesive Anchor System” by DeWalt. Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved.

I. All individuals installing dowel adhesive systems in horizontal to vertically overhead applications shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program, or equivalent.

PART 3 – EXECUTION

3.01 FABRICATION

A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.

C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved to be bent in the field. Reinforcing bars shall not be straightened or bent in a manner that will injure the material. Heating of bars will not be permitted.

D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

3.02 DELIVERY, STORAGE AND HANDLING

A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.

B. Reinforcing steel shall be stored above ground on platforms or other supports and shall always be protected from the weather by suitable covering. Reinforcing steel shall be stored in an orderly manner and plainly marked to facilitate identification.

C. Reinforcing steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.

D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where delay in

depositing concrete occurs, reinforcing shall be inspected again and if necessary recleaned.

3.03 PLACING

A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or plastic protected (CRSI Class 1) metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.

B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms to provide the specified concrete coverage.

D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.

E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.

F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.

H. Reinforcing shall not be straightened or bent unless specifically shown on the drawings. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.

I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer’s recommendations and as required in Article 2.04 above. A representative of the manufacturer must be on site prior to adhesive dowel installation to provide instruction on proper installation procedures for all adhesive dowel installers. Testing of adhesive dowels shall be as indicated below. If the dowels have a hook at the end to be

embedded in subsequent work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate adhesive dowel testing while maintaining required hook embedment in subsequent work.

J. All adhesive dowel installations in the horizontal or overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI Adhesive Anchor Installer Certification program, or equivalent, per ACI 318-14 17.8.2.2. Current AAI Certificates must be submitted to the Engineer for approval prior to commencement of any adhesive anchor installations.

K. Adhesive Dowel Testing

1. At all locations where adhesive dowels are shown on the Drawings, at least 10 percent of all adhesive dowels installed shall be tested to 80% of the yield load of the reinforcing bar, with a minimum of one tested dowel per group.

2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values, and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) prior to conducting any testing. Proof testing procedures shall be in accordance with ASTM E 3121.

3. Where Contract Documents indicate adhesive dowel design is the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. The Contractor shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable.

4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the load test. Dowels exhibiting damage shall be removed and replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be load tested.

5. Load testing of adhesive dowels shall be performed by an independent testing laboratory hired directly by the Contractor. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

3.04 SPLICING

A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.

B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.

C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.

E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to eliminate concrete, or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.05 INSPECTION

A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.

B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

3.06 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval.

END OF SECTION

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SECTION 03230
STRESSING TENDONS

PART 1 – GENERAL

1.01 THE REQUIREMENTS

A. The Contractor shall furnish and place all stressing tendons for pretensioned and post-tensioned prestressed concrete, including all burning, measuring, draping, preventing bond, jacking and any special work necessary to hold the tendons in place and protect them from injury and corrosion in accordance with the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03200 – Reinforcing Steel

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM A416 – Uncoated 7-Wire Stress-Relieved Strand for Prestressed Concrete
2. ASTM A421 – Uncoated Stress-Relieved Wire for Prestressed Concrete
3. ASTM A910 – Uncoated, Weldless, 2 and 3 Wire Steel Strand for Prestressed Concrete
4. AASHTO M203 – American Association of State Highway and Transportation Officials
5. ACI 222R – Protection of Metals in Concrete Against Corrosion
6. ACI 222.2R – Report on Corrosion of Prestressing Steels
7. ACI 318 – Building Code Requirements for Structural Concrete
8. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

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A. The Contractor shall submit the following in accordance with the requirements of Section 01300 – Submittals.

1. Records of standard, certified mill tests run by the tendon manufacturer shall be kept on file, and current copies shall be submitted to the Engineer.

2. The manufacturer's certification and load-elongation curve, in accordance with the prestressed concrete fabricator for each lot of tendon. The Contractor shall obtain and submit the data to the Engineer for approval, in permanent record form.

3. Tubular conduit for preventing bond, when breaking bond at specific locations as required by the design.

4. Bed layout showing method of draping and tensioning, including calculations.

5. Records of initial jacking load, final jacking load and respective elongation.

PART 2 – PRODUCTS

2.01 PRESTRESSING TENDONS

A. Prestressing tendons for use in pretensioned and post-tensioned, prestressed concrete shall consist of multi-wire (2, 3 or 7) stress-relieved strands, stress-relieved single wire, or low-relaxation strands conforming to the requirements of ASTM A910, ASTM A416, and ASTM A421, respectively.

B. Wires shall be uncoated and shall be of a size and of a stress relieved or low relaxation type such as to insure sufficient prestress transfer bond. Only cold-drawn wire shall be utilized, no quenched and tempered steel shall be allowed.

C. Oil tempered wires shall not be used.

D. The tendons shall be clean and free of excessive rust, scale and pitting.

E. Strands or wires used in units of any one bed layout shall be manufactured by the same plant.

PART 3 – EXECUTION

3.01 TENSIONING DEVICES

A. Devices for tensioning shall be adequate to produce and maintain the required tension in all tendons until the concrete has reached the required transfer strength. All jacks shall be equipped with accurate and calibrated gages for registering jacking loads. Gages

shall be calibrated for the jacks with which they are used. All jacks and gages shall be calibrated by an approved testing company at no cost to the Owner at intervals not to exceed 12 months. During progress of the work, if gage readings and elongations indicate materially differing loads, recalibration may be required. Gages shall have a full load capacity of 1-1/2 to 2 times their normal working load. The loads to be gaged shall be not less than one-fourth or more than three-fourths of the total graduated capacity unless calibration data clearly establishes consistent accuracy over a wider range. Gages shall have indicating dials at least 6 inches in diameter and the gage pointers shall not fluctuate, preventing an accurate reading, but shall remain steady until the jacking load is released. All gages shall have an accuracy of reading within 2 percent. Means shall be provided for measuring the elongation of tendons within 1/4-inch.

3.02 PLACING STRANDS

A. Tendons shall be positioned in accordance with the detailed dimensions shown on the Drawings or as detailed by the supplier and effectively secured against displacement from their correct positions. The steel reinforcing shall be placed in final position after tensioning of the tendons. All tie wires shall be bent to the inside of the member so that the ends are farther from the edge than the material being tied. Bottom tendons shall be supported at spacings not to exceed 20 feet by supports meeting the requirements of Section 03200 –Reinforcing Steel or by other means approved by the Engineer.

B. Tendons with kinks, bends, nicks, scale, excessive rust or other defects will not be permitted. No more than one broken wire per casting bed will be permitted. Slight rusting will not be cause for rejection, provided it is not sufficient to cause visible pits. Precautions shall be taken to prevent contamination of tendons and reinforcing steel. The tendons and reinforcing steel shall be cleaned to an acceptable condition before concrete is poured. Concrete shall not be placed in the forms until the tendon and reinforcement condition and arrangement have been inspected by the plant inspector.

C. Tendon splices will only be permitted at the end of a reel and when using a single strand jack. The tendon lengths to be spliced together shall have the same lay of wire to avoid unraveling and the splice shall be positioned so that it does not fall within a member. The ends of the tendon lengths to be spliced shall not be torch cut. They shall be cut by shears, abrasive grinders, or other means approved by the Engineer. No more than one strand splice will be permitted on an individual strand and the reuse of strands will not be permitted.

D. Where bonding of tendons is to be prevented, it shall be accomplished by encasing the tendons in a tubular conduit capable of resisting the pressure exerted by the concrete. Slit conduit shall not be used. The conduit used shall be of high density polyethylene or polypropylene with a minimum wall thickness of 0.025 inch. The inside diameter of the conduit shall be of sufficient size to allow free movement of the encased tendon but it shall not be greater than the diameter of the tendon plus 1/8-inch. The conduit shall be secured so that longitudinal movement along the tendon will be prevented, and bonding

of the tendon will be prevented at the location shown on the Drawings plus or minus 1 inch. Concrete shall be prevented from entering the conduit by taping. The tape shall be manufactured from a non-corrosive material compatible with the concrete, conduit, and steel.

3.03 CORROSION PROTECTION

A. All tendons, including all trimmed strand ends, shall be protected by multi-level corrosion protection appropriate for an aggressive environment. Examples of multi-level protection include adequate concrete or grout cover, use of low permeability concrete and grout, use of corrosion inhibiting admixtures, water resistant grease, sheathing, encapsulated strands, etc.

B. Time between tendon stressing and grouting shall not exceed 7 days to limit corrosion risk of unprotected tendons. Temporary corrosion protection is required when time between tendon stressing and grouting will exceed 7 days.

3.04 TENSIONING PROCEDURE

A. Each tendon shall be tensioned to the required load prior to placing the concrete.

B. The load induced in the tendon shall be measured both by jacking gages and strand elongations on at least the first 5 tendons and every third tendon thereafter on each pour. Loads on all other tendons shall be measured by either jacking gages or tendon elongations. When both methods of measurement are used, if a discrepancy between gage and elongation of more than 5 percent is apparent, the entire operation shall be carefully checked and the source of error determined before proceeding further. The computed elongation and jacking loads shall make appropriate allowances for load losses due to friction and all possible slippage or relaxation of the anchorage. References shall be established periodically at each tendon anchorage to indicate any yielding or slippage that may occur between the time of initial tensioning and final release of the tendons.

C. In determining the applied load by measuring the elongation of the tendon, a modulus of elasticity taken from the typical stress-strain curve for the brand, size, and type of tendon being tensioned shall be used. The Contractor shall submit stress-strain curve data for the actual heats of material used in the tendons to the plant inspector before the tendons are used. Each reel or tendon shall be identified by tagging in accordance with AASHTO M203. A standard color marking every 100 ft. on the tendons will be required. The standard color markings shall be white for stress relieved tendons, green for low relaxation tendons and a double marking of green and red for special low relaxation tendons.

D. Tendons may be tensioned in a group or individually. Prior to being given its full tensioning, each tendon shall be brought to an initial tension of 2,000 lbs, for all beds under 150 ft in length, 3,000 lbs, for all beds 150 to 300 ft in length, and 4,000 lbs for all

beds longer than 300 ft. in length. This initial tension shall be measured by a calibrated gauge or other approved means, and the elongation due to initial tensioning shall then be computed. The difference between the required final tension and the initial tension shall be used to compute the expected additional elongation.

E. After initial tensioning, the tendons shall be tensioned until the required elongation and jacking load are attained and reconciled with the limits specified above. A permanent record shall be kept of the initial jacking load, the final jacking load and the elongation produced thereby. In single tendon tensioning, rotation of the jacking ram will not be allowed.

F. When draped tendons are to be used, the Contractor shall submit to the Engineer for his approval a bed layout showing the method of draping and tensioning the draped tendons and also calculations determining the loads required for tensioning the draped tendons. The tendons for all members to be cast in any one tensioning operation shall be draped before any beam is cast. End templates or bulkheads at ends of beams shall remain vertical or as otherwise shown on the Drawings. Unless otherwise approved by the Engineer, draping for all members shall be done either simultaneously or in increments not to exceed one-fourth of the total draping.

G. The device used for deflecting the draped tendons shall be of a type and dimensions approved by the Engineer. The part in contact with the tendon shall be rounded to a diameter of not less than 3/4-inch. Support and hold-down devices shall be of sufficient rigidity and have adequate support so that the final position of the tendons will be as shown on the Drawings.

H. With tendons tensioned in accordance with the above requirements and with other reinforcement in place, the concrete members shall be cast so as to achieve the required lengths. Tendon load shall be maintained between anchorages until the concrete has reached the required compressive strength for transfer of load from the anchorages to the members.

3.05 TRANSFER OF LOAD

A. Transfer of load procedures shall be such as to not cause cracks in members. Transfer of load shall be by gradual release of the tendons as a group, by gradual release of part of the group, or by burning of the fully tensioning tendons at the ends of the members. If tendons are to be released by a method other than gradual release of the entire group, the proposed method and pattern of release, if not so shown on the Drawings, shall be submitted by the Contractor to the Engineer for his approval. The approved method and pattern of release shall be rigidly followed. When the fully tensioned tendons are being burned each tendon or group of tendons shall be burned simultaneously at each end of the bed in its indicated order in the pattern and at each end of each member before proceeding to the tendons in the next group in the pattern at any point.

B. When detensioning all beams, girders, cored slabs, and piles, tendons shall not be burned quickly but shall be heated with a low oxygen flame played along the tendon for a minimum of 5 inches until the metal gradually loses its strength. Heat shall be applied at such a rate that failure of the first wire in each tendon shall not occur until at least 5 seconds after heat is first applied. When detensioning other members, the above procedure shall be followed unless an alternate procedure has been approved by the Engineer. Detensioning by arc welder will not be allowed.

C. All tendon releases shall be in a manner as to cause a minimum shock and lateral eccentricity of loading and shall meet the Engineer's approval. Failure to follow the above procedures for transfer of load will be grounds for rejection of the members involved.

END OF SECTION

SECTION 03250
CONCRETE ACCESSORIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, crack inducing joint inserts, epoxy bonding agent, and neoprene bearing pads.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03290 – Joints in Concrete

C. Section 03300 – Cast-in-Place Concrete

D. Section 07900 – Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

2. ASTM D412 – Standard Tests for Rubber Properties in Tension

3. ASTM D 624 – Standard Test method for Rubber Property - Tear Resistance

4. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics

5. ASTM D1751 – Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (non-extruding and resilient bituminous types)

6. ASTM D 1752 – Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

7. ASTM D 1171 – Standard Test Method for Ozone Resistance at 500 pphm

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8. ASTM D 471 – Standard Test Method for Rubber Properties

9. ASTM D 2240 – Standard Test for Rubber Property – Durometer Hardness

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Manufacturer's literature on all products specified herein including material certifications.

2. Proposed system for supporting PVC waterstops in position during concrete placement.

3. Samples of products if requested by the Engineer.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.

B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.

C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.

D. The required minimum physical characteristics for this material are:

1. Tensile strength – 1,750 psi (ASTM D-638).

2. Ultimate elongation – not less than 280% (ASTM D-638).

E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.

F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.

G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.02 RETROFIT WATERSTOPS

A. Not used.

2.03 CHEMICAL RESISTANT WATERSTOPS

A. Not used.

2.04 WATERPROOF MEMBRANE PATCH

A. Waterproof membrane patch shall be Sikadur Combiflex by Sika Corporation or approved equal. Minimum width of waterstop material shall be twelve (12) inches unless shown otherwise on Contract Drawings.

2.05 HYDROPHILIC WATERSTOPS

A. Hydrophilic waterstops shall be designed to expand under hydrostatic conditions. For hydrostatic head pressure greater than 25 feet, waterstops shall be Adeka Ultra Seal MC-2010MN by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak. For hydrostatic head pressure 25 feet or less, Adeka Ultra Seal KBA-1510FP or Hydrotite CJ-1020-2K shall be used. Concrete cover and confinement requirements shall be in accordance with the manufacturer's recommendations.

B. Waterstops shall be fabricated from a chemically modified natural rubber product with a hydrophilic agent. Use of bentonite based waterstop material will not be allowed.

C. Waterstops shall either contain an interior stainless-steel mesh or an interior coextrusion of non-hydrophilic rubber to ensure expansion occurs along the width and thickness of the waterstop thereby restricting the expansion in the longitudinal direction.

2.06 WATERSTOP ADHESIVE

A. Adhesive between waterstops and existing concrete shall be Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

B. Hydrophilic, non-bentonite water swelling elastic sealant shall be used to bond hydrophilic waterstops to rough surfaces. Hydrophilic elastic sealant shall be P-201 by Adeka Ultra Seal/OCM, Inc., Leakmaster LV-Z by Sika Greenstreak, or approved equal.

2.07 JOINT SEALANTS

A. Joint sealants shall comply with Section 07900 – Joint Fillers, Sealants, and Caulking.

2.08 EXPANSION JOINT MATERIAL

A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:

1. Type I – Sponge rubber, conforming to ASTM D1752, Type I.

2. Type II –Cork, conforming to ASTM D1752, Type II.

3. Type III – Self-expanding cork, conforming to ASTM D1752, Type III.

4. Type IV – Bituminous fiber, conforming to ASTM Designation D1751.

2.09 EXPANSION JOINT SEAL

A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive, and pressurized during the adhesive cure time.

B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc.

2.10 CRACK INDUCING JOINT INSERTS

A. Crack inducing joint inserts shall be Zip-Cap by Greenstreak Plastic Products, Zip-Joint by BoMetals, Inc.

2.11 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, MasterEmaco ADH Series by Master Builders Solutions.

2.12 EPOXY RESIN BINDER

A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, MasterEmaco ADH 327 or 327 RS by Master Builders Solutions.

2.13 BEARING PADS

A. Neoprene bearing pads shall conform to requirements of A4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be nonlaminated

pads having a nominal Shore A durometer hardness of 70 in accordance with ASTM D2240. Adhesive for use with neoprene pads shall be an epoxy-resin compound compatible with the neoprene having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikadur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

PART 3 – EXECUTION

3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS

A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.

B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.

C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.

D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.

F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:

1. Tensile strength less than 80 percent of parent material.

2. Overlapped (not spliced) Waterstop.

3. Misalignment of waterstop geometry at any point greater than 1/16 inch.

4. Visible porosity or charred or burnt material in weld area.

5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

3.02 WATERPROOF MEMBRANE PATCH AND HYDROPHILIC WATERSTOPS

A. Patches and waterstops shall be installed only where shown on the Drawings.

B. Patches and waterstops shall be installed in strict accordance with manufacturer's recommendations.

3.03 WATERSTOP ADHESIVE

A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.

B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.04 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.

C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.

E. Type 1 joint sealant shall be used in all expansion and crack inducing joints in concrete, except where other specific types are required as stated below, and wherever else specified or shown on the Drawings. Sealant shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.

F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.

G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.05 EXPANSION JOINT SEAL

A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

3.06 CRACK INDUCING JOINT INSERTS

A. For joints in slabs, inserts shall be floated in fresh concrete during finishing.

B. For joints in walls, inserts shall be secured in place prior to casting wall.

C. Inserts shall be installed true to line at the locations of all joints as shown on the Drawings.

D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290 – Joints in Concrete.

E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

3.07 EPOXY BONDING AGENT

A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.

B. Bonding surface shall be clean, sound, and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.

D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

3.08 EPOXY RESIN BINDER

A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

3.09 BEARING PADS

A. Care shall be taken in fabricating pads and related metal parts so effects detrimental to the proper performance of the pads, such as uneven bearing and excessive bulging, will not occur.

END OF SECTION

SECTION 03290

JOINTS IN CONCRETE

PART 1 – GENERAL

1.01 THE REQUIREMENTS

A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.

B. Types of joints in concrete shall be defined as follows:

1. Construction Joints – Intentionally created formed joints between adjacent concrete placements with 100% of reinforcement continuous through joint.

2. Expansion Joints – Formed joints in concrete which separate adjacent sections to allow movement due to dimensional increases and reduction of adjacent sections (temperature and shrinkage). Reinforcement terminates within concrete on each side of joint. Expansion joints may also be considered isolation joints.

3. Contraction Joints – Formed joints in concrete to create interface between concrete placements to allow movement due to dimensional reduction of adjacent sections (shrinkage).

   a. Full Contraction Joints – Formed contraction joints with no bonded reinforcement passing through the joint.

   b. Partial Contraction Joints – Formed contraction joints with no more than 50% of bonded reinforcement passing through the joint.

4. Crack Inducing Joints – Joints formed, tooled, or sawcut in a monolithic placement to create a weakened plane to regulate the location of crack formation due to dimensional reduction of adjacent sections (shrinkage).

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03250 – Concrete Accessories

C. Section 03300 – Cast-in-Place Concrete

D. Section 07900 – Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 318 – Building Code Requirements for Structural Concrete

3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

4. ACI 224.3 – Joints in Concrete Construction

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Layout drawings showing location and type of all joints to be placed in each structure.

2. Details of proposed joints in each structure.

3. For sawcut crack-inducing joints, submit documentation indicating the following:

a. Proposed method of sawcutting indicating early entry or conventional sawing.

b. Description of how work is to be performed including equipment to be utilized, size of crew performing the work and curing methods.

c. Description of alternate method in case of time constraint issues or failure of equipment.

PART 2 – MATERIALS

2.01 MATERIALS

A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories and Section 07900 – Joint Fillers, Sealants and Caulking.

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PART 3 – EXECUTION

3.01 CONSTRUCTION JOINTS

A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and proposed location to Engineer for approval. All joints shall be construction joints or expansion joints unless otherwise specified on the Drawings or approved by the Engineer on the joint plan submittal.

B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 50’-0”. For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25’-0”.

D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.

E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.

F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

G. Joint plan of walls and slabs shall consider aspect ratio to create placement of sections as close to square as possible. Aspect ratio is defined as the ratio of plan dimensions for slab sections and length to height placement of wall sections. Aspect ratios shall be between 0.65 and 1.5.

3.02 EXPANSION JOINTS

A. Size and location of expansion joints shall be as shown on the Drawings. All joints shall be construction joints or expansion joints unless otherwise specified on the Drawings or approved by the Engineer on the joint plan submittal.

B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250 – Concrete Accessories.

3.03 CONTRACTION JOINTS

A. Contraction joints shall be located as shown on the Drawings or otherwise approved by the Engineer on the joint plan submittal. Contractor shall submit proposed locations and details of all contraction joints concurrent or prior to submission of reinforcement drawings. Use of contraction joints at locations not specifically detailed on the Drawings requires Engineer approval and will only be considered if meeting the stipulations herein.

B. Full contraction joints may be considered where the structural behavior of the element allows termination of all reinforcement through joint without compromise of structural integrity of element.

C. Partial contraction joints may be considered where the structural behavior of the element requires partial continuation of reinforcement through joint to ensure structural integrity.

D. Where full contraction joints are allowed, maximum distance between horizontal contraction joints in slab and vertical contraction joints in walls shall be 50’-0”. For exposed walls with fluid or earth on the opposite side, spacing between vertical and horizontal contraction joints shall be a maximum of 25’-0”.

E. Bond breaker shall be provided between sections for all contraction joints.

F. Joint plan of walls and slabs shall consider aspect ratio to create placement of sections as close to square as possible. Aspect ratio is defined as the ratio of plan dimensions for slab sections and length to height placement of wall sections. Aspect ratios shall be between 0.65 and 1.5.

3.04 CRACK INDUCING JOINTS

A. Location of crack inducing joints shall be as shown on the Drawings or submitted by Contractor and approved by Engineer.

B. Crack inducing joints shall be formed either by saw cutting, tooling, or use of approved inserts as specified in Section 03250 – Concrete Accessories.

C. If approved by the Engineer, saw cutting of contraction joints in lieu of forming or tooling shall conform to the following requirements:

1. Joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.

2. Curing shall be performed using wet curing methods as indicated in Section 03370 – Concrete Curing. Curing mats, fabrics or sheeting materials shall remain in place to the extent possible while cutting of joint is being performed. Curing materials shall only be removed as required and shall be immediately reinstalled once cutting of the joint has been completed.

3. Depth of joint shall be as shown on the drawings or noted in these specifications. At locations where the joint cannot be installed to full depth due to curbs or other stopping points hand tools shall be used to complete joints.

4. Saw cut joints shall meet the requirements of ACI 224.3, Section 2.8, Jointing Practice.

D. Unless noted otherwise on Drawings, depth of crack inducing joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.05 JOINT PREPARATION

A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.

C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.

D. All joints shall be sealed as shown on the Drawings and specified in Section 03250 – Concrete Accessories.

END OF SECTION

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SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, materials, and services necessary for the manufacture, transportation, and placement of all plain and reinforced concrete work, as shown on the Drawings or as required by the Engineer.

B. The requirements in this section shall apply to the following types of concrete:

1. Class A1 Concrete: Normal weight structural concrete to be used in all structures qualifying as environmental concrete structures designed in accordance with ACI 350 including pump stations, tanks, basins, process structures, and any structures containing fluid or process chemicals, or other materials used in treatment process.

2. Class A2 Concrete: Normal weight structural concrete in all structures other than environmental concrete structures as described above, and for all sidewalks and pavement.

3. Class A4 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A4 concrete is identical to Class A2 concrete except that coarse aggregate specified in Article 2.08 below shall be Size #8 in accordance with ASTM C33.

4. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03200 – Reinforcing Steel

C. Section 03250 – Concrete Accessories

D. Section 03290 – Joints in Concrete

E. Section 03350 – Concrete Finishes

090923

F. Section 03370 – Concrete Curing

G. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. ACI 214 – Guide to Evaluation of Strength Test Results of Concrete

3. ACI 301 – Specifications for Structural Concrete

4. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete

5. ACI 305 – Specification for Hot Weather Concreting

6. ACI 306 – Standard Specification for Cold Weather Concreting

7. ACI 309R – Guide for Consolidation of Concrete

8. ACI 318 – Building Code Requirements for Structural Concrete and Commentary

9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

10. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field

11. ASTM C 33 – Standard Specification for Concrete Aggregates

12. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

13. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

14. ASTM C 88 – Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate

15. ASTM C 94 – Standard Specification for Ready-Mixed Concrete

16. ASTM C 114 – Standard Test Method for Chemical Analysis of Hydraulic Cement

17. ASTM C 136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

18. ASTM C 138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

19. ASTM C 143 – Standard Test Method for Slump of Hydraulic Cement Concrete

20. ASTM C 150 – Standard Specification for Portland Cement

21. ASTM C 157 - Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete

22. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete

23. ASTM C 192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

24. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

25. ASTM C 260 – Standard Specification for Air-Entraining Admixtures for Concrete

26. ASTM C 295 – Standard Guide for Petrographic Examination of Aggregates for Concrete

27. ASTM C 457 – Standard Test Method for Microscopical Determination of the Air-Void System in Hardened Concrete

28. ASTM C 494 – Standard Specification for Chemical Admixtures for Concrete

29. ASTM C 595 – Standard Specification for Blended Hydraulic Cements

30. ASTM C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

31. ASTM C 989 – Standard Specification for Slag Cement for Use in Concrete and Mortars

32. ASTM C 1012 – Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution

33. ASTM C 1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

34. ASTM C 1157 – Standard Performance Specification for Hydraulic Cement

35. ASTM C 1260 – Test Method for Potential Alkali Reactivity of Aggregates (Mortar Bar Method)

36. ASTM C 1567 – Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

37. ASTM C 1579 – Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)

38. ASTM C 1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

39. ASTM C 1609 – Standard Test Method for Flexural Performance of Fiber Reinforced Concrete (Using Beam with Third-Point Loading)

40. ASTM C 1778 – Standard Guide for Reducing the Risk of Deleterious Alkali – Aggregate Reaction in Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.

2. Certified current (less than 1 year old) chemical analysis (mill test report) of the Portland Cement or Blended Cement to be used. The chemical analysis must include the equivalent alkali content of the Portland Cement or Blended Cement.

3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.

4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, potential reactivity, aggregate soundness tests, petrographic analysis, mortar bar expansion testing, etc.

5. Manufacturer's data on all admixtures stating compliance with required standards.

6. Concrete mix design for each class of concrete specified herein.

7. Verification concrete mix and individual constituents in concrete meet requirements for NSF 61 approval for potable water applications where required.

8. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

9. Drying shrinkage test results from trial concrete mixes.

1.05 QUALITY ASSURANCE

A. Tests on materials used in the production of concrete shall be required as specified in Part 2 – Products. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.

B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.

C. Field quality control tests, as specified in Article 3.11, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field-Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

1.06 CONCRETE COORDINATION CONFERENCE

A. Unless waived by the Engineer, prior to any concrete submittals and at least 35 days prior to the start of the concrete construction schedule, the Contractor shall conduct a meeting at the site. The purpose of the meeting is to review the proposed concrete mix designs, to discuss the proposed approaches and procedures for mixing, transporting, placing, testing, finishing, and curing of all aspects of concrete work to ensure the concrete construction is performed in accordance with the Specifications, and to clarify roles of the parties involved. The Contractor shall send a concrete coordination conference agenda to all attendees 20 days prior to a mutually agreed upon date for the conference.

B. As a minimum the agenda shall include:

1. Concrete Materials and Mix Designs

2. Inspection Responsibilities

3. Concrete Sampling and Testing Specification Requirements

4. Cylinder Storage and Transportation

5. Acceptance/Rejection Responsibility and Authority for Fresh Concrete

6. Concrete finishing

7. Concrete Curing

8. Test Report Distribution

9. Miscellaneous Items

C. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the following:

1. Contractor's superintendent

2. Engineer

3. Owner's representative (if he chooses to attend)

4. Laboratory retained for trial batching and construction quality control testing for the concrete.

5. Any subcontractors involved in placing, finishing, and curing of concrete

6. Concrete supplier

7. Concrete pumping subcontractor (if pumping is being proposed)

D. Minutes of the meeting shall be recorded, typed, and printed by the Contractor and distributed to all attendees and any other concerned parties within five days of the meeting.

PART 2 – PRODUCTS

2.01 NSF/ANSI STANDARD 61 CERTIFIED CONCRETE

A. NSF/ANSI Standard 61 certified concrete is required only where the concrete is uncoated and in contact with potable water, the volume of water is less than 350,000 gallons, and the ratio of the concrete surface area in contact with potable water to the volume of water exceeds 0.8 square inches per liter for static water conditions or 0.08 square inches per liter for flowing water conditions. The following structures and utilities require this certification:

1. Carbon Slurry Tanks – ALTERNATE BID

2. Filtered Water Mixing Vault

B. Potable water is water at the start of flash mixing in drinking water treatment plants, and at all locations downstream of flash mixing in the water treatment, storage, and

distribution system. Concrete surface area in contact with potable water shall include submerged surfaces and surfaces above the water where water can condense and drip back into the water.

C. Where NSF/ANSI certified concrete is required by the paragraphs above, certification of compliance with NSF/ANSI Standard 61 shall be included with the concrete mix design submittal(s) and shall be provided by either one of the following two options:

    1. NSF/ANSI Standard 61 certified testing of concrete aggregates, hydraulic cement, and supplemental cementitious materials shall be provided individually for each constituent showing that each constituent complies with NSF/ANSI Standard 61

    2. NSF/ANSI Standard 61 testing of concrete cylinders formed from the trial batch concrete containing all the proposed constituents of the concrete shall be provided showing that the concrete mix complies with NSF/ANSI Standard 61.

D. Regardless of whether NSF/ANSI Standard 61 certified concrete is required by the paragraphs above, all admixtures used in concrete where the concrete is uncoated and in contact with potable water shall be individually tested and confirm to follow NSF/ANSI Standard 61.

2.02 HYDRAULIC CEMENT

A. Portland Cement

    1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.03 or 2.04, respectively.

    2. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

    3. Portland Cement shall also meet performance requirements of ASTM C 1157.

B. Blended Cement

    1. Blended cements shall be Type IP (Portland Fly Ash Cement), Type IS (Portland Slag Cement), or Type IL (Portland Limestone Cement) conforming to ASTM C 595.

    2. Type IP cement shall be an inter-ground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.

3. Type IS cement shall be an inter-ground blend of Portland Cement and slag cement in which the slag cement constituent is between 30% and 40% of the weight of the total blend.

4. Type IL cement shall be an inter-ground blend of Portland Cement and limestone in which the limestone constituent is between 5% and 15% of the weight of the total blend.

5. Fly ash, slag cement, and limestone used in the production of blended cements shall meet the requirements of Articles 2.03, 2.04, and 2.05 respectively.

6. Cements meeting ASTM C 1157 shall not be used in manufacture of blended cements.

7. Blended cement shall meet the Physical Requirements of Tables 2 and 3 of ASTM C 595 including the requirements for high sulfate resistance in Table 3 as tested per ASTM C1012.

C. Different types of cement shall not be mixed, nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

D. Cement shall be stored in a suitable weather-tight building to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.03 FLY ASH

A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618. Fly ash shall be considered as a supplemental cementitious material.

B. For fly ash to be used in the production of Type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.

C. Where reactive aggregates as defined in Article 2.08 are used in the concrete mix, the fly ash constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of fly ash shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where fly ash is used, the minimum fly ash content shall be 15%.

D. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.04 SLAG CEMENT

A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.

B. Where reactive aggregates as defined in Article 2.08 are used in concrete mix, the slag cement constituent shall be as needed to satisfy the concrete alkali loading requirements stipulated in Section 2.06. The percentage of slag cement shall also be set to meet the mean mortar bar expansion requirements in provisions of Article 2.08.G.2. Where Slag Cement is used, the minimum Slag Cement content shall be 30%, and the maximum Slag Cement content shall be 40%.

C. For Type A1 concrete as required for use in environmental concrete structures, i.e., process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

D. Additional slag cement shall not be included in concrete mixed with Type IS or IP cement.

2.05 PORTLAND LIMESTONE CEMENT (TYPE IL)

A. Portland Limestone Cement (Type IL) cement shall meet the requirements of ASTM C 595.

B. Limestone used for blended cement Type IL shall be naturally occurring and meet the requirements of ASTM C 33.

C. Fly ash or slag cement shall be used with Type IL cement to meet requirements for durability, ASR resistance, sulfate resistance, and use for environmental structures, as specified herein.

2.06 CONCRETE ALKALI LOADING

A. All concrete mixes containing potentially reactive aggregates shall have a maximum alkali loading of the concrete of 3.0 pounds per cubic yard.

B. The alkali loading of concrete is the Portland Cement equivalent alkali content multiplied by the Portland Cement content of the mix in pounds per cubic yard divided by 100. The Portland Cement equivalent alkali content shall be included in the certified chemical analysis of the Portland Cement.

C. Means of evaluating alkali loading of concrete and proportioning constituents of concrete to minimize alkali loading of content shall also conform to the guidelines of ASTM C1778.

2.07 WATER

A. Water used for mixing concrete shall be clear, potable, and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts, and other impurities.

B. Water shall not contain more than 100 PPM chloride.

C. Water shall not contain more than 500 PPM dissolved solids.

D. Water shall have a pH in the range of 4.5 to 8.5.

E. Water shall meet requirements of ASTM C 1602.

2.08 AGGREGATES

A. All aggregates used in normal weight concrete shall conform to ASTM C 33.

B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.

C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel, or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.

D. For Class A4 concrete, coarse aggregate shall be Size #8 in accordance with ASTM C33.

E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.

F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using either magnesium sulfate or sodium sulfate.

G. All aggregates shall be evaluated in accordance with ASTM C 1778 to determine potential reactivity. All aggregates shall be considered reactive unless they meet the requirements below for non-reactive aggregates. Aggregates with a lithology like sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.

1. Non-reactive aggregates shall meet the following requirements:

a. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

1) Optically strained, micro-fractured, or microcrystalline quartz, 5.0%, maximum.

2) Chert or chalcedony, 3.0%, maximum.

3) Tridymite or cristobalite, 1.0%, maximum.

4) Opal, 0.5%, maximum.

5) Natural volcanic glass in volcanic rocks, 3.0%, maximum.

2. Concrete mixed with reactive aggregates shall meet the following requirements:

a. If aggregates are deemed potentially reactive as per ASTM C1778 and fly ash or slag cement is included in proposed concrete mix design, proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

b. If aggregates are deemed potentially reactive as per ASTM C-1778 and a straight cement mix without fly ash or slag cement is proposed for concrete mix design, aggregates shall be evaluated by ASTM C-1260. Mean mortar bar expansions at 16 days shall be less than 0.08%.

c. If the proposed aggregates are deemed potentially reactive, the concrete mix shall be evaluated and confirmed to meet the requirements for concrete alkali loading as stipulated in Section 2.06.

H. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.09 SYNTHETIC FIBERS

A. Not used.

2.10 ADMIXTURES

A. Admixtures containing intentionally added chlorides shall not be used.

B. Admixtures containing 1,4 Dioxane shall not be used in Projects located in a State or Commonwealth where 1,4 Dioxane limits are required.

C. Air entraining admixture shall be added to all concrete unless noted otherwise. The air entraining admixture shall conform to ASTM C 260. The admixture proposed shall be selected in advance so that adequate samples may be collected, and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.

D. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set, and enhancing durability. Admixtures permitted shall confirm to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.

1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are “Eucon Series” by the Euclid Chemical Company, “Master Pozzolith Series or Master Polyheed Series” by Master Builders Solutions, and “Plastocrete Series” by Sika Corporation.

2. High range water reducer shall conform to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at the batch plant and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured, and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day’s operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are “Eucon 37” or Plastol 5000 by the Euclid Chemical Company, “Master Rheobuild 1000 or Master Glenium Series” by Master Builders Solutions, and “Daracem 100 or Advaflow Series” by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year’s duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are “MasterSet AC 534 or MasterSet FP 20” by Master Builders Solutions, “Accelguard 80/90 or NCA” by the Euclid Chemical Company and “Daraset” by W.R. Grace.

4. A retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type B or D. Acceptable products are “Eucon NR or Eucon Retarder 100” by the Euclid Chemical Company, “MasterSet R Series or MasterSet DELVO Series” by Master Builders Solutions, and “Plastiment” by Sika Corporation.

5. Workability Retaining Admixture shall conform to ASTM C 494, Type S. The admixture shall retain concrete workability without affecting time of setting or early-

age strength development. Acceptable products are “MasterSure Z 60” by Master Builders Solutions, or equal.

6. A crystalline permeability reducing admixture shall be used where specifically indicated on the Drawings or required herein. The admixture shall conform to ASTM C 494, Type S. The admixture shall be of the crystalline type that chemically controls and permanently establishes a non-soluble crystalline structure throughout the capillary voids and cracks within the concrete. The crystalline structure shall assist in sealing the concrete to minimize both infiltration and exfiltration of liquids from any direction. The admixture shall be capable of sealing hairline cracks and resisting hydrostatic pressure. Acceptable products are “Xypex Admix C-500 NF” by Xypex Chemical Corporation, “MasterLife® 300 Series” by Master Builders Solutions, and “Krystol Internal Membrane (KIM)” by Kryton International Inc. Submit certified letter from manufacturer of crystalline admixture stating required dosage rate for job specific concrete mix. Concrete truck ticket shall confirm crystalline admixture was included in concrete being placed.

E. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted. The addition of admixtures to prevent freezing is not permitted.

F. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review.

2.11 CONCRETE MIX DESIGN

A. The proportions of cement, aggregates, admixtures, and water used in the concrete mixes shall be based on laboratory trial mixes in conformance with ACI 301. Trial mixes shall also conform to Article 3.01 of this Specification. Trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.

B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

1. Compressive Strength (28-Day)

Concrete Class A1	4,500 psi (min.), 6500 psi (max.)
Concrete Class A2, A4	4,000 psi (min.), 6000 psi (max.)
Concrete Class B	3,000 psi (min.), 5000 psi (max.)

2. Water/cementitious materials ratio, by weight

	Maximum	Minimum
Concrete Class A1	0.42	0.39
Concrete Class A2, A4	0.45	0.39
Concrete Class B	0.50	0.39

3. Slump range

   a. 4" nominal unless high range water reducing admixture is used

   b. 8” max if high range water reducing admixture is used.

4. Air Content

Concrete Class A1, A2, A4	6% ±1.5%
Concrete Class B	3% Max (non-air-entrained)

2.12 TRIAL MIXES

A. Trial mixes shall be used to confirm the quality of a proposed concrete mix in accordance with ACI 301. An independent qualified testing laboratory designated and retained by the Contractor shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the aggregates, cement, supplementary cementitious materials, and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and density (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. “. If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch

testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

2.13 SHRINKAGE TESTS

A. Concurrent with the trial batch requirements stated in Article 3.01, the testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein. Shrinkage testing is only required for concrete to be used for environmental concrete structures (Class A1).

B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows.

1. Remove specimens from molds at an age of 23 hours ± 1 hour after trial batching.

2. Place specimens immediately in water at 70 °F ± 3 °F for at least 30 minutes.

3. Measure within 30 minutes thereafter to determine original length, then submerge in saturated lime water at 73 °F ± 3 °F.

4. At age seven days, measure to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).

5. Store specimens immediately in a humidity-controlled room maintained at 73 °F ± 3 °F and 50 percent ± 4 percent relative humidity for the remainder of the test.

6. Make and report separately measurements to determine shrinkage expressed as base length percentage for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

C. Compute the drying shrinkage deformation for each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation for the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage for any specimen departs from the average test age for that test by more than 0.0004 inch, disregard the results obtained from that specimen. Report results from the shrinkage test to the nearest 0.001 percent of shrinkage. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered part of the normal compression tests for the project.

D. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or

0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.

E. If the trial batch specimens do not meet both the strength and shrinkage requirements, revise the mix designs and/or materials and retest.

2.14 PRODUCTION OF CONCRETE

A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready-mix concrete plant or from a site mixed plant. In selecting the source for concrete production, the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

B. Ready-Mixed Concrete

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.

2. Truck mixers shall be equipped with electrically actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed within the time requirements stated in Article 3.04 of this Section.

6. Every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:

    a. Date and truck number

    b. Ticket number

    c. Mix designation of concrete

    d. Cubic yards of concrete

    e. Cement brand, type, and weight in pounds

    f. Weight in pounds of fine aggregate (sand)

    g. Weight in pounds of coarse aggregate (stone)

    h. Air entraining agent, brand, and weight in pounds and ounces

    i. Other admixtures, brand, and weight in pounds and ounces

    j. Water, in gallons, stored in attached tank

    k. Water, in gallons, maximum that can be added without exceeding design water/cementitious materials ratio

    l. Water, in gallons, used (by truck driver)

    m. Time of loading

    n. Time of delivery to job (by truck driver)

7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ±0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

a.	Cement, fly ash, or slag cement	± 1 percent
b.	Water	± 1 percent
c.	Aggregates	± 2 percent
d.	Admixtures	± 3 percent

3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

5. Mixers with a rated capacity of one cubic yard or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of one cubic yard or less shall be mixed for not less than one minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.

7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.

8. Controls shall be provided to ensure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.

9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if recommended by the manufacturer.

11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.

12. Addition of retarding admixtures shall be completed within one minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.

13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

2.15 CONCRETE PLACEMENT

A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.

B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice, and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures required.

C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.

D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.

E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided the design water-cementitious materials ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix meeting all specified requirements.

F. Concrete shall be conveyed as rapidly as practical to the point of deposit by methods which prevent the separation or loss of the ingredients. The concrete shall be deposited so that additional handling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates unless workability-retaining admixtures are included and approved by the Engineer. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.10 of this Section.

G. Where concrete is conveyed to position by chutes, a continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise.

H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds.

I. Placing of concrete shall be regulated so the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet, and enough tremies shall be placed in the form to ensure the concrete remains level.

K. When placing concrete which will be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.

L. Concrete shall be placed to thoroughly embed all reinforcement, inserts, and fixtures.

M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. Concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.

N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.

O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. Vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration shall not be continued in any one location to the extent that pools of grout are formed.

P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall ensure that each layer is placed while the previous layer is soft or plastic, so the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and water stops, and/or any proposed deviations from the stated requirements to the Engineer for review and approval.

S. Concrete shall not be placed during rains sufficiently heavy or prolonged to prevent washing of mortar from coarse aggregate on the forward slopes of the placement. Once

placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

2.16 PLACING FLOOR SLABS ON GROUND

A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.

B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing, the temperature shall be raised and maintained above 50° long enough to remove all frost from the subgrade.

C. The subgrade shall be moist at the time of concreting. If necessary, the subgrade shall be dampened with water in advance of concreting, but no free water shall remain standing on the subgrade nor any muddy or soft spots when the concrete is placed.

D. Thirty-pound felt-paper shall be provided between edges of slabs-on-ground and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

E. Contraction joints shall be provided in slabs-on-ground at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03 15 16 – Joints in Concrete.

F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03 35 00 – Concrete Finishes. Interior floor slabs shall be placed with non-air-entrained concrete (Class A3) if a steel troweled or hardened finish is required.

G. Tremie shall consist of a tube having a diameter of not less than 10 inches and constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported to permit free movement of the discharge and over the entire top surface of the work and shall permit rapid lowering when necessary to choke off or retard the flow. The discharge end shall be sealed, and the tremie tube kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the placement has been completed.

2.17 PLACING CONCRETE UNDER PRESSURE

A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall produce a continuous stream of concrete without air pockets. To obtain the least line

resistance, the layout of the pipeline system shall contain minimum bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.

C. No aluminum parts shall be in contact with the concrete during the placing of concrete under pressure.

D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a material's testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used during construction, and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.

E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.

G. The minimum diameter of the hose (conduits) shall be four inches.

H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.

I. Concrete samples for quality control in accordance with Article 3.11 will be taken at the placement (discharge) end of the line.

2.18 ORDER OF PLACING CONCRETE

A. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

2.19 CONCRETE WORK IN COLD WEATHER

A. Cold weather concreting procedures shall conform to the requirements of ACI 306.1.

B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed these minimum values by more than 20°F, unless otherwise approved by the Engineer.

C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature greater than 100°F. to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

2.20 CONCRETE WORK IN HOT WEATHER

A. Hot weather concreting procedures shall conform to the requirements of ACI 305.1.

B. When air temperatures exceed 85°F., or when extremely dry or high wind conditions exist even at lower temperatures, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing, and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation, and the Engineer reserves the right to modify the proposed measures consistent with the requirements herein. All necessary materials and equipment shall be in place prior to each placing operation.

C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

D. The temperature of the concrete mix when placed shall not exceed 95°F.

E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being considered. Stockpiled aggregates shall be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, the ice must be entirely melted prior to addition of the water to the dry mix.

F. Delivery schedules shall be carefully considered in advance to ensure concrete is placed as soon as practical after mixing. For hot weather concrete work (air temperature greater

than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched, unless workability-retaining admixtures are included and approved by the Engineer.

G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

2.21 QUALITY CONTROL

A. Field Testing of Concrete

1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.

2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material, or labor costs due to such occurrences.

2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. Concrete with a specified nominal slump shall be placed having a slump within 1” (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Density

1. Samples of freshly mixed concrete shall be tested for density by the materials testing consultant in accordance with ASTM C 138.

2. Density tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31, and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement more than five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.

3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the cylinders made in any four consecutive working days and to protect the specimens from falling over, being jarred, or otherwise disturbed during the period of initial curing. The box shall be erected, furnished, and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. The curing box shall be placed in an area free from vibration such as pile driving and traffic of all kinds and such that all cylinders are shielded from direct sunlight and/or radiant heating sources. No concrete requiring testing shall be delivered to the site until such storage curing box has been provided. Cylinders shall remain undisturbed in the curing box until ready for delivery to the testing laboratory, but not less than sixteen hours.

5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of cylinders with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day

the curing box contains cylinders. Temperature shall be recorded a minimum of three times a day with one recording at the start of the day and one recording at the end of the day.

6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.

2. The strength level of concrete will be considered satisfactory if the following conditions are satisfied.

   a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.11).

   b. No individual compressive strength test result falls below the minimum specified strength by more than 500 psi.

3. If any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.

4. If condition 3.11.F.2.b is not met, additional tests in accordance with Article 3.11, Paragraph H shall be performed.

5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:

   a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.

   b. Maintain or add temporary structural support as required.

   c. Correct the mix for the next concrete placement operation, if required to remedy the situation.

6. All concrete which fails to meet the ACI requirements, and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.

H. Additional Tests

1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.

2. If the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.11, Paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

a. Three cores shall be taken for each sample in which the strength requirements were not met.

b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.

c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.

e. The diameter of core specimens should be at least 3 times the maximum nominal size of the coarse aggregate used in the concrete but must be at least 2-inches in diameter.

f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.

g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.

h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

3. If the concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM C 457.

2.22 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed.

C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed.

D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced or repaired as directed. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an approved epoxy injection system. Non-structural cracks shall be repaired using an approved hydrophilic resin pressure injected grout system unless other means of repair are deemed necessary and approved. All repair work shall be performed at no additional cost to the Owner.

E. Concrete which fails to meet the strength requirements as outlined in Article 3.11, Paragraph F, will be analyzed as to its adequacy based upon loading conditions, resultant stresses, and exposure conditions for the area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be as directed by the Engineer.

END OF SECTION

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SECTION 03 35 00

CONCRETE FINISHES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-in-Place Concrete

C. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Manufacturer's literature on all products specified herein.

PART 2 – PRODUCTS

2.01 CONCRETE FLOOR SEALER

A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, MasterKure CC 300 SB by Master Builders Solutions.

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2.02 CONCRETE LIQUID DENSIFIER AND SEALANT

A. Concrete liquid densifier and sealant shall be a high performance, deeply penetrating concrete densifier and sealant. Product shall be odorless, colorless, VOC-compliant, non-yellowing siliconate based solution designed to harden, dustproof, and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete surfaces. The product must contain a minimum solids content of 20% of which 50% is siliconate. Acceptable products are Diamond Hard by the Euclid Chemical Company, and Seal Hard by L&M Construction Chemicals, and Masterkure HD 200 WB by Master Builders Solutions.

2.03 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

A. Non-oxidizing heavy-duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or MasterTop 200 by Master Builders Solutions.

2.04 NON-SLIP FLOORING ADDITIVE

A. Non-slip flooring additives for slip resistant floors shall be non-metallic. Non-slip flooring additives shall be MasterTop 120SR by Master Builders Solutions, A-H Alox by Anti-Hydro, or Euco Grip by the Euclid Chemical Company.

PART 3 – EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.06 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. See Article 3.05 for surfaces to receive paint or protective coatings. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. Type I - Rough: All fins, burrs, offsets, marks, and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bug holes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels, that will permit packing

the hole solidly with cement grout. Cement grout shall consist of one-part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been pre-dampened over an extended amount of time to reach the condition of saturated surface dry (SSD), a slurry consisting of one part cement (including an appropriate quantity of white cement to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.

3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type II finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded using a carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.

1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2” minimum deep grooves prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The

finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than the finish obtained with a wood float. The finish shall be obtained by power or band floating with cork floats.

4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.

6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout with inclusion of micro-synthetic fibers in accordance with Section 03600 – Grout shall be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.

   Type “G” Hardened Finish: This finish shall be applied after completion of a Type “B” or Type “C” finish and prior to application of a Type “D” finish. Hardeners shall be applied in strict accordance with the manufacturer’s requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type “D” finish shall be applied following completion of application of the hardener. Non-oxidizing, heavy-duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.2.

7. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring additive concurrently with the application of a Type "D" finish and/or installation of floor sealants. Application procedure shall be in accordance with manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.

8. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of ±1/4 inch.

3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein. Concrete sealers and densifiers shall not be used as concrete curing compounds. Curing compounds, when allowed, shall be in accordance with Section 03 39 00 – Concrete Curing.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer’s requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.

E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

A. Formed surfaces of equipment pads shall receive a Type III finish.

B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 FINISHES FOR SURFACES TO RECEIVE PAINT OR COATINGS

A. Surfaces indicated or specified to receive paint or special coatings shall be prepared per specifications in Division 09. All products applied to the concrete surfaces during the placement, finishing, and curing process shall be compatible with the painting or coating system as required by the manufacturer.

3.06 CONCRETE FINISH SCHEDULE

Item	Type of Finish
Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09 97 00 – Special Coatings)	I
Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures:	
From 1 feet below water surface to bottom of wall	I
From top of wall to 1 feet below water surface	II
Exterior concrete walls below grade	I
Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures, and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere	II
All interior exposed concrete walls and vertical surfaces	III
Interior exposed ceiling, including beams	III
Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes	B
All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet	D or E *PM/Engineer to discuss with Client.
All interior finish floors of buildings and structures which are not continuously or intermittently wet	D
Floors to receive tile, resilient flooring, or carpeting	D
Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather	E
Floors of process equipment tanks indicated on Drawings to receive micro-synthetic fiber reinforced grout topping	F
Garage, storage area floors, and loading docks	G
Precast concrete form panels, hollow core planks, double tees	J

END OF SECTION

SECTION 03370

CONCRETE CURING

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-In-Place Concrete

C. Section 03350 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete

2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete

3. ACI 305.1 – Specification for Hot Weather Concreting

4. ACI 306.1 – Standard Specification for Cold Weather Concreting

5. ACI 308.1 – Specification for Curing Concrete

6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete

7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Proposed procedures for protection of concrete under wet weather placement conditions.

2. Proposed normal procedures for protection and curing of concrete.

3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

4. Proposed method of measuring concrete surface temperature changes.

5. Manufacturer's literature and material certification for proposed curing compounds.

PART 2 – PRODUCTS

2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/m2 when applied at manufacturer’s recommended volume for square feet of area. Manufacturer’s certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company.

B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are “Kurez DR VOX” or “Kurez W VOX” by the Euclid Chemical Company. Install in strict accordance with manufacturer’s requirements.

2.02 EVAPORATION REDUCER

A. Evaporation reducer shall be "MasterKure ER 50” by Master Builders Solutions, or "Euco-Bar" by Euclid Chemical Company.

PART 3 – EXECUTION

3.01 PROTECTION AND CURING

A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.

B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provisions shall be made for maintaining the concrete in a moist

condition for at least a 7-day period thereafter, except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, and localized drying will not be permitted.

C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of seven days. Use of a curing compound will not be acceptable for applications of this type.

D. The Contractor shall use one of the following methods to ensure that the concrete remains in a moist condition for the minimum period stated above.

1. Ponding or continuous fogging or sprinkling.

2. Application of mats or fabric kept continuously wet.

3. Continuous application of steam (under 150°F).

4. Application of sheet materials conforming to ASTM C171.

5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.

E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.

F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300 – Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or slag cement. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.

C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose

shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sunshades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.

C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least six (6) additional days using one of the methods listed in paragraph 3.01D.

E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of seven days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.

B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time, and the subsequent appearance of the concrete surface shall not be affected.

C. The compound shall be applied in strict accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Coverage rates for the curing and sealing compound shall be in strict accordance with manufacturer’s requirements for the specific type of finish required. For rough surfaces, apply in two directions at right angles to each other.

END OF SECTION

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SECTION 03400
PRECAST CONCRETE

PART 1 – GENERAL

1.01 REQUIREMENTS

A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 – Utility Structures

B. Section 03200 – Reinforcing Steel

C. Section 03230 – Stressing Tendons

D. Section 03300 – Cast-in-Place Concrete

E. Section 03350 – Concrete Finishes

F. Section 03370 – Concrete Curing

G. Section 03600 – Grout

H. Section 05010 – Metal Materials

I. Section 05035 – Galvanizing

J. Section 05050 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.

1. North Carolina Building Code

2. ACI 318 – Building Code Requirements for Structural Concrete

3. ASTM D2240 – Standard Test for Rubber Property – Durometer Hardness

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4. PCI Standard MNL-116 – Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

5. PCI Design Handbook

1.04 SUBMITTALS

A. The Contractor shall submit the following for review in accordance with Section 01300 – Submittals.

1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.

2. A list of the design criteria used by the manufacturer for all manufactured, precast items.

3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the in the State or Commonwealth in which the project is located.

4. Certified reports for all lifting inserts, indicating allowable design loads.

5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing, and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.

B. Manufacturer Qualifications: The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.

C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years' experience in precast concrete work.

PART 2 – PRODUCTS

2.01 CONCRETE

A. Concrete materials including Portland cement, aggregates, water, and admixtures shall conform to Section 03300 – Cast-in-Place Concrete.

B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.

C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4,500 psi for fluid containing and other environmental concrete structures and 4,000 for other structural concrete structures, unless otherwise specified.

2.02 GROUT

A. Grout for joints between panels shall be a cement grout in conformance with Section 03600 – Grout.

B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.03 REINFORCING STEEL

A. Reinforcing steel used for precast concrete construction shall conform to Section 03200 – Reinforcing Steel.

2.04 PRESTRESSING STRANDS

A. Prestressing strands shall be 7-wire, stress-relieved, high-strength strands Grade 250K or 270K in conformance with Section 03230 – Stressing Tendons.

2.05 STEEL INSERTS

A. Steel inserts shall be in accordance with Section 05010 – Metal Materials.

B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05035 – Galvanizing.

2.06 WELDING

A. Welding shall conform to Section 05050 – Metal Fastening.

2.07 BEARING PADS

A. Neoprene bearing pads shall conform to the requirements of A4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be nonlaminated

pads having a nominal Shore A durometer hardness of 70 in accordance with ASTM D2240. Adhesive for use with neoprene pads shall be an epoxy-resin compound compatible with the neoprene having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikadur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

PART 3 – EXECUTION

3.01 FABRICATION AND CASTING

A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true, and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.

B. All cover of reinforcing shall be the same as detailed on the Drawings.

C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.

E. Concrete shall be finished in accordance with Section 03350 – Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.

F. Curing of precast members shall be in accordance with Section 03370 – Concrete Curing. Use of a membrane curing compound will not be allowed.

G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28-day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.

B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.

C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.

D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.

E. Precast concrete members shall not be used as storage areas for other materials or equipment.

F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools, and materials required for proper execution of the work.

B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.

C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.

D. Connections which require welding shall be properly made in accordance with Section 05050 – Metal Fastening.

E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.

F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on

the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).

G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.

H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

END OF SECTION

SECTION 03 41 13
PRECAST PRESTRESSED CONCRETE
HOLLOW CORE PLANKS

PART 1 – GENERAL

1.01 REQUIREMENTS

A. The Contractor shall furnish all materials, labor, equipment, tools, etc., required for the design, fabrication, delivery and erection of precast, prestressed concrete hollow core planks in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03400 – Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 423 – Recommendations for Concrete Members Prestressed with Unbonded Tendons

2. PCI Design Handbook

1.04 SUBMITTALS

A. Submittals shall comply with Section 03400 – Precast Concrete.

1.05 QUALITY ASSURANCE

A. Quality assurance shall comply with Section 03400 – Precast Concrete.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials shall comply with Section 03400 – Precast Concrete, except as stated below.

B. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi.

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PART 3 – EXECUTION

3.01 DESIGN CRITERIA

A. All units shall be designed in accordance with the applicable provisions of ACI 318 and PCI Design Handbook, prestressed to sustain the superimposed dead and live loads indicated herein and on the Drawings. Design and subsequent fabrication shall provide for a camber in each unit to eliminate total dead load deflection.

B. Superimposed Roof Loads

1. Dead Loads - Uniform load shall be that resulting from weight of member and weights of insulation material, built-up roofing, ballast, and lightweight concrete, as shown on the Drawings. Concentrated load at crane rail hanger-support shall be that resulting from contributing weight of crane rail and its support-assembly.

2. Live Loads - Uniform live load shall be 30 psf unless noted otherwise on the Drawings. Concentrated hoist loads shall consist of the rated capacity plus 33% impact loading and shall occur where crane rails are shown on the Drawings.

3. Other applicable loads per the North Carolina Building Code as indicated on the Drawings.

3.02 FABRICATION AND CASTING

A. All hollow core planks shall comply with Section 03400 – Precast Concrete.

B. Hollow core plank dimensions shall comply with PCI Design Handbook and as indicated on the Drawings.

C. Curing of hollow core planks shall be equivalent to three days moist curing at 70°F.

D. Unless otherwise noted on the Drawings, permitted dimensional tolerances are as follows:

Length	±1/2"
Width	±1/4" Max.
Depth	±1/4" Max.

Differential Camber Between Adjacent Units	1/4" Max.
Horizontal Alignment	±1/8" per 10' ±1/2" Max.
Location of openings, blockouts, anchors, plates and inserts	±1/2" Max.
Square Ends	±1/8" per 12" of Height

3.03 HANDLING, TRANSPORTING, AND STORING

A. Handling, transporting, and storing shall comply with Section 03400 – Precast Concrete.

3.04 ERECTION

A. Erection shall comply with Section 03400 – Precast Concrete.

B. All hollow core planks shall bear on bearing pads at each end.

1. All hollow core planks shall bear on plastic or neoprene bearing pads at each end in accordance with Section 03400 – Precast Concrete. Pads shall be the size shown on the Contract Drawings.

2. Where neoprene pads are shown on the Drawings, hollow core planks shall bear on neoprene bearing pads at each end in accordance with Section 03400 – Precast Concrete. Pads shall be the size shown on the Contract Drawings and shall be adhered to the supporting concrete surface below with an approved adhesive.

C. The top of all hollow core planks which receive concrete topping shall be cleaned of all contaminants and thoroughly wetted just prior to placing the topping.

3.05 ANCHORS FOR ITEMS SUSPENDED FROM PLANKS

A. Anchors for hangers attached to the bottom of hollow core planks shall be designed by the Contractor and coordinated with the hollow core plank manufacturer to support the loads imposed on the anchors.

B. The anchors shall be designed for the forces indicated on the Contract Drawings. Where forces are not indicated, the Contractor shall determine the applied forces.

C. The anchor design for all anchors with applied forces over 400 pounds shall be sealed and signed by a Professional Engineer currently registered in the State or Commonwealth where the Project is located. All anchor forces and anchor designs shall be submitted to the Engineer for record purposes.

D. Prior to installing anchors, the Contractor shall consult with the manufacturer of the hollow core planks to determine locations of prestressing strands and interior voids in planks. Prestressing strands shall not be cut or damaged under any circumstances.

E. Anchors shall be embedded and installed as directed by the anchor manufacturer.

END OF SECTION

SECTION 03480
PRECAST CONCRETE SPECIALTIES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery, and installment of precast concrete manhole vaults and meter box structures in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03400 – Precast Concrete

1.03 SUBMITTALS

A. The Contractor shall submit samples and/or shop drawings and in accordance with Section 01300 – Submittals.

B. In addition to items listed in Section 03400 – Precast Concrete, Shop Drawings shall include, but not be limited to:

1. Piping and conduit sheets.

2. Complete layout and installation drawings and schedules with clearly marked dimensions.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Federal Specification No. SS-5-00210.

2. ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections.

PART 2 – PRODUCTS

2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

A. Precast concrete manholes shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast manholes shall be watertight and conform to the requirements of ASTM C-478 with reinforcing steel of ASTM A615, Grade 60 bars and the following modifications there to:

1. Materials shall conform to Section 03400 – Precast Concrete.

2. The minimum wall thickness shall be 8 inches.

3. The date and time of manufacturer shall be marked inside each precast sections.

4. No more than two lift holes may be cast or drilled in each section.

5. Dimensions shall be as shown on the Drawings.

6. Vault covers and frames shall comply with Section 05500 – Metal Fabrications. The frames and covers shall be provided by the vault manufacturer. Covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05050 – Metal Fastening. When leveling bolts are used to set the vault top sections, the Contractor shall ensure that the load on the vault will be transferred through the mortar to the vault and will not be carried by the leveling bolts.

7. Mechanical details such as piping, electrical, and other details shall be as shown on the Drawings.

B. Joints between manhole riser sections and at base slabs shall be groove type. Joints shall be sealed with two (2) individual self-sealing butyl rubber gaskets conforming to Federal Specification No. SS-5-00210. The gasket material shall be Kent Seal.

2.02 PIPE CONNECTIONS

A. The precast reinforced concrete manhole base shall be provided with circular openings at the locations and elevations for the proper connection of all pipes. The pipe connections shall be sealed with either a flexible manhole seal assembly or with mortar.

B. When a flexible manhole seal assembly is used to seal the pipe connection, the seal assembly shall be installed in accordance with the recommendations of the seal assembly manufacturer and shall conform to ASTM C923.

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C. Flexible manhole seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

D. The flexible manhole seal assembly shall be manufactured by Interpace Corp (Lock Joint Flexible Manhole Sleeve), National Pollution Control Systems, Inc. (Kor-N-Seal) or Press-Seal Gasket Corp. Manhole seal assemblies produced by other manufacturers will be considered for use by Engineer if submitted by the Contractor. Such manhole seal assemblies shall be acceptable only if the Shop Drawings are approved.

E. Short lengths of sewer pipe shall be installed entering and leaving the precast manhole base. These short lengths of pipe shall have a maximum length of 3'3". A concrete cradle shall be placed under the short length of pipe in accordance with the dimensions shown on the Drawings.

F. The concrete cradle is not necessary when a flexible manhole seal assembly is used.

2.03 MANHOLE LADDERS

A. Manhole ladders shall conform to Section 06610 – Glass Fiber and Resin Fabrications.

PART 3 – EXECUTION

3.01 DESIGN CRITERIA

A. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.

B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.

3.02 MANUFACTURED ITEMS

A. Precast concrete manhole sections shall be set so as to be vertical, with sections in true alignment. The joint of the previously set section shall be covered with mortar and preformed joint sealant before the next section is placed. Before the mortar is set, joints shall be pointed, and exterior joints shall be thoroughly tooled so as to be slightly concave with a hard polished surface, free of cracks. Interior joints shall be tooled flush in a similar manner.

B. Precast wall sections shall be of such lengths as will permit the setting of the manhole frame for the required elevation on two or three courses of brick masonry laid around the top of the upper section. Such brick work shall be given a 1-inch mortar coat on the inside and outside.

C. Precast items shall be installed in accordance with the manufacturer's recommendations, unless otherwise required by the Drawings.

3.03 MANHOLE LADDERS

A. The ladder shall be installed so bottom of ladder rests on or in the concrete shelf of the invert fill. The bottom step shall not interfere with piping. Angle brackets shall be spaced a maximum of 6 feet apart, with a minimum to two brackets per ladder section. The anchor bolts shall not be located within 12 inches of any joint in the manhole sections. Ladders shall be installed in conformance with the Drawings.

END OF SECTION

SECTION 03 60 00

GROUT

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 01 and Division 02 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. CRD-C 621 – Corps of Engineers Specification for Non-shrink Grout

2. ASTM C 33 – Standard Specification for Concrete Aggregates

3. ASTM C 109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens)

4. ASTM C 531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacings

5. ASTM C 579 – Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings

6. ASTM C 827 – Standard Test Method for Early Volume Change of Cementitious Mixtures

7. ASTM C 1107 – Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink)

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.

2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of grout used in the work.

1.05 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to ensure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.

a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days, and any additional times as appropriate.

b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time as appropriate.

2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.

3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one-part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White Portland Cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4000 psi.

3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness. Cement grout used for surfaces swept in by a mechanism shall also contain micro-synthetic fibers in accordance with Section 03 30 00.

4. Sand shall conform to the requirements of ASTM C33.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "NS Grout" by the Euclid Chemical Company, "Sikagrout 212" by Sika Corporation, “Conspec 100 Non-Shrink Non-Metallic Grout” by Conspec, “MasterFlow 928” by Master Builders Solutions.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "E3 Series" by Euclid Chemical, “MasterEmaco ADH 1090 RS” by Master Builders Solutions.

2. Epoxy grout shall be modified as required for each application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be “Sikadur 42, Grout-Pak” by Sika Corporation, or “MasterFlow 648” by Master Builders Solutions.

2.02 CURING MATERIALS

A. Curing materials shall be as specified in Section 03370 – Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

PART 3 – EXECUTION

3.01 GENERAL

A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.

1. Cement grout shall be used for grout toppings and for patching of fresh concrete, when approved by the Engineer. Grout toppings swept in by equipment mechanisms shall contain micro-synthetic fibers as specified in Section 03 30 00.

2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.

3. Epoxy grout shall be used for bonding new concrete to hardened concrete.

4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.

B. New concrete surfaces to receive cement grout shall be as specified in Section 03350 – Concrete Finishes, and shall be cleaned of all dirt, grease, and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping, or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370 – Concrete Curing.

C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

3.02 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be placed from one side only and allowed to flow across to the open side to avoid air-entrapment.

END OF SECTION

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SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Mortar for unit masonry work.

2. Grout for grouting masonry.

3. Mortar for pointing and touchup.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04150 - Masonry Accessories

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, the Work shall conform to the applicable requirements of the following documents:

1.	ASTM C91	Standard Specification for Masonry Cement
2.	ASTM C144	Standard Specification for Aggregate for Masonry Mortar
3.	ASTM C150	Standard Specification for Portland Cement
4.	ASTM C207	Standard Specification for Hydrated Lime for Masonry Purposes
5.	ASTM C270	Standard Specification for Mortar for Unit Masonry
6.	ASTM C476	Standard Specification for Grout for Masonry
7.	ASTM C979	Pigments for Integrally Colored Concrete
8.	ASTM C1019	Standard Methods of Sampling and Testing Grout

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9. ACI 530.1/ASCE 6 Specification for Masonry Structures

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's data and mixing instructions for each product.

2. Certificate of compliance with these specifications for each material specified below.

3. Test reports.

4. Samples of colored masonry mortar.

1.05 DELIVERY AND STORAGE

A. Deliver materials in manufacturer's original containers, bearing labels indicating product and manufacturer's name.

B. Store cementitious materials in waterproof locations to prevent damage by elements. Reject containers showing evidence of damage.

C. Store aggregates in separate bins to prevent intrusion of foreign particles. Do not use bottom 6 inches of sand or other aggregate stored in contact with the ground.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. LaFarge, Reston, VA

2. Lehigh Cement Company, Allentown, PA

3. Holcim, Inc., Dundee, MI

2.02 MATERIALS

A. Mortar and Grout Materials

1. Portland Cement: ASTM C-150, Type I above grade and Type II below grade.

2. Hydrated lime: ASTM C-207, Type "S".

3. Sand: Clean, coarse, free of loam, salt, organic and foreign matter and conforming to ASTM C-144.

4. Coarse and fine aggregates for grout: ASTM C-404.

5. Masonry Cement: ASTM C 91, Type S and meet the following criteria:

   a. Prepackaged masonry cement shall contain Portland Cement, hydrated lime and plasticizing admixtures or hydraulic hydrated lime. Masonry cements which contain other materials, including ground limestone, ground slag, or other cementitious and non-cementitious materials, are not acceptable.

6. Water - clean, fresh, potable and free from injurious amounts of oil, acids, alkalies, salts, organic matter or other deleterious substances.

B. Admixtures

1. Do not use calcium chloride.

2. Provide water repellant admixture in mortar used for architectural concrete masonry units. Admixture shall be compatible with ACMU water repellant admixture.

3. Do not use admixtures, without written approval of Engineer.

C. Mortar pigment

1. Natural or synthetic iron oxide and chromium oxides meeting the requirements of ASTM C979.

2. Pigment shall not exceed 10% of the weight of Portland cement. Carbon black shall not exceed 2% of Portland cement.

3. Color shall be selected by the Owner from the manufacturer's full range of colors.

2.03 GROUT AND MORTAR MIXES

A. Masonry mortar shall be Type "S" according to ASTM C-270. Proportions for masonry mortar shall be one of the following:

1. Proportions by volume: 1 part Portland cement to 1/4 - 1/2 parts hydrated lime, and aggregate volume of not less than 2-1/4 or more than 3 times the sum of the volumes of cement and lime.

2. Proportions by volume: 1/2 part Portland cement to 1 part masonry cement, and aggregate volume of not less than 1-1/4 or more than 3 times the sum of the volumes of cement and lime.

B. Proportions for pointing mortar.

1. Proportions by volume: 1 part Portland cement to 1/4 part hydrated lime and 2 parts extra fine sand.

C. Masonry Grout shall conform to the requirements of ASTM C 476 and ACI 530.1/ASCE 6, strength of grout, tested in accordance with ASTM C 1019 shall be equal to f'm as specified in Section 04200, but not less than 2,000 psi.

1. Test grout for every 5,000 square feet of masonry, with a minimum of one test per structure.

PART 3 -- EXECUTION

3.01 FIELD MORTAR MIXING

A. Mixing shall be by mechanically operated batch mixer. Entirely discharge before recharging. Mix sand, lime, cement and admixtures dry for two (2) minutes minimum, add water and mix for three (3) minutes minimum. Control batching procedures by measuring materials by volume. Measurement by shovel count shall not be permitted. Mix mortar with less water than the maximum amount, consistent with workability, to provide near maximum tensile bond strength. Mix only quantity that can be used before initial set, or within the first one-half hour.

B. Mixers, wheel barrows, mortar boards, etc., shall be kept clean.

C. Retempering of mortar will not be permitted and mortar allowed to stand more than one (1) hour shall not be used.

3.02 INSTALLATION

A. Install mortar and grout in accordance with ACI 530.1/ASCE 6.

3.03 REPOINTING MORTAR

A. Prehydrate the mortar by mixing ingredients together dry, and then add only enough water to make a damp, stiff mix that will retain its form when pressed into a ball. After one to two hours, add water to bring it to the proper consistency.

- END OF SECTION -

SECTION 04150

MASONRY ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Metal joint reinforcement for masonry.

2. Accessories for masonry construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04100 - Mortar and Masonry Grout

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications, Work shall conform to the applicable requirements of the following documents:

1.	ASTM A1064/1064M	Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
2.	ASTM A153	Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
3.	ASTM A 951	Standard Specification for Steel Wire Masonry Joint Reinforcement
4.	ASTM D1056	Standard Specification for Flexible Cellular Materials - Sponge or Extruded Rubber
5.	ACI 530.1/ASCE 6	Specifications for Masonry Structures

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Provide manufacturer's complete product data.

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2. Provide manufacturer's certification attesting compliance of material and source of each material specified below.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS FOR MASONRY REINFORCEMENT

A. Subject to compliance with the Specifications, provide products manufactured by the following:

1. AA Wire Products, Company, Chicago, IL

2. Dur-O-Wal, Inc., Arlington Heights, IL

3. Heckmann Building Products, Inc., Chicago, IL.

4. Holman and Barnard, Inc., Hauppauge, NY.

2.02 MATERIALS

A. Multi Wythe Joint Reinforcement

Steel ladder type reinforcement conforming to ASTM A 951 with adjustable pintel and eye assembly; 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A1064/1064M, with widths 2-inches less than nominal wall thickness. Provide seismic clip with 9 gauge continuous wire.

B. Single Wythe Joint Reinforcement

Steel ladder type reinforcement conforming to ASTM A 951 with 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A1064/1064M, with widths 2-inches less than nominal wall thickness.

C. Anchors: Cast into concrete or weld to steel.

1. Dovetail Slot shall be 1 inch back by 1 inch deep by 5/8 inch throat, 22 gauge, foam filled.

2. Dovetail Anchor - accessory for anchoring triangular flexible tie to dovetail slot, shall be 12 gage by 1 inch wide 1/2 inch long dovetail section.

3. Wire/Strap Anchor - 1/4 inch wire or 12 gauge x 3/4 inch x length required, welded or mechanically attached to back up structure.

D. Ties

1. Triangular Flexible Tie: 3/16 inch wire, sized to suit application.

2. Adjustable Tie: Pintel and eye full tie; properly sized for application, 3/16 inch cold drawn steel.

E. Seismic Clip and Continuous Wire

1. Seismic clip shall be impact resistant PVC with retaining ridges to accept continuous wire.

2. Continuous wire shall be 9 gauge galvanized steel.

F. Top of Wall Anchor

1. Top of wall anchor shall be a 3/8” diameter rod welded to a 3/16” plate with two anchor holes. Provide a plastic tube to allow vertical deflection.

G. Finish

1. Reinforcements, anchorages and ties shall be hot dipped galvanized, Class B-2, after fabrication in accordance with ASTM A153.

2.03 ACCESSORIES

A. Expansion and Joint Filler Material

1. Closed cell neoprene material conforming to ASTM D 1056, with a minimum compressibility of 50%. Horizontal joint filler shall be 1/4 inch thick. Expansion joints shall be a minimum 3/8" thick.

B. Weep and Vent Holes

1. Open head joints for brick and half-head joints for concrete masonry veneer.

C. Control Joint

1. Wide flange rapid preformed neoprene or PVC gasket.

D. Hardware Cloth

1. Waterproof paper backed with 1/2 inch hardware cloth.

E. Through Wall Flashing

1. Self-sealing, fully adhering composite flashing consisting of 32 mil rubberized asphalt bonded to an 8 mil cross laminated polyethylene film to produce an overall 40 mil thickness.

2. Provide Perm-A-Barrier Wall Flashing by W.R. Grace, Flash-Bond by Wire-Bond or Poly-Barrier Wall Flashing by Polytite Manufacturing Corporation.

F. Cavity Drainage Mat

1. CavClear Masonry Mat by CavClear, Hudson WI. Or approved equal. Description: Fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100% recycled polymer with PVC binder. Thickness of actual air space minus tolerances recommended by manufacturer.

PART 3 -- EXECUTION

3.01 REINFORCEMENT AND ANCHORAGE

A. In masonry wall panels, place horizontal joint reinforcement at a vertical spacing of 16 inches on center, unless otherwise noted.

B. Lap side rods at each end joint a minimum of 6 inches.

C. Install prefabricated corner and tee assemblies at each wall corner and intersection.

D. Mitre and butt end joints are prohibited.

E. Place horizontal joint reinforcement in approximate center of out-to-out wall assembly and assuring a 5/8 inch, minimum, mortar coverage on exterior face and 1/2 inch on interior face.

F. Adjustable anchor assemblies may be offset no more than that which is stated in manufacturer's published instructions. Pintles may be installed either up or down.

G. Install horizontal joint reinforcement continuous, terminating only at vertical control joints.

H. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend 24 inches minimum each side of opening.

I. Place joint reinforcement continuous and at 8 inches on center vertically above roof.

J. Place reinforcing bars supported and secured against displacement. Maintain position with ½ inch to true dimension.

K. Coordinate and verify that dowels and anchorages embedded in concrete and attached to structural steel members are properly placed.

L. Provide wall ties for masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place at maximum 8 inches on center each way around perimeter of openings, within 12 inches of openings.

M. Masonry adjacent to steel and concrete columns to be attached to the column with masonry anchors at 16 inches on center. Anchors to be attached to each face of the column which is adjacent to a masonry wall, unless otherwise noted.

3.02 DOVETAIL SLOTS AND ANCHORS

A. Provide dovetail slots to concrete contractor for placement into the concrete construction. Dovetail slots shall be placed vertically and spaced 16 inches on center horizontally.

B. Remove slot filler after forms are removed.

C. Hook dovetail anchor into slots and set in masonry joints at 16 inches on center.

3.03 BENDING, CUTTING AND SPLICING REINFORCEMENT

A. Make bends and splices in reinforcement only where indicated, or prior-approval by Engineer. Bend reinforcement only when cold, and prior to any placement in construction, forming around a steel pin of diameter at least 6 times the reinforcement size. Cut bars only by approved sawing, shearing or welding methods. Make ends of reinforcement straight, square, clean and free of defects before splicing. Do not heat or weld bends and splices at points of maximum stress. Clip and bend any tie wires as required to direct the ends away from external surfaces of masonry walls.

B. Where welding is necessary, provide materials and perform welding in accordance with AWS requirements.

C. All lap splices to be 48 bar diameters, unless otherwise noted.

3.04 THROUGH WALL FLASHING

A. Clean areas to receive flashing. Surface shall be free of voids, spalled areas, or sharp protrusions. Concrete surfaces shall be cured a minimum of 7 days.

B. Apply Primer as recommended by manufacturer.

C. Apply flashing in strict accordance with manufacturer's instructions and recommendations. Sidelaps shall be a minimum of 2½ inches. End laps shall have a 6" minimum lap. Provide end dams at ends of lintels and other interruptions.

D. Seal flashing where vertical reinforcing penetrates flashing with a mastic approved for use by manufacturer.

3.05 CAVITY DRAINAGE MAT

A. Install cavity drainage mat in air-space between insulation and masonry veneer construction full height of cavity.

B. Cavity drainage mat shall be temporarily fastened in accordance with manufacturer’s instructions.

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SECTION 04200

UNIT MASONRY

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified work.

1. Principal items of work include:

a. Exterior masonry wall construction.

b. Interior masonry wall construction.

c. Installation of masonry reinforcement and accessories.

d. Masonry unit lintels.

e. Installing dampproofing, insulation, flashing and work required to be built into masonry work.

f. Building into masonry work all anchors, inserts, hangers and the like provided under other Sections.

g. Pointing and cleaning of exposed masonry surfaces.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04100 – Mortar and Masonry Grout

B. Section 04150 – Masonry Accessories

C. Section 07150 – Dampproofing

D. Section 07210 – Building Insulation

E. Section 07600 – Flashing and Sheet Metal

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications the Work shall conform to the applicable requirements of the following documents:

1. TMS 402/ACI 530/ASCE 5 Building Code Requirements for Masonry Structures

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2. ACI 530.1/ASCE 6 Specifications for Masonry Structures

a) ACI 530.1/ASCE 6, jointly published by the American Concrete Institute and the American Society of Civil Engineers, hereafter referred to as ACI 530.1 shall be considered minimum specifications for all materials, workmanship, methods and techniques for all masonry work.

b) Obtain a copy of the above Specifications prior to beginning any work in this Section.

3. ASTM C62 Standard Specification for Building Brick

4. ASTM C90 Standard Specification for Load-Bearing Concrete Masonry Units

5. ASTM C140 Standard Methods for Sampling and Testing Concrete Masonry Units

6. ASTM C216 Standard Specification for Facing Brick

7. ASTM C744 Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units

8. ANSI A41.1 R70 Code Requirements for Masonry

1.04 TESTING

A. Tests

The Owner reserves the right to test materials for compliance with these specifications. Sampling and testing will be done in accordance with the ASTM standard, by an independent testing agency employed by the Owner. Materials that fail to meet requirements are considered defective. Subsequent tests to establish compliance (of the same or new materials) shall be paid for by the Contractor.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:

1. Samples of each material to be used showing full range of colors.

2. Manufacturer's specifications and certifications of compliance to the Specifications, including results of tests on masonry units showing such compliance, for each type of masonry. Provide handling, storage, and installation instructions along with protection instructions. Indicate by transmittal that installer has received copies of each instruction.

3. Cold and/or hot weather construction procedures in accordance with ACI 530.1/ASCE 6 sections 2.3.2.2. and 2.3.2.3.

4. Cleaning procedures and cleaner for each masonry type.

1.06 MOCK-UPS

A. Build mock-ups at the site, where directed, full thickness and approximately 4 feet x 4 feet, indicating the proposed color range, texture and workmanship for each type of masonry. Obtain Engineer's acceptance of visual qualities of the mock-up before start of masonry work. Do not alter, move or destroy mock-ups until Work is completed and removal is directed by the Engineer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in the manufacturer's original unbroken, undamaged and unopened packaging with labels bearing the name of the manufacturer and the product. Masonry units and brick shall be factory packaged and strapped, delivered to the site and stored on skids.

B. Store and handle materials to prevent inclusion of water or foreign matter and to prevent damage of any nature.

C. Distribute materials on floor slabs to prevent overloading. Designated live loads shown for floor shall not be exceeded.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Provide special shape, type or size indicated or for application requiring a form, size or finish which cannot be produced from standard masonry units by sawing. Provide solid units where masonry unit is exposed.

B. Masonry units for fire-rated walls shall comply with Underwriter's Laboratory requirements for fire rating shown on the Drawings.

2.02 MATERIALS

A. Mortar

1. In accordance with Section 04100 - Mortar and Masonry Grout

B. Face Brick

1. ASTM C-216, Type FBS, SW. modular as manufactured and distributed by Belden Brick Company, Glen-Gery Corporation, Cherokee Sanford Group, Inc. or equal. Face brick shall be selected and approved by the Owner from samples

submitted. Select color from manufacturer's gray and brown color range. Sand finished brick shall not be accepted.

a. 200 Powder Activated Carbon Feed Building
    i. Select color from manufacturer's black and gray color range.
b. 900 Electrical Building
    i. Select color from manufacturer's gray and brown color range.

2. Net area compressive strength of brick masonry units shall be a minimum of 3,350 psi when tested in accordance with ASTM C67. Compressive strength of masonry (f'm) shall be a minimum of 1,500 psi in accordance with ACI 530.1 when these units are used with the mortar specified in Section 04100.

C. Concrete Masonry Units

1. Provide units conforming to ACI 530.1 unless otherwise specified.

2. Provide light weight units meeting the requirements of ASTM C90 for hollow and solid load bearing CMU.

3. Manufacture units of Portland Cement, conforming to ASTM C-150 and light weight aggregate conforming to ASTM C331 and ASTM C33. Weight of unit shall not exceed 105 lb. per cu. ft. when measured in accordance with provisions of ASTM C140. Units shall be nominally 8 inches x 16 inches x thicknesses shown or as required. Masonry units shall be manufactured not less than 30 days prior to being used and stored under cover until shipment. All units shall have true, sharp edges and corners, free from cracks or other defects. Provide half special sizes and shapes as required by the Drawings or to meet job conditions.

4. Net area compressive strength of concrete masonry units shall be a minimum of 2,000 psi when tested in accordance with ASTM C140. Compressive strength of masonry (f'm) shall be a minimum of 2,000 psi in accordance with ACI 530.1 when these units are used with the mortar specified in Section 04100.

D. Concrete Masonry Lintels

Specially formed units with reinforcing bars and grout fill provided where shown and wherever openings in masonry are indicated without structural steel or other supporting lintels.

PART 3 -- EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which masonry is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Do not wet concrete masonry units.

C. Brick having absorption rates in excess of 0.025 oz. per square inch per minute (as determined per ASTM C 67) shall be wetted sufficiently so that the rate of absorption, when brick is laid, does not exceed this amount.

D. Clean reinforcing, removing loose rust, ice or other coatings from bars, before placement.

E. Thickness of cavity and composite walls, and other masonry construction shall be the full thickness shown. Build single wythe walls to the actual size of masonry units.

F. Build chases and recesses as shown and as required for the work of other trades.

G. Build other work into masonry work as shown, fitting masonry units around other work and grouting to assure anchorage.

H. Cut masonry units with motor driven saw designed to cut masonry with clean, sharp, unchipped edges. Cut units as required to provide pattern shown or specified, and to fit adjoining work neatly.

I. Cold and hot weather construction.

1. No masonry shall be erected when ambient temperature has dropped below 45°F unless it is rising and at no time when it has dropped below 40°F. Provisions shall be made for heating and drying of materials, and the complete work shall be protected in accordance with the ACI 530.1/ASCE 6 Section 2.3.2.2. Masonry shall not be laid with ice or frost on its surfaces, and no masonry shall be laid on frozen work. Any work which freezes before the mortar has set shall be removed and replaced at the Contractor's own expense. Do not use any admixtures or antifreeze in the mortar.

2. When the temperature is above 100°F or 90°F with a wind velocity greater than 8 mph, mortar beds shall be spread no more than 4 feet ahead of masonry and masonry units shall be set within one minute of spreading mortar.

3.02 CONSTRUCTION TOLERANCES

A. Variation from plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.

B. Variation from level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.

C. Variation of Linear Building Line: For position shown on plan and related portion of columns, walls, and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

D. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".

E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.03 LAYING MASONRY WALLS

A. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs, and wherever possible at other locations.

B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below.

D. Stopping and Resuming Work: Rack back 1/2 unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, and remove loose masonry units and mortar prior to laying fresh mortar.

E. Cover top of walls at the end of each day. Protect wall from water infiltration from the top until wall is capped.

F. Built-In Work: As work progresses, build-in items specified under this and other sections of these Specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of hardware cloth in the joint below and rod grout into core.

3. Fill cores in hollow masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise noted.

4. Seal masonry tight around wall penetrations such as beams, joists, pipes, ducts, and conduit by cutting masonry units to fit as tightly as possible, then closing final gap all around with mortar, or joint filler and caulking as necessary.

3.04 MORTAR BEDDING AND JOINTING

A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs with mortar in starting courses on footing or floors, and where adjacent cells are to be reinforced or filled with grout. For starting courses where cells are not grouted, spread full mortar bed including areas under cells.

C. Maintain joint widths of 3/8", except for minor variations required to maintain bond alignment.

D. Tooling: Joints shall be tooled to a uniform concave joint. Head joints first and then the bed joints.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners and jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean and reset in fresh mortar.

3.05 JOINT REINFORCING

A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints not more than 16" o.c. vertically.

B. Parapets: Use continuous horizontal joint reinforcement installed in horizontal joints at 8" o.c. vertically.

C. Reinforced masonry openings greater than 12" wide, with horizontal joint reinforcing placed in 2 horizontal joints immediately above the lintel and immediately below the sill. Extend reinforcements 2'-0" beyond jambs of the opening except at control joints.

D. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

E. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures and other special conditions.

F. Intersecting Load-bearing Walls: Provide rigid steel anchors at not more than 2'-0" o.c vertically. Embed ends in mortar-filled cores.

G. Non-loadbearing Interior Partitions: Build full height of story to underside of solid floor or structure above, unless shown otherwise. Fill joint with mortar after dead load deflection of structure above approaches final position.

3.06 CAVITY WALLS

A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity, flush.

B. Tie exterior wythe to back-up wythe of masonry with horizontal joint reinforcement at 16" o.c. vertically.

C. Coordinate placement of dampproofing and insulation board with work to ensure there are no gaps or air spaces between pieces of insulation board.

D. Weep joints shall be placed in exterior wythe of cavity wall, spaced a maximum of 32" o.c. horizontally, immediately above ledges, at lintels over openings, and as shown.

3.07 CAVITY WALL INSULATION

A. Provide and install insulation as shown and as specified in Section 07210, Building Insulation.

3.08 CONTROL AND EXPANSION JOINTS

A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where shown. Where not shown provide vertical control joints in concrete masonry units at 40 feet on center maximum or as recommended by the masonry unit manufacturer. Build-in related items as the masonry work progresses.

3.09 LINTELS

A. Install galvanized steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 8" for brick size units and 1'-4" for block size units are shown without structural steel or other supporting lintels. Provide precast or poured-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

C. For hollow concrete masonry unit walls, use specially formed "U"-shaped lintel units with reinforcement bars placed as shown and filled with grout.

D. Provide minimum bearing of 8" at each jamb.

3.10 FLASHING

A. Provide flashing as shown and as specified in Section 07600, Flashing and Sheet Metal.

3.11 REINFORCED UNIT MASONRY

A. Vertical reinforcement shall be held in place by means of frames or other suitable means. Place horizontal joint reinforcement as masonry work progresses. Provide minimum clear distance between longitudinal bars equal to nominal diameter of bar. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4", except 6 gage or smaller wires may be laid in 3/8" mortar joints. Collar joints which contain both horizontal and vertical reinforcement shall have a minimum width of 1/2" larger than the diameter of the horizontal and vertical reinforcement.

B. Bar splices shall be contact lap splices. Length of splice shall be a minimum of 24" for #4 bars and 30" for #5 bars.

C. Low lift grouting shall be used when grout space is less than 2" in width. Place grout at maximum intervals of 24" in lifts of 6 to 8 inches as the work progresses. Cores to be grouted shall be clean of mortar, mortar dropping and debris. Agitate grout to assure complete filling and coverage of reinforcement. Hold grout 1-1/2 inches below to top of masonry if work is discontinued for more than an hour.

D. High lift grouting may be used when the grout space is greater than 2". Grout shall not be placed in lifts greater than 4 feet. Grout core shall be kept clean of mortar, mortar dripping and debris. Provide cleanout holes as required for inspection and cleaning. Replace cleanout plugs after inspection and acceptance. Do not place grout until entire wall has been in place a minimum of 3 days. Hold grout 1-1/2 inches below top of masonry if work is discontinued for more than an hour.

E. Forms and shoring shall be substantial and tight to prevent leakage of mortar or grout. Brace and shore forms to maintain position and shape. Do not remove forms or shoring until masonry gains enough strength to sufficiently carry its own weight and any other loads, temporary or permanent, placed on it during construction.

3.12 PROTECTION OF WORK

A. Exposed masonry surfaces shall be protected from staining. Tops of wall shall be covered with nonstaining waterproof coverings when work is not in progress. Installed material shall be secure in high winds.

B. Protection shall be provided for all openings in the walls to prevent damage to sills, jambs, etc., from all causes. Aluminum or steel frames and other finish materials shall be protected from damage during masonry work.

3.13 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing of Masonry: At the completion of the masonry work, all holes in exposed masonry shall be pointed. Defective joints shall be cut out and tuckpointed solidly with mortar. Pointing and tuckpointing shall be done with a pre-hydrated mortar. The mortar cement shall be controlled so that, after curing of the mortar, no difference in texture or color exists with that of adjacent masonry.

C. Masonry Cleaning: While laying masonry units, good workmanship and job housekeeping practices shall be used so as to minimize the need for cleaning the masonry work. Protect the base of the wall from mud splashes and mortar droppings. The technique for laying masonry shall be such that mortar does not run down the face of the wall or smear onto the face.

1. After the joints are tooled, cut off mortar failings with the trowel and brush excess mortar burrs and dust from the face of the masonry, use a bricklayer's brush made with medium soft hair.

2. Remove all large mortar particles with a hardwood scraper.

3. If, after using the above outlined techniques, additional cleaning of the walls is found necessary, allow the walls to cure one month prior to initiating further cleaning processes.

D. Clean masonry to comply with the masonry manufacturer's directions and applicable NCMA "Tek" bulletins or BIA technical notes and the following requirements.

1. Saturate the wall with clean water. The wall shall be thoroughly saturated prior to and at the time the cleaning solution is applied.

2. Clean masonry with an approved cleaning solution for each type of masonry applied with a brush, starting at the top of the wall. Approved cleaners shall be composed primarily of detergents, wetting agents, buffering agents, and a maximum of 10% muriatic acid. Do not use acids on masonry surfaces that will be damaged by use of an acid cleaner. The use of any of the above cleaning agents shall first be approved in writing by the manufacturer of the masonry being cleaned and the Engineer. The concentration, method of application of the cleaning solution, and method of scraping shall be as outlined on the container by the manufacturer.

3. High pressure water and sandblasting shall not be used for cleaning except with the recommendation of the masonry manufacturer and the written approval of the Engineer.

4. Immediately after cleaning a small area, the wall shall be rinsed thoroughly with quantities of water.

5. Protect adjacent surfaces and materials during masonry cleaning operations.

6. After the walls are cleaned, take the necessary precautions to ensure that other contractors and subcontractors do not damage or soil the walls. Mud protection around the base of walls shall be left in place until the grading work is done.

- END OF SECTION -

SECTION 05010

METAL MATERIALS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials for fasteners are included in Section 05050 – Metal Fastening.

B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM A36 – Standard Specification for Structural Steel

B. ASTM A47 – Standard Specification for Malleable Iron Castings

C. ASTM A48 – Standard Specification for Gray Iron Castings

D. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

E. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

F. ASTM A276 – Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes

G. ASTM A307 – Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

H. ASTM A446 – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality

I. ASTM A500 – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

J. ASTM A501 – Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

032320

K. ASTM A529 – Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)

L. ASTM A536 – Standard Specification for Ductile Iron Castings

M. ASTM A570 – Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

N. ASTM A572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

O. ASTM A992 – Standard Specification for Structural Steel Shapes

P. ASTM A666 – Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications

Q. ASTM A1085 – Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

R. ASTM B26 – Standard Specification for Aluminum-Alloy Sand Castings

S. ASTM B85 – Standard Specification for Aluminum-Alloy Die Castings

T. ASTM B108 – Standard Specification for Aluminum-Alloy Permanent Mold Castings

U. ASTM B138 – Standard Specification for Manganese Bronze Rod, Bar, and Shapes

V. ASTM B209 – Standard Specification for Aluminum-Alloy Sheet and Plate

W. ASTM B221 – Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

X. ASTM B308 – Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

Y. ASTM B574 – Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod

Z. ASTM F468 - Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

AA. ASTM F593 – Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials, the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 – PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

Steel W, C, and MC Shapes	A992
Steel HP Shapes	A572 Grade 50
Steel M and S shapes and Angles, Bars, and Plates	A36
Rods	F 1554 Grade 36
Pipe - Structural Use	A53 Grade B
Hollow Structural Sections	A500 Grade C or A1085 Grade A
Cold-Formed Steel Framing	A 653

2.02 STAINLESS STEEL

A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.

B. Material types and ASTM designations are listed below:

Plates and Sheets	ASTM A167 or A666 Grade A
Structural Shapes	ASTM A276

Fasteners (Bolts, etc.)	ASTM F593

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

Structural Shapes	ASTM B308
Castings	ASTM B26, B85, or B108
Extruded Bars	ASTM B221 - Alloy 6061
Extruded Rods, Shapes and Tubes	ASTM B221 - Alloy 6063
Plates	ASTM B209 - Alloy 6061
Sheets	ASTM B221 - Alloy 3003

C. All aluminum structural members shall conform to the requirements of Section 05140 – Structural Aluminum.

D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

Gray	ASTM A48 Class 30B
Malleable	ASTM A47
Ductile	ASTM A536 Grade 60-40-18

2.05 BRONZE

A. Material types and ASTM designations are listed below:

Rods, Bars and Sheets	ASTM B138 - Alloy B Soft

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

2.07 DISSIMILAR METALS

A. Dielectric isolation shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			●	●	●	●	●	●	●
Galvanized Steel			●	●	●	●	●	●	●
Aluminum	●	●		●	●	●	●	●	●
Cast Iron	●	●	●				●	●	●
Ductile Iron	●	●	●				●	●	●
Mild Steel/ Carbon Steel	●	●	●				●	●	●
Copper	●	●	●	●	●	●			●
Brass	●	●	●	●	●	●			●
Stainless Steel	●	●	●	●	●	●	●	●	

1. "●" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.

PART 3 – EXECUTION (NOT USED)

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SECTION 05035

GALVANIZING

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. ASTM A123 – Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip

3. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A653 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

5. ASTM A924 – Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

6. ASTM A780 – Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings

7. ASTM F2329 – Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

090817

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

PART 2 – PRODUCTS

2.01 GALVANIC COATING

A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 – EXECUTION

3.01 FABRICATED PRODUCTS

A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.

B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.

C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.02 HARDWARE

A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153 and ASTM F2329.

3.03 ASSEMBLED PRODUCTS

A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.

B. Assemblies shall be provided with vent and drain holes as required by the fabricator. All vent and drain holes shall be plugged and finished to be flush with and blend in with the surrounding surface. Where water intrusion can occur, the plug shall be carefully melted into the surrounding zinc coating using an appropriate fluxing agent.

3.04 METAL DECK

A. Unless noted otherwise, metal deck shall be galvanized in accordance with ASTM A653 G60 minimum. In moist environments or as indicated on the Contract Drawings, galvanizing shall meet the requirements of ASTM A653 G90.

B. Galvanized metal deck shall meet the requirements of ASTM A924.

3.05 REPAIR OF GALVANIZING

A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

END OF SECTION

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SECTION 05050

METAL FASTENING

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05035 – Galvanizing

C. Section 05061 – Stainless Steel

D. Section 05120 – Structural Steel

E. Section 05140 – Structural Aluminum

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. AC 193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements

3. AC 308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

4. ACI 318 – Building Code Requirements for Structural Concrete

5. ACI 355.2 – Qualifications of Post-Installed Mechanical Anchors in Concrete

6. ACI 355.4 – Qualifications of Post-Installed Adhesive Anchors in Concrete

7. AISC – RCSC Specification for Structural Joints Using High Strength Bolts

8. AISC – Code of Standard Practice

072122

9. AWS D1.1 – Structural Welding Code – Steel

10. AWS D1.2 – Structural Welding Code – Aluminum

11. AWS D1.6 – Structural Welding Code – Stainless Steel

12. Aluminum Association – Specifications for Aluminum Structures

13. ASTM A572/A572M-94C – Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50

14. ASTM A36 – Standard Specification for Carbon Structural Steel

15. ASTM A489 – Standard Specification for Eyebolts

16. ASTM A563 – Standard Specifications for Carbon and Alloy Steel Nuts

17. ASTM D1785 – Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe

18. ASTM E3121 – Standard Test Methods for Field Testing of Anchors in Concrete or Masonry

19. ASTM F436 – Standard Specification for Hardened Steel Washers

20. ASTM F467 – Standard Specification for Nonferrous Nuts for General Use

21. ASTM F593 – Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs

22. ASTM F594 – Standard Specification for Stainless Steel Nuts

23. ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

24. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch and Metric Dimension

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.

2. Anchor design calculations sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. Only required if design not shown on Contract Drawings.

3. A current Evaluation Report shall be submitted for all anchors that will be considered for use on this project.

4. Manufacturer's installation instructions.

5. Copy of valid certification for each person who is to perform field welding.

6. Certified weld inspection reports, when required.

7. Welding procedures.

8. Installer qualifications.

9. Certification of Installer Training.

10. Inspection Reports.

11. Results of Anchor Proof Testing.

12. Manufacturer's Literature for Resistance of Adhesive to Appropriate Chemical Exposure, where deemed necessary.

1.05 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Evaluation Report: A current Evaluation Report from an independent testing and evaluation agency (ITEA) shall be submitted for all anchors that will be used on this project. The ITEA producing the evaluation report shall be accredited in accordance with the requirements for ITEA's in ACI 355.2 (for mechanical anchors) or 355.4 (for adhesive anchors). Acceptable ITEA's include but are not necessarily limited to the International Code Council Evaluation Service (ICC-ES) and the International Association of Plumbing and Mechanical Officials Uniform Evaluation Service (IAPMO-UES).

C. Installer Qualifications: All concrete anchors shall be installed by an Installer with at least three years of experience performing similar installations. Concrete adhesive anchor installers for anchor installations in horizontal to vertically overhead applications shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

D. Installer Training: For concrete anchors, conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process to include but not be limited to the following:

1. Hole drilling procedure.

2. Hole preparation and cleaning technique.

3. Adhesive injection technique and dispenser training/maintenance.

4. Concrete adhesive anchor preparation and installation.

5. Proof loading/torquing.

6. Provide a list of names of all installers who are trained by the Manufacturer's Field Representative on this jobsite prior to installation of products. Record must include the installer name, date of training, products included in the training and trainer name and contact information.

7. Provide a copy of the current ACI/CRSI "Adhesive Anchor Installer" certification cards for all installers who will be installing adhesive anchors in the horizontal to vertically overhead orientation.

E. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless-steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

F. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

G. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

H. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

I. Special inspections for concrete adhesive anchors shall be conducted in accordance with the manufacturer's instructions and Section 01450 – Special Inspections.

Downward installations require periodic inspection and horizontal and overhead installations require continuous inspection.

PART 2 – PRODUCTS

2.01 ANCHOR RODS

A. Anchor rods shall conform to ASTM F1554 Grade 55 except where stainless steel or other approved anchor rods are shown on the Drawings or stated herein. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A. Washers shall meet the requirements of ASTM A436.

B. All anchors into concrete shall be cast-in-place anchors unless specifically referenced otherwise on Drawings.

C. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot dipped galvanized in accordance with ASTM F1554.

D. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.02 HIGH STRENGTH BOLTS

A. High strength bolts and associated nuts and washers shall be in accordance with ASTM F3125, Grade A325 Type 1 or Grade F1852 Type 1. Bolts, nuts, and washers shall meet the requirements of RCSC “Specification for Structural Joints Using High Strength Bolts”.

B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot dipped galvanized in accordance with ASTM A325.

2.03 STAINLESS STEEL BOLTS

A. Stainless steel bolts shall conform to ASTM F-593 for alloy groups 1 and 2, Condition CW1, or ASTM F-3125. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts, washers, and lock washers shall be of the same alloy as the bolts.

2.04 CONCRETE ANCHORS

A. General

1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. If no specific type is indicated on the Drawings, the concrete anchor shall be a cast-in-place anchor. The determination of anchors equivalent to those listed below shall be based on test data performed by an approved independent testing laboratory. Two types of anchors shall be used:

    a. Mechanical anchors include any of the following anchors:

        1) Expansion anchors shall be mechanical anchors of the wedge, sleeve, or drop-in type that are set by expanding against the sides of the drilled hole.

        2) Screw anchors are mechanical anchors that derive tensile holding strength by the mechanical interlock provided by threads cutting into the concrete during installation. Screw anchors shall be one-piece, heavy duty screw anchors with a finished head.

    b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two-part injection type using the manufacturer’s static mixing nozzle and shall be supplied as an entire system.

2. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to the International Building Code and ACI 318 Chapter 17 requirements as applicable, including seismic test requirements.

3. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire-resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.

4. Engineer’s approval is required for use of concrete anchors in locations other than those shown on the Drawings.

B. Wedge Anchors:

    a. Do not use when subjected to vibration.

b. Do not use in exterior locations or locations subjected to freezing.

c. Do not use in submerged, intermittently submerged, or buried locations.

d. Suitable for use in overhead applications.

C. Screw Anchors:

a. Do not use when subjected to vibration.

b. Do not use in exterior locations or locations subjected to freezing.

c. Do not use in submerged, intermittently submerged, or buried locations.

d. Do not use in overhead applications.

D. Sleeve Anchors:

a. Do not use when subjected to vibration.

b. Do not use in exterior locations or locations subjected to freezing.

c. Do not use in submerged, intermittently submerged, or buried locations.

d. Suitable for use in overhead applications.

E. Undercut Anchors:

a. Suitable for use where subjected to vibration.

b. Do not use in exterior locations or locations subjected to freezing.

c. Do not use in submerged, intermittently submerged, or buried locations.

d. Suitable for use in overhead applications.

F. Adhesive Anchors in Concrete:

a. Suitable for use where subjected to vibration.

b. Suitable for use in exterior locations or locations subjected to freezing.

c. Suitable for use in submerged, intermittently submerged, or buried locations.

d. Do not use in overhead applications, unless otherwise shown or approved by Engineer.

e. Suitable for use in chemical areas provided manufacturer's literature confirms appropriate chemical resistance.

f. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

G. Adhesive Anchors in Masonry

a. Suitable for use where subjected to vibration.

b. Suitable for use in exterior locations or locations subjected to freezing.

c. Do not use for pipe hangers, unless otherwise shown or approved by Engineer.

d. Suitable for use in precast hollow core planks.

H. Concrete Anchor Design:

1. Basis of design shall include the following design parameters:

a. Actual compressive strength of concrete.

b. Cracked concrete conditions.

c. Dry or water saturated installation conditions.

d. Base material temperature between 40- and 104-degrees Fahrenheit.

e. Installation with hammer drill or hollow-drill bit system drilling methods.

f. Installation not prior to 21-day minimum age of concrete.

2. An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, the anchors shall be installed to the prescribed size, spacing, embedment depth, and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

a. The Contractor shall submit design with signed and sealed calculations and drawings performed by an Engineer currently registered in the State or Commonwealth in which the project is located. Anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and

shall be designed by the Contractor in accordance with ACI 318 Appendix Chapter 17.

b. Embedment Depth

1) Minimum anchor embedment shall be as indicated on the Drawings unless anchor design is stipulated to be by Contractor or equipment provider. The provider of equipment including pumps, blowers, etc. shall provide anchor design including size of anchors, pattern, and embedment depth. If the equipment provider is unable to provide design of embedment depth, the design shall be provided by the contractor using the loads furnished by the equipment provider. Although all manufacturers listed are permitted, the embedment depth indicated on the Drawings is based on “HIT HY-200 Adhesive Anchoring System” by Hilti. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the required embedment and the Contractor shall provide the required embedment depth stipulated by the Engineer specific to the approved dowel adhesive.

2) Where the embedment depth is not shown on the Drawings, concrete anchors shall be embedded no less than the manufacturer’s standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod according to the manufacturer (adhesive anchors).

3) The embedment depth shall be determined using the actual concrete compressive strength, a cracked concrete state, maximum long-term temperature of 110 degrees F, and maximum short-term temperature of 140 degrees F. In no case shall the embedment depth be less than the minimum or more than the maximum stated in the manufacturer’s literature.

I. Anchors:

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be “Kwik Bolt TZ” by Hilti, Inc., “Strong-Bolt 2” by Simpson Strong-Tie Co. or “Power-Stud+SD1” or “Power-Stud+ SD-2” by DeWalt.

b. Screw Anchors: Screw anchors shall be “KWIK HUS-EZ”, “KWIK HUS-EZ-I”, or “KWIK HUS-EZ CRC” by Hilti, Inc., “Titen HD” or “Stainless Steel Titen HD” by Simpson Strong-Tie Co., or “Screw-Bolt+” by DeWalt.

c. Sleeve Anchors: Sleeve anchors shall be “HSL-3 Heavy Duty Sleeve Anchor” by Hilti, Inc. or “Power-Bolt +” by DeWalt.

d. Shallow Embedment Internally Threaded Insert (3/4” max embedment): “Mini-Undercut +Anchor” by DeWalt, “HDI-P-TZ” by Hilti, Inc. or approved equal.

e. Concrete Undercut Anchors: Concrete undercut anchors shall be “HDA Undercut Anchors” by Hilti, Inc, “DUC Ductile Undercut Anchor”, by USP Structural Connectors, or approved equal.

f. Mechanical anchor systems shall comply with ACI 355.2 or alternatively the latest revision of AC 193 and shall have a valid evaluation report in accordance with the applicable building code.

2. Adhesive Anchors:

a. Adhesive anchors shall be “HIT HY-200 Adhesive Anchoring System” by Hilti, Inc., “SET-3G Epoxy Adhesive Anchors” by Simpson Strong-Tie Co., or “Pure 110+ Epoxy Adhesive Anchor System” by DeWalt.

b. Adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Adhesive anchor systems shall comply with ACI 355.4 or alternatively the latest revision of AC308 and shall have a valid evaluation report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner**.

J. Concrete Anchor Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.

2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be manufactured from stainless steel unless noted otherwise. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

3. Nuts, washers, lock washers and other hardware shall be of a material to match the anchors.

2.05 MASONRY ANCHORS

A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system. The adhesive system shall be “HIT HY-270 System” as manufactured by Hilti, Inc., “AC100+ Acrylic Adhesive” by DeWalt, or “SET-XP” as manufactured by Simpson Strong-Tie Co.

B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust prior to installation of adhesive and anchor. Contractor shall follow manufacturer’s installation instructions. The adhesive system shall be “HIT HY-270 System” as manufactured by Hilti, Inc., “AC100+ Acrylic Adhesive” by DeWalt, or “SET-XP” as manufactured by Simpson Strong-Tie Co.

C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer’s recommendations for proposed adhesive system but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be manufactured from stainless steel unless noted otherwise. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless-steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

E. Nuts, washers, lock washers and other hardware shall be of a material to match the anchors.

F. Although all manufacturers listed are permitted, the masonry anchor design is based on “HIT HY-270 System” as manufactured by Hilti. If the contractor submits one of the other concrete adhesive anchors listed, the Engineer shall evaluate the proposed product and the Contractor shall provide the conditions stipulated by the Engineer specific to the approved adhesive anchor.

2.06 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.07 WELDED STUD CONNECTORS

A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS

A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS

A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276. Hastelloy fasteners shall be used for fasteners located in chemical areas containing Hydrochloric Acid (Muriatic Acid), Hydrofluosilicic Acid (Fluoride), or Sulfuric Acid.

2.10 TITANIUM FASTENERS

A. Titanium fasteners, washers, and nuts shall conform to ASTM B348, Grade 2. Titanium fasteners shall be used for fasteners located in chemical areas containing Ferric Chloride or Sodium Hypochlorite.

2.11 ANTISEIZE LUBRICANT

A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 – EXECUTION

3.01 MEASUREMENTS

A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 FASTENER INSTALLATION

A. Anchor Rods, Concrete Anchors, and Masonry Anchors

1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during

anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.

2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.

4. All stainless-steel threads shall be coated with anti-seize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with RCSC “Specification for Structural Joints Using High Strength Bolts”. All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Stainless Steel Bolts

1. Where connections indicate the use of stainless-steel bolts, the bolts shall be installed to the snug tight condition. Connections shall include stainless steel washers under both the bolt head and the nut head. Lock washers shall be utilized for all connections and shall be placed under the nut head.

D. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days, have a minimum compressive strength of 2500 psi, and ambient temperature at time of installation shall be at least 50 degrees F.

2. Concrete Anchor Testing:

a. At all locations, at least 10 percent of all concrete anchors installed shall be proof tested to 80% of the yield strength of the anchor rod, with a minimum of one tested anchor per anchor group.

b. Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Proof testing of anchors

shall be in accordance with ASTM E3121 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.

c. Where Contract Documents indicate anchor design to be the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located. Documentation shall also be submitted indicating the Contractor's proof testing procedures have been reviewed and the proposed procedures are acceptable. Proof testing procedures shall be in accordance with ASTM E3121.

d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.

e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all proof testing, including additional testing required due to previously failed tests.

3. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.

4. All holes shall be drilled in accordance with the manufacturer's instructions except that cored holes shall not be allowed unless specifically approved by the Engineer. If cored holes are allowed, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris, drill dust, and water in accordance with the manufacturer's instructions prior to installation of adhesive and threaded rod unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Installation conditions shall be either dry or water saturated. Water filled or submerged holes shall not be permitted unless specifically approved by the Engineer. Injection of adhesive into the hole shall be performed to minimize the formation of air pockets in accordance with the manufacturer's instructions. Wipe rod free from oil that may be present from shipping or handling.

5. All adhesive anchor installations in the horizontal to vertically overhead orientation shall be conducted by a certified Adhesive Anchor Installer as certified by ACI/CSRI per ACI 318-14 17.8.2.2. Current AAI Certificate must be submitted to

the Engineer of Record prior to commencement of any adhesive anchor installations**.**

E. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be isolated via an approved dielectric.

2. All stainless-steel bolts shall be coated with anti-seize lubricant.

3.03 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

C. Welds shown on the Drawings with a field weld symbol shall be field welded. All other welds shall be shop welded unless specifically approved by the Engineer.

3.04 INSPECTION

A. High strength bolting will be visually inspected in accordance with RCSC “Specification for Structural Joints Using High Strength Bolts”. Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

END OF SECTION

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SECTION 05061
STAINLESS STEEL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish, install and erect the stainless steel work as shown on the Contract Drawings and specified herein.

B. Stainless steel work shall be furnished complete with all accessories, mountings and appurtenances of the type of stainless steel and finish as specified or required for a satisfactory installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 05010 – Metal Materials

C. Section 05050 – Metal Fastening

D. Section 05500 – Metal Fabrications

1.03 REFERENCES

A. ASTM A193 – Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

B. ASTM A194 – Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service

C. ASTM A262 – Practice for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel

D. ASTM A276 – Stainless and Heat-Resisting Steel Bars and Shapes

E. ASTM A314 – Stainless and Heat-Resisting Steel Billets and Bars for Forging

F. ASTM A380 – Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems

G. ASTM A473 – Stainless and Heat-Resisting Steel Forgings

H. ASTM A666 – Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar

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I. ASTM A774 – Stainless Steel Pipe Fittings

J. ASTM A778 – Stainless Steel Pipe

K. ASTM A967 – Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts

L. ASTM F593 – Stainless Steel Bolts, Hex Cap Screws and Studs

M. ASTM F594 – Stainless Steel Nuts

N. ANSI/ASME B1.1 – Unified Inch Screw Thread (UN and UNR Thread Form)

1.04 TESTS

A. All stainless steel materials including stainless test welds, shall be checked for compliance with tests for susceptibility to intergranular attack. Such tests shall be Practices A, B and E of ASTM A262. Detailed procedures for the tests shall be submitted to the Engineer for approval prior to start of work. Practice A shall be used only for acceptance of materials but not for rejection of materials, and shall be used for screening material intended for testing in Practice B and Practice E. The maximum acceptable corrosion rate under Practice B shall be 0.004 inch per month, rounded off to the third decimal place. If the certified mill report indicates that such test has been satisfactory performed, the fabricator may not be required to repeat the test. Material passing Practice E shall be acceptable.

B. Sample selection for the susceptibility to intergranular attack tests shall be as follows:

1. One (1) sample per heat treatment lot for plates and forgings;

2. One (1) sample per each Welding Procedure Qualification regardless of the joint design;

3. If tests indicate a reduction in corrosion resistance, welding procedure shall be adjusted or heat treatment determined as needed to restore required corrosion resistance.

4. The samples so chosen shall have received all the post-weld heat treatments identical to the finished part.

1.05 SUBMITTALS

A. The Contractor shall prepare and submit for approval shop drawings for all stainless steel fabrication in accordance with Section 01300 – Submittal Procedures.

B. Submittals shall include, but not be limited to, the following:

1. Certified test reports for susceptibility to intergranular attack.

2. Affidavit of compliance with type of stainless steel shown on the Contract Drawings or specified herein.

3. Certified weld inspection reports.

4. Cleaning and handling of stainless steel in accordance with Paragraph 3.04, Cleaning and Handling.

C. Samples of finish, on each type of stainless steel to be furnished, shall be submitted to the Engineer upon request.

1.06 QUALITY ASSURANCE

A. Shop inspections may be made by the Engineer. The Contractor shall give ample notice to the Engineer prior to the beginning of any stainless steel fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the works.

B. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the Contract Drawings or the Specifications.

C. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship.

1.07 HANDLING, STORAGE AND DELIVERY

A. Mechanical damage (e.g., scratches and gouges) to the stainless steel material shall not be permitted and is cause for rejection. Care shall be taken in the material handling since such mechanical damage will result in the passive oxide film being "punctured" leading to a possible lower resistance to the initiation of corrosion than the surrounding chemically-passivated surface.

B. Stainless steel plates and sheets shall be stored vertically in racks and not be dragged out of the racks or over one another. Racks shall be protected to prevent iron contamination.

C. Heavy stainless steel plates shall be carefully separated and chocked with wooden blocks so that the forks of a fork-lift could be inserted between plates without mechanically damaging the surface.

D. Stainless steel plates and sheets laid out for use shall be off the floor and be divided by wooden planks to prevent surface damage and to facilitate subsequent handling.

E. Plate clamps, if used, shall be used with care as the serrated faces can dig in, indent and gouge the surface.

F. Stainless steel fabrications shall be loaded in such a manner that they may be transported and unloaded without being overstressed, deformed or otherwise damaged.

G. Stainless steel fabrications and packaged materials shall be protected from corrosion and deterioration and shall be stored in a dry area. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with approved effective and durable covers.

H. Stainless steel fabrications shall not be placed in or on a structure in a manner that might cause distortion or damage to the fabrication. The Contractor shall repair or replace damaged stainless steel fabrications or materials as directed by the Engineer.

1.08 FIELD MEASUREMENTS

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 – PRODUCTS

2.01 MATERIALS AND FINISHES

A. Stainless steel shall be Type 304 unless it is used for underwater service. Stainless steel for underwater service shall be Type 316. Minimum mechanical finish shall be No. 4 as stated in Table 2 unless otherwise noted on the Contract Drawings.

B. The basic mill forms (sheet, strip, plate and bar) are classified by size as shown on Table 1. Tables 2, 3 and 4 identify finishes and conditions in which sheet, bar and plate are available.

C. Tables 2, 3 and 4 show numbered finishes and conditions for sheet, bar and plate. While there are no specific designations for polished finishes on bar or plate, the sheet finish designations are used to describe the desired effect. This also applies to finishes on ornamental tubing.

D. There are three standard finishes for strip, which are broadly described by the finishing operations employed:

1. No. 1 Strip Finish

a. No. 1 strip finish is approximately the same as No. 2D Sheet Finish. It varies in appearance from dull gray matte to a fairly reflective surface, depending largely on alloy composition and amount of cold reduction.

2. No. 2 Strip Finish is approximately the same as a No. 2B sheet finish. It is smoother, more reflective than No. 1, and likewise varies with alloy composition.

3. Bright annealed finish is a highly reflective finish that is retained by final annealing in a controlled atmosphere furnace.

Table 1: Classification of Stainless Steel Product Form

Item	Description	Dimensions		
		Thickness	Width	Diameter or Size
Sheet	Coils and cut length:			
	Mill finishes Nos. 1, 2D and 2B	under 3/16"	24" and over all widths	-
	Polished finishes Nos. 3, 4, 6, 7 & 8			
Strip	Cold finished, coils or cut lengths:			
	Polished finishes Nos. 3, 4, 6,7 & 8	under 3/16"	under 24" all widths	-
Plate	Flat rolled or forged	3/16" and over	over 10"	-
Bar	Hot finished rounds, squares, octagons and hexagons	-	-	1/4" and over
	Hot finished flats	1/8" to 8" incl.	1/4" to 10" incl.	-
	Cold finished rounds, squares, octagons and hexagons	-	-	over 1/8"
	Cold finished flats	1/8" to 4-1/2"	3/8" to 4-1/2"	-
Wire	Cold finishes only: (in coil)			
	Round, square, octagon, hexagon and flat wire	under 3/16"	under 3/8"	-
Pipe & Tubing	Several different classifications, with differing specifications, are available.			
Extrusion	Not considered “standard” shapes. Currently limited in size to approximately 6-1/2" diameter or structurals.			

Table 2: Standard Mechanical Sheet Finishes

Unpolished or Rolled Finishes		Polished Finishes	
No. 1	A rough dull surface which results from hot rolling to the specified thickness followed by annealing and descaling.	**No. 3**	An intermediate polish surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required. A No. 3 finish usually receives additional polishing during fabrication
No. 2D	A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a final light roll pass through unpolished rolls. A 2D finish is used where appearance is of no concern.	**No. 4**	A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general purpose bright finish with a visible "grain" which prevents mirror reflection.
No. 2B	A bright cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing.	**No. 6**	A dull satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a high luster is undesirable, and to contrast with brighter finishes.
		No. 7	A high reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is used chiefly for architectural and ornamental purposes.
		No. 8	The most reflective surface, which is obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors.

Table 3: Conditions and Finishes for Bar

Conditions	Surface Finishes[1]
Hot worked only	(a) Scale not removed (excluding spot conditioning) (b) Rough turned[2] (c) Pickled or blast cleaned and pickled.
Annealed or otherwise heat treated	(a) Scale not removed (excluding spot conditioning) (b) Rough turned (c) Pickled or blast cleaned and pickled (d) Cold drawn or cold rolled (e) Centerless ground (f) Polished
Annealed and cold worked to high tensile strength[3]	(a) Cold drawn or cold rolled (b) Centerless ground (c) Polished

Table 4: Conditions and Finishes for Plate

Condition and Finish	Description and Remarks
Hot rolled	Scale not removed. Not heat treated. Plates not recommended for final use in this condition.[4]
Hot rolled, annealed or heat treated	Scale not removed. Use of plates in this condition is generally confined to heat resisting applications. Scale impairs corrosion resistance.[1]
Hot rolled, annealed or heat treated, blast cleaned or pickled	Condition and finish commonly preferred for corrosion resisting and most heat resisting applications.
Hot rolled, annealed, descaled and temper passed	Smoother finish for specialized applications.

[1] Surface finishes (b), (e) and (f) are applicable to round bars only.

[2] Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades, such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.

[3] Produced in Types 302, 303Se, 304 and 316.

[4] Surface inspection is not practicable on plates which have not been pickled or otherwise descaled.

Hot rolled, annealed, descaled cold rolled, annealed, descaled, optionally temper passed	Smooth finish with greater freedom from surface imperfection than the above.
Hot rolled, annealed or heat treated, surface cleaned and polished	Polished finishes refer to Table 2.

PART 3 – EXECUTION

3.01 FABRICATION

A. Holes for bolts and screws shall be drilled. Fastenings shall be concealed where practicable. Joints exposed to the weather shall be formed to exclude water.

B. As far as practicable, all fabricated units shall be fitted and assembled in the shop, with all cuts and bends made to precision measurements in accordance with details shown on approved shop drawings.

C. Work shall be fabricated so that it is installed in a manner that will provide for expansion and contraction, prevent the shearing of bolts, screws and other fastenings, ensure rigidity, and provide close fitting of sections.

D. All finished and/or machined faces shall be true to line and level. Stainless steel sections shall be well formed to shape and size with sharp lines and angles; curved work shall be sprung evenly to curves.

E. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection. Proper care shall be exercised in handling all work so as not to injure the finished surfaces.

3.02 WELDING

A. Welding shall be done in a manner that will prevent buckling and in accordance with Section 05050 – Metal Fastening, and as modified hereinafter.

B. All welds exposed in the work shall be ground smooth and finished to match the finish of the adjacent stainless steel surfaces.

C. Select weld rods that provide weld filler metal having corrosion resistant properties as nearly identical or better than the base metal to insure preservation of the corrosion-resistant properties. Provide heat treatment at welds where testing of weld procedure indicates it is required to restore the corrosion resistance.

D. Thermal conductivity of stainless steel is about half that of other steels; and the following methods may be used to accommodate this situation:

1. Use lower weld current setting.

2. Use skip-weld techniques to minimize heat concentration.

3. Use back-up chill bars or other cooling techniques to dissipate heat.

E. Edges of the stainless steel to be welded shall be cleaned of contaminants.

3.03 FASTENERS

A. Stainless steel fasteners shall be used for joining stainless steel work.

B. Stainless steel fasteners shall be made of alloys that are equal to or more corrosion resistant than the materials they join.

3.04 CLEANING AND HANDLING

A. All stainless steel surfaces shall be precleaned, descaled, passivated and inspected before, during and after fabrication in accordance with the applicable sections of ASTM A380 and as detailed in the procedures to be submitted to the Engineer for approval prior to start of work. Chemical passivation in accordance with ASTM A967 is required for all stainless steel in contact with process water. Degreasing and passivation of stainless steel articles shall be conducted as the last step after fabrication.

B. Measures to protect cleaned surfaces shall be taken as soon as final cleaning is completed and shall be maintained during all subsequent handling, storage and shipping.

1. The Contractor shall submit for approval specific procedures listing all the steps to be followed in detecting contamination and in descaling, cleaning, passivation and protecting of all stainless steel.

2. Area showing clear indications of contamination shall be recleaned, repassivated and reinspected.

C. At approved stages in the shop operations, contaminants such as scale, embedded iron, rust, dirts, oil, grease and any other foreign matter shall be removed from the metal, as directed or approved by the Engineer. The adequacy of these operations shall be checked by the Engineer. Operations in the shop shall be conducted so as to avoid contamination of the stainless steel and to keep the metal surfaces free from dirt and foreign matter.

D. In order to prevent incipient corrosion during fabrication, special efforts shall be made at all times to keep all stainless steel surfaces from coming in contact with other metals.

1. Stainless steel and stainless steel welds shall be cleaned with clean sand free of iron, stainless steel wool, stainless steel brushes, or other approved means and

shall be protected at all times from contamination by any materials, including carbon steel, that shall impair its resistance to corrosion.

2. Approved methods of cutting, grinding and handling shall be used to prevent contamination. If air-arc, or carbon-arc cutting is used, additional metal shall be removed by approved mechanical means so as to provide clean, weldable edges. All grinding of stainless steel shall be performed with aluminum oxide or silicon carbide grinding wheels bonded with resin or rubber. Grinding wheels used on carbon steel shall not be used on stainless steel.

3. Sand, grinding wheels, brushes and other materials used for cleaning stainless steel shall be checked periodically by the Engineer for contaminants. Cleaning aids found to contain contaminants shall not be used on the work.

3.05 INSTALLATION

A. All stainless steel fabrications shall be erected square, plumb and true, accurately fitted, adequately anchored in place, set at proper elevations and positions.

B. All inserts, anchor rods and all other miscellaneous work specified in the Detailed Specifications or shown on the Contract Drawings or required for the proper completion of the work, which are embedded in concrete, shall be properly set and securely held in position in the forms before the concrete is placed.

C. All stainless steel fabrications shall be installed in conformance with details shown on the Contract Drawings or on the approved shop drawings.

END OF SECTION

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SECTION 05120
STRUCTURAL STEEL

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05 10 00 – Metal Materials

B. Section 05 05 13 – Galvanizing

C. Section 05 05 23 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. North Carolina Building Code

2. AISC – "Code of Standard Practice"

3. AISC – "Specification for Structural Steel Buildings"

4. AISC – RCSC “Specification for Structural Joints Using High Strength Bolts”

5. AWS – "Structural Welding Code"

6. ASTM A786 – Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

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a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

c. Detailed drawings indicating jointing, anchoring and connection details and vent and drain holes where required.

1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

B. The structural steel erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector.

C. The structural steel fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Building Fabricator.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Structural Steel

1. Structural steel for W, C, and MC shapes shall conform to ASTM A992 unless otherwise indicated.

2. Structural steel for HP shapes shall conform to ASTM A572 Grade 50 unless otherwise indicated.

3. Structural steel for S and M shapes and angles and plates shall conform to ASTM A36 unless otherwise indicated.

4. Steel pipe shall be ASTM A53, Grade B.

5. HSS shall be ASTM A500, Grade C or ASTM A1085. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.

6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.

7. Fasteners for structural steel shall be in accordance with Section 05050 – Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050 – Metal Fastening.

PART 3 – EXECUTION

3.01 MEASUREMENT

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods, vent and drain holes or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

E. All structural steel shall be galvanized in accordance with Section 05035 – Galvanizing.

F. Checkered floor plate shall meet the requirements of ASTM A786.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct

contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.

C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050 – Metal Fastening.

F. All bolted connections shall use high strength bolts in accordance with Section 05050 – Metal Fastening. High strength bolts shall be installed in accordance with RCSC “Specification for Structural Joints Using High Strength Bolts”. Bolts specified or noted on the Drawings to be a tension or slip critical “SC” type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600 – Grout.

4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900 – Painting and the following additional requirements.

1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.

2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

END OF SECTION

SECTION 05140
STRUCTURAL ALUMINUM

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural aluminum work in accordance with the Contract Documents. The term "structural aluminum" shall include items as defined in the Aluminum Association "Specifications for Aluminum Structures".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05050 – Metal Fastening

C. Section 09900 – Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of the Bid.

1. North Carolina Building Code

2. Aluminum Association "Specifications for Aluminum Structures"

3. AWS D1.2 – "Structural Welding Code"

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

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c. Detailed drawings indicating jointing, anchoring and connection details.

1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Structural aluminum shall comply with Section 05010 – Metal Materials.

B. Fasteners for structural aluminum shall be in accordance with Section 05050 – Metal Fastening.

C. Electrodes for welding shall be in accordance with Section 05050 – Metal Fastening.

PART 3 – EXECUTION

3.01 MEASUREMENT

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Fabrication shall be in accordance with the Aluminum Association "Specifications for Aluminum Structures". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural aluminum members required for anchors, anchor rods, bolts, or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural aluminum members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before being permanently fastened.

C. No cutting of structural aluminum members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05 05 23 – Metal Fastening.

F. All bolted connections shall comply with Section 05050 – Metal Fastening.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor bolts and bolt holes in aluminum members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600 – Grout.

4. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900 – Painting.

B. Aluminum surfaces in contact with concrete or dissimilar metals shall be thoroughly protected with two coats of epoxy paint with a minimum total thickness of 16 mils or other approved isolating material in accordance with the requirements of Section 09900 – Painting.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 – GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.

B. Work shall include but may not be limited to lintels, guard posts, hoppers, and chutes.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05050 – Metal Fastening

C. Section 05035 – Galvanizing

D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. AISC – Specification for Structural Steel Buildings

3. AISI – Specifications for the Design of Cold-Formed Steel Structural Members

4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.

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2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used in metal fabrications shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in metal fabrication shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 LINTELS

A. Provide lintels as shown on the Drawings and specified herein with 8 inches minimum bearing each side unless noted otherwise.

B. All lintels shall be steel in accordance with Section 05120 – Structural Steel and shall be galvanized in accordance with Section 05035 – Galvanizing, unless noted otherwise.

2.04 GUARD POSTS (BOLLARDS)

A. Guard posts shall be 6-inch diameter Schedule 40 galvanized steel pipe in accordance with ASTM A53.

Guard posts shall be concrete filled and crowned, as detailed in the Drawings.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 – Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in Section 09900 – Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metal work shall be field painted when as specified in accordance with Section 09900 – Painting.

END OF SECTION

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SECTION 05510
METAL STAIRS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal stairs in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05035 – Galvanizing

C. Section 05050 – Metal Fastening

D. Section 05140 – Structural Aluminum

E. Section 05520 – Guards and Railings

F. Section 05531 – Gratings, Access Hatches, and Access Doors

G. Section 05550 – Stair Treads and Nosings

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. AISC – Specification for Structural Steel Buildings

3. AISI – Specification for the Design of Cold-Formed Steel Structural Members

4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

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A. Submit the following in accordance with Section 01300 – Submittals.

1. Complete fabrication and erection drawings of all metal work specified herein.

2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

3. Submit structural calculations and detailed erection drawings for steel pan stairs. Calculations and drawings shall be signed and sealed by a Professional Engineer currently registered in the State or Commonwealth in which the project is located.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for metal stairs shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in metal stairs shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 METAL STAIRS AND LANDINGS

A. Stair stringers and structural framing of landings shall be fabricated from steel or aluminum as indicated on the Drawings.

1. Steel stairs shall be fabricated from steel in accordance with Section 05120 – Structural Steel.

2. Aluminum stairs shall be fabricated from aluminum alloy 6061-T6 in accordance with Section 05140 – Structural Aluminum.

B. Regardless of material of stringers, all stair treads shall be aluminum in accordance with Section 05550 – Stair Treads and Nosings.

C. Where metal landings are required as indicated on the Drawings, gratings at landings shall conform to Section 05531 – Gratings, Access Hatches, and Access Doors.

D. Guards for metal stairs shall conform to Section 05520 – Guards and Railings. Contractor shall coordinate attachment of guards to metal stairs.

E. All clips, anchors, and necessary appurtenances shall be provided for a complete and rigid installation.

F. Closure plates shall be provided for all exposed ends of stringers.

G. All exposed connections shall be welded and ground smooth, unless otherwise indicated on the Drawings.

H. Stairs and landings shall be designed to support a 100 psf live load, minimum, unless otherwise indicated on the Drawings.

2.04 STEEL PAN STAIRS

A. General

1. All steel stairs and landings with concrete filled steel pan risers and treads shall meet all applicable OSHA, ANSI, and NFPA codes.

2. Stair assemblies shall conform to the dimensions and arrangements shown on the Drawings.

3. Stair assemblies shall be designed to support a minimum 100 psf live load unless otherwise indicated on the Drawings.

4. Steel framing, hangers, columns, struts, clips, brackets, bearing plates, and other necessary appurtenances shall be provided for support of stairs and platforms as shown on the Drawings.

5. Exposed portions of steel pans, platforms, framing system stringers, and portions of aluminum nosings in contact with concrete, steel, or masonry shall be painted in accordance with Section 09900 – Painting.

6. Concrete fill shall be 3-inches thick for platforms and 1-1/2 inches thick for pan treads.

7. Cast-in-place safety stair nosings in accordance with Section 05550 – Stair Treads and Nosings, shall be provided for treads and platforms.

8. Metal pan treads, platforms, and risers shall be fabricated from 0.1084-inch thick (12 gauge minimum), galvanized structural steel sheets.

9. Risers and treads shall be supported by steel angle brackets welded to the stringers. Metal pans shall be secured to the brackets with welds.

10. Closure pieces shall be provided for ends of stringers.

11. Contractor shall be exclusively responsible for the design of steel pan stairs as shown on the Drawings including, but not limited to, treads, risers, landings, framing, hangers, beams, columns, struts, clips, brackets, bracing, bearing plates, connections (bolts, welds, concrete anchors, fasteners, etc.), guardrail, handrail, and other necessary components and appurtenances required for complete design and assembly of the steel pan stair system.

a. Steel pan stairs shall be designed for all applicable loads (dead, live, wind, seismic, snow, etc.) as required by the governing building code and ASCE 7. See Structural Drawings and as specified herein for minimum required loads and site-specific parameters. Design shall consider all loads, erection, temperature, and anchorage stresses.

b. All welds and fasteners used in steel pan stairs shall conform to Section 05 05 23 – Metal Fastening, unless noted otherwise.

c. Design of concrete anchors shall include design of anchor size, embedment, and edge distances.

B. Connections

1. All connections between steel components shall be welded unless otherwise shown on the Drawings or specified herein. All welds shall be continuous and ground smooth where exposed. Welding and fasteners shall conform to Section 05050 – Metal Fastening.

2. Assemblies shall be fabricated such that bolts and other fastenings do not appear on finished surfaces.

3. All joints shall be true and tight, and connections between parts shall be light-proof tight.

C. Guards for steel pan stairs shall conform to Section 05520 – Guards and Railings. Contractor shall coordinate connection of guards to stairs.

2.05 ALTERNATING TREAD STAIRS

A. Stairs, landings, and platforms shall be designed to carry a live load of 100 lbs. per square foot, unless noted otherwise on the Drawings.

B. The stairs shall be welded, alternating tread type stairs having a center spine and a cast integrally welded combination mounting plate and top landing, flush with the upper floor level. Handrails shall be custom formed and contoured to provide close body support and shall be welded on to the balusters which extend directly from the treads. All risers shall be equal, including the first and last risers, and treads shall have anti-skid surfaces. The stringer bottoms shall be bent and/or cut and welded to a floor plate. All exposed connections shall be welded and ground smooth.

C. Treads, floor plate castings, and landing shall be aluminum alloy AAF356F. Half treads shall be at least 9-inches wide and 10-inches deep. The central stringer shall be aluminum alloy 6063-T52, 1-3/4-inches x 4 inches x 1/8-inch box shape. Guards shall be aluminum alloy 6061-T4. Finish shall be Aluminum Association M12C22A41.

D. The alternating tread type stairs shall be Model 68AL, as manufactured by Lapeyre Stair, Harahan, Louisiana.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 – Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in accordance with Section 09900 – Painting.

3.02 INSTALLATION

A. Assembly and installation of metal stairs shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metal stairs shall field painted when specified in accordance with Section 09900 – Painting.

END OF SECTION

SECTION 05515
LADDERS

PART 1 – GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all ladders in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05050 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. North Carolina Building Code

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.

2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for ladders shall conform to Section 05010 – Metal Materials, unless noted otherwise.

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2.02 METAL FASTENING

A. All welds and fasteners used for ladders shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 LADDERS

A. Ladders shall be furnished with all mounting brackets, baseplates, fasteners, and necessary appurtenances for a complete and rigid installation.

B. Unless noted otherwise on the Drawings, all ladders shall be aluminum alloy 6061-T6 or 6063-T5, with a clear, anodized finish, Aluminum Association M12C22A41.

C. All ladders shall conform to dimensions indicated on the Drawings and shall comply with OSHA requirements.

D. Side rails shall be 1-1/2 inch diameter Schedule 80 pipe, minimum.

E. Rungs shall be serrated 3/4 inch diameter, minimum.

F. All exposed connections shall be welded and ground smooth.

G. Ladders shall be as manufactured by Thompson Fabricating Company, or equal.

2.04 LADDER SAFETY SYSTEM

A. All ladders with an uninterrupted climb length exceeding 24 feet between rest platform landings or floors shall be installed with a ladder safety system.

B. Ladder safety system shall comply with all OSHA requirements and meet ANSI A14.3 design requirements.

C. Ladder safety system shall include all necessary components to provide a fully operational system, including one full body safety harness with a 310 lb. weight capacity for each ladder safety system.

D. Ladder Safety Systems shall be Miller Vi-Go by Honeywell, LAD_SAF by DBI Sala, or approved equal.

2.05 LADDER RETRACTABLE SAFETY EXTENSION

1. Where the Contract Documents indicate fixed ladders are required under access doors and checkered floor plates, they shall be provided with “LadderUp, Model LU-4” by Bilco Company, “L1E Ladder Extension” by Halliday Products Inc., or “Ladder Climb-out Device” by Thompson Fabricating.

2. For access doors, the safety extension shall be manufactured from the same material as the access door with telescoping tubular sections that lock automatically when fully extended.

3. Upward and downward movement shall be controlled by a stainless-steel balancing mechanism.

4. Safety extension shall be assembled in strict accordance with manufacturer's recommendations.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 – Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in accordance with Section 09900 – Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metalwork shall be field painted when specified in accordance with Section 09900 – Painting.

END OF SECTION

SECTION 05 52 00

GUARDS AND RAILINGS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal guards and railings in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05050 – Metal Fastening

C. Section 06610 – Glass Fiber and Resin Fabrications

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Complete fabrication and erection drawings of all metal work specified herein, sealed by a Professional Engineer currently licensed in the State or Commonwealth in which the Project is located.

2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

3. Structural calculations on guard and handrail system sealed by a Professional Engineer currently licensed in the State or Commonwealth in which the project is located.

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PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for guards and railings shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in guards and railings shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 GUARDS AND RAILINGS

A. General – Design of guard and handrail systems is the exclusive responsibility of the Contractor. Guard systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.

1. All guard systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 finish, unless otherwise noted.

2. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 minimum pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 minimum pipe.

3. The top of the upper guard rail shall be 42 inches above the walking surface for level guards. For stair guards, the top of the upper guard rail shall be 42 inches above the leading edge of the tread nosing. The top of stair handrail shall be 34 inches above the leading edge of the tread nosing.

4. Posts

a. Maximum horizontal spacing between posts for level rail shall be six feet.

b. Maximum horizontal spacing between posts for stair rail shall be five feet.

5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.

6. Toeboards

a. Toeboards shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.

b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.

c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.

7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the guards.

8. The guard system shall be designed to resist the design loads specified by both OSHA and the North Carolina Building Code.

9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the North Carolina Building Code.

B. The Contractor shall have the option of providing a guard system of either an all welded type construction or a component type construction.

1. With both the all welded or component type construction, the baseplates and toeboards shall be furnished as shown on the Drawings.

2. Component Type System

a. All fittings and brackets shall be designed for stainless steel concealed set screws with internal tyne type connectors.

b. Exposed fittings shall be cast or extruded aluminum, or stainless steel to match guard material, except where corrosion-resistant steel is employed as a standard fabricator's item for use.

c. Component type guards shall be as manufactured by Thompson Fabricating Company, Inc., or Hollaender Manufacturing Company, Inc.

3. Welded guards may be field assembled using component type fittings as described herein.

C. Guards shall be either Type I or Type II guards as shown on the Drawings. If no type is indicated on Drawings, guards shall be Type I.

1. Type I guards shall be a two-rail system. The intermediate rail shall be located as required to prevent passage of a 21-inch diameter sphere at any point.

2. Type II guards shall be a three-rail system with vertical posts spanning between the two intermediate rails.

    a. The centerline of the lower intermediate rail shall be 7 inches above the walking surface.

    b. The upper intermediate members, whether additional rails or vertical posts, shall be located below the top rail at a spacing as required to prevent passage of a 4-inch diameter sphere between the two rails.

    c. Vertical posts spanning between the intermediate rails shall be 1/2" diameter schedule 40 pipe or fiberglass rod.

    d. Spacing of vertical posts shall be as required to prevent passage of a 4-inch diameter sphere at any point.

D. Where gates are required in guards as shown on the Drawings, they shall be self-closing and shall be provided by the same manufacturer as the guards. Gates shall swing away from the opening being protected by the guards.

E. Where safety chains are required in guards as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap hooks shall be boat type and eye bolts for attachment of chains shall be 3/8-inch bolts with 3/4-inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

2.04 FREE STANDING RAILING SYSTEM

A. Free standing railing system shall be installed on roof ledges where accessible equipment is provided on roof and roof does not have a perimeter parapet wall of a minimum height of 42 inches. Free standing railing system shall be Safety Rail 2000 Guardrail System by BlueWater Mfg., Inc. or approved equal.

B. Toe Board brackets shall be used when the parapet wall is less than 3-1/2” in height.

C. Performance Characteristics: Shall meet and exceed OSHA (Standards - 29 CFR) 1926.502 (b).

    1. Railing System shall be designed to withstand a minimum 200 pounds of test load in any direction.

    2. Railing System shall consist of a top rail and rail at mid height between top rail and walking surface.

    3. Railing system shall extend to a height of at least 42" from the finished roof deck.

4. Railing system shall be free of sharp edges and snag points.

D. Railing and Base

1. Rail shall be 1 5/8” O.D. Hot Rolled Pickled Electric Weld Tubing

2. Each support post shall have a free standing base cast from Class 30 Gray Iron material.

3. Each base shall have four (4) receiver posts for accepting the rails.

4. The receiver posts shall have a positive locking system. A friction locking system will not be acceptable.

5. The receiver posts shall have a slot to enable the rails to be mounted in any direction.

E. Hardware

1. The securing pins shall be made from 1010 carbon steel. The pins shall be zinc plated and yellow chromate dipped. The pins shall consist of a collared pin and a lanyard that connects to a lynch pin.

2. For Gate Assemblies Only. Bolts and washers shall be 3/8" x 3 ½" and 3/8" x 3" grade 5, zinc plated.

3. Finish

a. Rails: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

b. Bases: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practical, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. Concrete anchors and bolts for attachment of guard baseplates to supporting members shall conform to Section 05050 – Metal Fastening.

G. All fabricated items shall be shop painted in accordance with Section 09900 – Painting.

3.02 INSTALLATION

A. Assembly and installation of guards and railings shall be performed in strict accordance with manufacturer's recommendations.

B. All guards and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

END OF SECTION

SECTION 05531

GRATINGS, CHECKERED FLOOR PLATES, AND ACCESS DOORS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and access doors in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05035 – Galvanizing

C. Section 05050 – Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

4. ANSI/NAAMM MBG 531 – NAAMM Metal Bar Grating Manual

5. ASTM C1802 – Design, Testing, Manufacture, Selection, and Installation of Fabricated Metal Access Hatches for Utility, Water, and Wastewater Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Complete fabrication and erection Drawings of all gratings, floor plates, and access doors specified herein.

2. For checkered floor plates, structural calculations signed and sealed by a currently registered Professional Engineer in the State or Commonwealth in which the

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Project is located verifying the proposed floor plate meets the minimum load and deflection requirements stipulated herein.

3. For access doors provided by a manufacturer not specifically named herein, structural calculations signed and sealed by a Professional Engineer currently registered in the State or Commonwealth in which the Project is located verifying the proposed access door meets the minimum load and deflection requirements stipulated herein. For access doors provided by a named manufacturer, sealed calculations are not required provided the applicable ASTM C1802 load rating is clearly indicated in the submittal for each proposed product.

4. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for gratings, floor plates, and access doors shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for gratings, floor plates, and access doors shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 GRATING

A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.

2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.

3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 150 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.

4. Grating installed in cast-in-place concrete shall be provided with embedded support frames on all perimeter and bearing edges. Support frames shall be extruded frames with continuous means of anchoring frames to concrete around entire perimeter of frame. Support frames shall be fabricated from the same material as the grating.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating attachment to frames and any other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.

2. Grating shall be “IB” by Harsco Industrial IKG, “I-Bar 19SGI4", by Ohio Grating Inc., or “I-Bar” by Thompson Fabricating LLC.

C. Aluminum Plank Grating

1. Aluminum plank grating shall be unpunched planks of extruded aluminum welded together to form panels. Panel ends shall have an extruded aluminum end bar welded in place. Two stainless steel recessed lifting handles shall be provided for individual panels, one handle at each end, where specifically shown on drawings. All support members shall be aluminum. Plank clips for grating attachment to frames and any other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel. Provide embedded aluminum support frames for cast-in-place concrete installations.

2. Aluminum plank grating shall be HD-P manufactured by Harsco Industrial IKG., Heavy Duty Series manufactured by Ohio Gratings, Inc., or Unpunched Duo-Grip Extruded Series manufactured by Alabama Metal Industries Corporation (AMICO).

D. Heavy Duty Steel Grating

1. Heavy duty steel grating shall be galvanized according to Section 05035 – Galvanizing.

2. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating. Provide embedded galvanized steel support frames for cast-in-place concrete installations.

3. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for HS-20 truck.

4. Grating shall be manufactured by Harsco Industrial IKG and Ohio Gratings, Inc.

2.04 CHECKERED FLOOR PLATES

A. Floor plates shall meet the requirements of ASTM C1802 for Load Level 1 – Light Pedestrian Load, minimum, unless otherwise indicated on the Drawings.

B. Floor plates shall be aluminum unless noted otherwise.

C. All floor plates shall be checkered plate with an approved raised pattern, non-skid surface.

D. Openings greater than 42 inches in either direction shall require two plates opening via hinges in opposite directions.

E. Floor plates shall be designed to carry a minimum service level live load of 150 psf, or a concentrated load of 300 pounds applied over a 5.50 inch by 5.50 inch area, whichever produces the greatest stress, unless indicated otherwise on the Drawings. Loading shall be positioned to produce the greatest stresses, both due to maximum moment and maximum shear load conditions.

F. All components of checkered floor plates shall have a minimum tensile yield strength of 23,000 psi and a minimum compressive yield strength of 21,000 psi. Yield strengths shall be indicated on both the structural calculations and the fabrication drawings.

G. Live load deflection shall be limited to L/200 of the span, but no greater than 3/16 inch.

H. All checkered floor plates shall be fabricated from 1/4" plate, minimum and shall be stiffened as required to maintain allowable stress and deflection requirements specified herein.

I. Stiffeners shall consist of angles or bars welded to the bottom of the plate.

J. Checkered floor plate hinges shall be either stainless steel or aluminum with stainless steel pins and fasteners.

K. All checkered floor plates shall be provided with recessed handles. Handle material shall be as shown on the Contract Drawings.

L. Air-tight and water-tight checkered floor plates shall be provided with a 1/8-inch-thick neoprene gasket between the checkered plate and the support frame. Gasket material shall be bonded to the support frame and checkered floor plates shall be bolted to the structural support frame with countersunk stainless-steel flathead screws.

M. All floor plates shall be clearly marked with the information listed below. Markings shall be indicated on metal or plastic tags permanently attached to the floor plate or frame or shall be permanently painted or printed.

1. The manufacturer’s name or trademark, location, and telephone contact number.

2. The manufacturer’s model number and ASTM designation.

3. The design load level as indicated in ASTM C1802. If the design requires deviation from the Load Level requirements specified in ASTM C1802, a description of the modifications shall be included.

4. Date of manufacture and/or serial number.

2.05 ACCESS DOORS

A. General

1. Door opening sizes, number, and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the dimensions of the openings in the concrete. Clear opening dimensions shall be no smaller than six inches less than the concrete opening.

2. All doors shall be aluminum unless otherwise noted.

3. All door components shall have a minimum tensile yield strength of 23,000 psi and a minimum compressive yield strength of 21,000 psi. Yield strengths shall be indicated on both the structural calculations and the fabrication drawings.

4. Openings larger than 42 inches in either direction shall have double leaf doors.

5. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

6. All doors shall be provided with an automatic hold-open arm with release handle.

7. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.

8. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.

9. All doors specifically required to be watertight shall be installed with a continuous gasket.

10. Access door frames with integral gutter systems shall be equipped with a 1-1/2-inch minimum drainpipe located by the manufacturer. The drainpipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

11. All doors shall be clearly marked with the information listed below. Markings shall be indicated on metal or plastic tags permanently attached to the door or frame or shall be permanently painted or printed.

    a. The manufacturer's name or trademark, location, and telephone contact number.

    b. The manufacturer's model number and ASTM designation.

    c. The design load level as indicated in ASTM C1802. If the design requires deviation from the Load Level requirements specified in ASTM C1802, a description of the modifications shall be included.

    d. The nominal door opening dimensions and/or the manufacturer's model number.

    e. Date of manufacture and/or serial number.

B. Floor, Wet Well and Dry Pit Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.

2. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

3. All doors shall have an enclosed compression spring assist and open to 90 degrees.

4. Doors not required to support traffic loading shall meet the requirements of ASTM C1802 for Load Level 2 – Pedestrian Load as a minimum and the following:

    a. Doors shall be designed to carry a minimum service level live load of 300 psf or a concentrated load of 600 pounds applied over a 5.50 inch by 5.50 inch area, whichever produces the greatest stress, unless indicated otherwise on the Drawings. Loading shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.

    b. Live load deflection shall be limited to L/200 of the span, but not greater than 3/16 inch.

    c. Unless otherwise noted, exterior doors shall have an integral gutter system and be Type "FDDP" by Nystrom, Type "W1S" or "W2S" by Halliday

Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., or Type "THG" or "THG-D", by Thompson Fabricating LLC, or Type “J-AL” or “JD_AL” by the Bilco Company.

d. Unless otherwise noted, interior doors shall be Type "FDNP” by Nystrom, Type ”S1S” or “S2S” by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., or Type "TH" or "TH-D", by Thompson Fabricating LLC.

5. Doors required to support traffic loadings shall meet the requirements of ASTM C1802 for Load Level 4 – Occasional Truck Traffic, unless otherwise indicated on the Drawings.

a. For openings less than or equal to 48 inches, the design loading shall consist of a service level 16,000 pound load applied over a 10 inch by 20 inch area with traffic both parallel and perpendicular to the span considered. Loadings shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.

b. For openings greater than 48 inches, two load cases shall be considered. Load Case 1 shall consist of two service level 16,000 pound loads spaced at 48 inches on center with each load applied over a 10 inch by 20 inch area and assuming the traffic direction is perpendicular to the span of the door. Load Case 2 shall consist of two service level 12,500 pound loads spaced at 48 inches on center with each load applied over a 10 inch by 20 inch area and assuming the traffic direction is parallel to the span of the door. Loadings for both cases shall be positioned to produce the maximum stresses, both due to maximum moment and maximum shear load conditions.

c. Live load deflections shall be limited to L/250 of the span, but not greater than 3/16 inch, and shall be determined based off a service level 16,000 pound load.

d. Unless otherwise noted, doors rated for HS-20 traffic loading shall have an integral gutter system and be Type “FDDH” by Nystrom, Type “H1C” or “H2C” by Halliday Products, Inc., Type “THS” or “THD” by U.S.F. Fabrication Inc., Type “THG-H20” by Thompson Fabricating LLC, or “Type JAL-H20” or “JDAL-H20” by the Bilco Company.

C. Roof Access Doors

1. Doors shall be designed for 40 psf live load unless noted otherwise.

2. Doors for service stairs shall be Bilco Type L roof Scuttles.

3. Doors for ladder access shall be Bilco Type S or SS Roof Scuttle.

2.06 FALL THROUGH PREVENTION SYSTEM

A. All checkered floor plates and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except as noted on the Contract Drawings. Checkered floor plates and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum live load, unless noted otherwise.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 – Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All gratings, checkered floor plates, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.

C. Where access doors utilize leveling bolts, or are placed on irregular surfaces, and are not to be embedded in concrete, the area beneath the frames shall be fully grouted with non-shrink grout to create a uniformly loaded bearing surface.

D. Grating shall not be field cut or modified unless approved by Engineer.

E. Grating shall not be used for equipment support or anchorage.

END OF SECTION

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SECTION 05540
CASTINGS

PART 1 – GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 – Utility Structures

B. Section 05010 – Metal Materials

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Complete fabrication and erection drawings of all castings specified herein.

2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for castings shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for castings shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

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2.03 IRON CASTINGS

A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets/.

1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.

2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.

3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.

B. Covers and Grates

1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.

2. Round covers and frames shall have machined bearing surfaces.

3. Design loadings:

a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.

b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.

C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

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SECTION 05550
STAIR TREADS AND NOSINGS

PART 1 – GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all stair treads and nosings in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 – Metal Materials

B. Section 05050 – Metal Fastening

C. Section 05510 – Metal Stairs

D. Section 06610 – Glass Fiber and Resin Fabrications

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. North Carolina Building Code

2. Aluminum Association Specifications for Aluminum Structures.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittal Procedures.

1. Complete fabrication and erection drawings of all work specified herein.

2. Other submittals as required in accordance with Section 05010 – Metal Materials and Section 05050 – Metal Fastening.

PART 2 – PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for stair treads and nosings shall conform to Section 05010 – Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for stair treads and nosings shall conform to Section 05050 – Metal Fastening, unless noted otherwise.

2.03 SAFETY STAIR NOSINGS

A. Abrasive cast aluminum, safety stair nosings shall be provided on all concrete or concrete filled steel pan stairs, including the top stair of metal stairs that attach to concrete, and as shown on the Drawings unless noted otherwise.

B. Nosing shall be 3 inches wide and shall extend the full width of the stairway minus 3 inches on either side. Nosing shall be cast into the concrete and held in place with butterfly type extruded anchors.

C. The nosing shall be "Style 231-A", by Amstep Products, “Alumogrit Type 101", by Wooster Products, Inc., "Type AX", by Safe-T-Metal Company. For steel pan concrete filled stairs, nosing shall be "Type 101-SP", Wooster Products, Inc., or "Type AXPE", by Safe-T-Metal Company. For pan stairs, nosing shall be continuous over corner of stair treads to fully protect corner of treads from abrasion. All exposed fasteners shall be Type 304 stainless steel.

2.04 STAIR TREADS

A. Stair treads shall be aluminum with an abrasive nosing as shown on the Drawings.

B. Stair treads shall be designed for the live load specified in Section 05510 – Metal Stairs.

C. Stair treads shall be as manufactured by IKG Industries, Ohio Gratings, Inc., or Safe-T-Metal Company.

2.05 FRP STAIR NOSINGS

A. FRP stair nosings shall be provided on all concrete stairs in sodium hypochlorite areas and as indicated on the Drawings.

B. FRP stair nosings shall conform to Section 06610 – Glass Fiber and Resin Fabrications as indicated on the Drawings.

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2.06 FRP STAIR TREADS

A. FRP stair treads shall be provided for FRP stairs in sodium hypochlorite areas and as indicated on the Drawings.

B. FRP stair treads shall conform to Section 06610 – Glass Fiber and Resin Fabrications.

PART 3 – EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

E. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050 – Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of stair treads and nosings shall be performed in strict accordance with manufacturer's recommendations.

B. All stair treads and nosings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

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SECTION 06100

ROUGH CARPENTRY

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on the Drawings and specified herein.

B. Principal items of work include:

1. Wood blocking, nailers, grounds, furring, ties, centering, etc., necessary or required for attachment or support of work under this Section, and other Sections.

2. Fasteners, including nails, screws, bolts, anchors and other fastenings, required to secure work under this Section.

3. Temporary enclosures and protective boarding.

4. Wood preservative treatment for all wood members in contact with roofing, masonry, concrete, and exposed to the elements.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. AWPA-CA Preservative Standards, Lumber and Plywood.

2. AWPA-C20 Structural Lumber Fire-Retardant Treatment by Pressure Process.

3. AWPC-C27 Plywood Fire-Retardant Treatment by Pressure Process.

4. AWPA-M4 Standards for Care of Preservative Treated Wood Products.

5. APA Guide to Plywood Grades.

6. FM 1-49 Perimeter Flashing

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Certifications of Preservative and Fire Retardant Treatment.

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2. Warranty of treatment manufacturer.

3. Certification of type and grade of lumber to be used.

4. Certification of type, rating and conformance to APA Standards.

1.04 DELIVERY AND STORAGE

A. Take all measures necessary to protect products against damage during delivery and storage.

B. Store lumber in enclosed places in such a manner to provide ventilation and protection from the weather.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Blocking, nailers, grounds and the like: Eastern Spruce or Douglas Fir - No. 3 Dimension Lumber or Construction Grade, with a moisture content not to exceed 19%.

B. Plates, blocking, and nailers in contact with concrete or masonry: Pressure treated southern yellow pine.

C. Plywood: Identified with APA Grade trademarks of the American Plywood Association, in thickness as shown on the Drawings.

1. Exterior: AC-EXT-APA where exposed to view or a finish is required, CD-EXT-APA where concealed.

2. Interior: AC-INT-APA where exposed to view or a finish is required, CD-INT-APA where concealed.

D. Structural Framing Lumber: Douglas Fir No.1 grade with fb = 1,500 pounds per square inch and E = 1,700,000 pounds per square inch, 19 percent moisture content.

E. Fasteners: Provide clamps, connectors, straps, nails, bolts, screws, anchors, ties and other accessories and fasteners shown or required to properly secure all rough carpentry. Fasteners and accessories shall be stainless steel, galvanized, or other noncorrosive metal recommended for use. Fasteners used with pressure treated wood shall be compatible with the wood preservative treatment to prevent corrosion of fasteners.

F. Wood Preservative Treatment: Waterborne pressure treatment in conformance with the American Wood Preservers' Association standard P5. Retention shall be in accordance with AWPA Standards and be a minimum of 0.40 pounds per cubic foot for contact with or below ground, concrete, or masonry and 0.25 pounds per cubic foot for above ground. Stamp each piece of treated wood with a trademark identifying the classification of the treatment or a certificate from the processor for each shipment.

G. Fire Retardant Treatment: Fire-retardant lumber and plywood must have an Underwriters Laboratories stamp signifying a FR-S rating and certifying a 25 or less flame spread and smoke developed value, when tested in accordance to UL 723, ASTM E 84, and NFPA 255 "Tunnel Test", and when the test is extended for 20 additional minutes. Treatment formulation shall contain no halogens, sulfates, chlorides or ammonium phosphate. Smoke toxicity shall be no more than that of untreated wood.

PART 3 -- EXECUTION

3.01 COORDINATION

A. Coordinate with all trades as to nailers, blocking, grounds and the like required for the attachment of their work and other items requiring same. Carry out all work as required to cooperate work of other trades.

3.02 INSTALLATION

A. Perform work in conformance manufacturer's recommendations and specifications, industry, national and local standards and codes.

B. Layout, cut, fit and erect rough blocking, nailers, furring and other rough carpentry. Do cutting work in connection with carpentry and finish for other trades. Brace plumb and level all members in true alignment and rigidly secure in place with sufficient nails, spikes, screws and bolts. Defects which render any piece or part unable to serve its intended purpose shall be discarded or, cut out and replaced.

C. Provide all bracing, supports and shoring required to support construction.

D. Protect all masonry including edges of concrete platforms and similar items. Remove protective covering when directed. Take special precautions at masonry openings and corners of the building.

E. Set all rough hardware, such as plates, spikes, bolts, nails, lag screws, lagging bolts, anchors, etc., as required to hold woodwork together or to anchor or secure it to other materials and construction.

F. Provide wood grounds, nailing strips and similar items wherever necessary or required throughout the project for the support, proper erection or installation of the work and support of mirrors, cabinets, shelf cleats, base and similar items. Thoroughly secure in place by approved means.

G. Secure wood grounds, nailing strips and similar items to metal plugs set in masonry, toggle or expansion bolts. Give the mason all necessary information to enable him to lay out correctly the location for metal wall plugs. Wood plugs will not be accepted.

H. Construct joints to support dead loads, live loads, snow loads, wind loads, or combinations in conformance with "National Design Specifications for Stress Grade Lumber and its Fastenings", recommended by National Forest Products Association.

I. Nailers and Blocking: Provide and secure wood nailers, blocking, for the reception of roof curbs, roofing, etc. in accordance with FM I-49, or as required by the Building Code, whichever is most stringent. Coordinate attachment with roofing system, where roofing system design includes design of nailers provide attachment in accordance with engineered roofing design.

1. Provide nailers of sizes, shapes and profiles indicated on the Drawings. Nailers shall not be less than 2 x6. Build up nailers as required to achieve thickness of insulation or as required to provide proper attachment of roofing and curbs. Provide anchors as required for secure attachment of roofing systems, copings, gravel stops or other edge terminations.

3.03 TEMPORARY PROTECTION

A. Provide and install all temporary protection in accordance with applicable provisions of the Contract Documents, OSHA regulations, and as follows:

1. Temporary protection shall include wood doors, railings, protection of floor or roof openings, temporary partitions, and the like; adequately maintained in good repair during the life of the Contract.

2. Furnish and set temporary partitions with wood doors at all exterior doorways, exterior openings or in locations exposed to weather. Substantially build and hang, with proper hinges, locks and other necessary hardware, and remove and reset whenever required to accommodate the Work and keep in good repair.

3. Provide substantial temporary wood covering or guards for openings left in floor or roof slabs for ducts, shafts, etc., using rough planking at least 2 inch thick, cleated together and otherwise made sufficiently strong and put in place wherever required immediately after the forms have been removed.

3.04 JOB CONDITIONS

A. If the installation of metal frames and glass does not promptly follow the completion of the exterior enclosures, and if the absence of enclosures would cause damage, close in all such openings temporarily by the use of heavy polyethylene plastic sheeting, or canvas stretched over and nailed to frames of 1 inch x 2 inch or heavier strips.

3.05 REMOVAL OF TEMPORARY WORK

A. Remove all temporary protection when so directed, or prior to acceptance of this project.

- END OF SECTION -

SECTION 06610

GLASS FIBER AND RESIN FABRICATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all fiberglass items as specified herein and as shown on the Drawings. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05050, Metal Fastening

B. Section 07900, Joint Fillers, Sealants, and Caulking

C. Section 09900, Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM D2996 – Specification for Filament Sound Reinforced Thermosetting Resin Pipe

2. ASTM D3647 - Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition

3. ASTM D3917 - Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes

4. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products

1.04 SUBMITTALS

A. The Contractor shall submit shop drawings showing fabrication details and a Performance Affidavit for all items specified herein in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions.

B. Certification of compliance with ASTM Standards.

C. Where specifically requested, design calculations sealed by a currently Registered Professional Engineer in the State of North Carolina.

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1.05 QUALITY ASSURANCE

A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

B. It shall be the Contractor's responsibility to ensure that the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.

C. Manufacturer shall provide a 3-year warranty on all FRP products against defect in material and workmanship.

PART 2 -- MATERIALS

2.01 GENERAL

A. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples.

B. Ultraviolet light resistive resins shall be used for all exterior locations and where specified.

C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.

D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

2.02 GRATING AND TREADS

A. Fiberglass grating and treads shall be furnished and installed in areas shown on the Drawings including all FRP angle supports, fasteners and accessories. Gratings and treads shall consist of extruded bearing bars positioned and locked by crossbars. Grating and treads shall be installed in accordance with the manufacturer's recommendations.

B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.

C. Fasteners shall not project above the walking surface.

D. Fiberglass grating and treads shall be manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Grating and treads shall be produced by IKG Industries, Fibergrate, Inc., IMCO Reinforced Plastics, Inc., or equal.

E. Grating shall be designed for a uniform loading of 100 PSF over the gross projected area with deflection limited to 0.375” or grating span/240 whichever is less. Fiberglass or PVC support beams shall be provided as required to meet deflection criteria.

F. The grating and tread supplier shall supply all shelf support angles, embedded angles with anchors, concrete anchors and necessary 316 stainless steel grating clips coated with epoxy paint per Section 09900, Painting, for a complete system.

G. Treads shall be designed for a 300 lb. concentrated load at midspan. Treads shall be furnished with integral nosing.

2.03 GRATING FLOOR SYSTEM

A. Fiberglass grating floor system shall be furnished and installed in areas shown on the Drawings and shall include all FRP angle supports, FRP adjustable pedestal supports, FRP cross bracing, fasteners, and accessories as required for a complete system. Grating shall consist of bidirectional molded FRP gratings. Grating and supports shall be provided by a single manufacturer and installed in accordance with the manufacturer's recommendations to provide a level walking surface.

B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.

C. Fasteners shall not project above the walking surface.

D. Fiberglass grating and supports shall be manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Grating and supports shall be produced by Fibergrate, Inc., IMCO Reinforced Plastics, Inc., American Grating, LLC, or equal.

E. Grating and supports shall be designed for a uniform loading of 100 psf. Grating deflection shall be limited to 0.25".

F. Grating clips and metal fasteners shall be Type 316 stainless steel coated with epoxy paint per Section 09900, Painting.

2.04 FIBERGLASS WEIRS AND BAFFLES

NOT USED

2.05 WASHWATER EFFLUENT TROUGHS FOR FILTERS

NOT USED

2.06 PARSHALL FLUME

NOT USED

2.07 FRP STOP PLATES

A. The Contractor shall furnish FRP stop plates as specified herein and as shown on the Drawings.

B. Stop plates shall be constructed of fiberglass reinforced polyester containing ultraviolet absorbers and having a resin rich surface on both sides, thoroughly embedding all glass fibers, and shall be blue-green in color. Plates shall have sandwich core structural reinforcing throughout the high stress areas with the thickness as recommended by the manufacturer. The reinforcing shall be encapsulated with laminate of fiberglass and polyester not less than 1/8-inches thick on each side to insure against permeation by water to the sandwich core material. The stop plates shall be molded individually to the exact size required. Plates cut from flat stock are not acceptable.

C. Each stop plate shall contain reinforced handholes for installation and removal. Stop plates greater than two (2) feet in width shall have a minimum of two (2) handholes. Stop plates less than two (2) feet in width shall have a minimum of one (1) handhole.

D. Guide frames shall be surface mounted with 316 stainless steel anchor bolts, or shall be embedded in concrete as shown on the Drawings. All stop plates shall be sealed with neoprene rubber to form a watertight seal.

E. The mechanical properties of the laminate used in the manufacture of the stop plates shall be as follows:

Laminate Physical Properties 73°F

	ASTM Test Method	Minimum Properties
Ultimate Tensile Strength - PSI x 10^3 (Min.)	D-638	12
Flexural Strength - PSI x 10^3 (Min.)	D-790	19
Flexural Modulus of Elasticity - PSI x 10^6 (Min.)	D-790	.8
Barcol Hardness (Min.)	D-2583	35
Water Absorption (24 Hours)	D-570	2% Max.

2.08 FIBERGLASS (FRP) LOUVERS

A. Louvers furnished under this Specification apply to all louvers up to 24" x 24", and shall be shipped from the manufacturer's shop as completed units, ready for installation, packaged in cardboard or crated as required, together with mullions, trim, and accessory items which may be necessary for final installation. Field fasteners into steel or concrete to be supplied by Contractor.

B. Each piece, part, or unit shall be clearly identified with a chemical resistant tag, showing manufacturer's drawing number, part number, and location.

C. All louvers furnished under this Specification shall meet the following requirements.

Design

1. Louvers shall be fabricated from pultruded FRP structural shapes, using non-metallic pivot pins and epoxy bonded joints.

2. Adjustable louvers shall be supplied in individual units up to 48-inches wide. Fixed units shall be in widths up to 12 feet, with integral blade supports installed at 36-inch centers.

3. FRP mullion columns shall be used to subframe large openings for placement of multiple louver units. Metallic fasteners shall be Type 304 stainless steel, unless otherwise specified.

4. Standard louvers (fixed and adjustable) shall be 4-inches deep using "storm-proof" type blades, with a blade angle of 35 from the horizontal when open, and 45 percent minimum free area.

5. Standard manual lever-type positive locking operators shall be used on each adjustable unit. Spring and chain, gang, and air cylinder operators are available and should be so specified when required.

6. 1/2-inch mesh PVC bird screen shall be shop installed.

Material

1. All material supplied under this Specification shall be made from premium grade, chemical resistant, fire retardant, glass reinforced structural members, utilizing a synthetic surface mat to minimize the effects of ultraviolet degradation.

   a. Flame-spread - 25 max. (ASTM E-84)

   b. Pigmented grey throughout

      Mechanical properties:

(1)	Ultimate tensile strength	30,000 psi
(2)	Ultimate compressive strength	30,000 psi
(3)	Modulus of elasticity	2.5×10^6
(4)	Barcol hardness	50

2. Nonstructural fasteners shall be nylon, structural fasteners shall be 316 stainless steel, unless otherwise specified.

Workmanship

1. All cut edges and holes shall be sealed with a compatible resin.

2. All work shall be square and true; blades shall not bind in operation.

3. Surfaces shall be free of fiber blemish.

Source

1. Louvers shall be as manufactured by IMCO Reinforced Plastics, Inc., 858 N. Lenola Rd., Moorestown, N.J. 08057, or approved equal.

2. Manufacturer shall submit Shop Drawings for approval, and fabrication shall not proceed until time of approval by the purchaser or other authority.

2.09 MANHOLE LADDERS

A. The ladders shall be of fiberglass construction with pultruded structural channel shapes, non skid grit surfaces used on top surface of each rung and a synthetic surfacing veil for chemical and ultraviolet resistance and high strength. Ladders shall possess Class one fire retardant, with an ASTM E-84 flame-spread rating of 25 maximum and shall conform to OSHA 1910.27. Color shall be safety yellow (beige for immersed ladders).

B. Ladders shall utilize channel side rails and 1-3/8 inch minimum diameter round rungs. Rung to side connections shall utilize a keyed, pinned and bonded joint for prevention of rung rotation and pullout. The ladders shall be attached to the bracket angles with two stainless steel bolts, washers and nuts per angle bracket.

C. Concrete anchors shall be minimum 5/8 inch diameter with 3 inch embedment and shall comply with Section 05050, Metal Fastening. Fiberglass pultruded parts shall be ISOFR except for sodium hypochlorite and hydrofluosilicic acid applications where VEFR shall be used. Shades shall be manufactured by Strongwell, Inc., or equal. Ladders shall conform to OSHA requirements and to the details shown on the Drawings.

2.10 FIXED LADDERS

A. The Contractor shall provide fixed ladder systems with all safety cages, landings, mounting clips, fasteners, and necessary appurtenances for a complete and rigid installation.

B. The ladder systems shall be designed to meet or exceed all OSHA requirements.

C. Ladders and cages shall be fabricated from pultruded shapes conforming to ISOFR except for sodium hypochlorite and hydrofluosilicic acid applications where VEFR shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

D. Ladder side rails shall be fabricated from channel members or 1-3/4 inch minimum square tube.

E. Side rails shall be anchored with FRP standoff clips manufactured of polyester resin except for sodium hypochlorite and hydrofluosilicic acid applications where vinyl ester resin shall be used. Clips shall be placed at the top and bottom of the ladder and at 6 foot maximum vertical centers.

F. Rungs

1. Rungs shall be 18 inches long, serrated and covered with a silica grit to produce and ant-skid surface.

2. Rungs shall be uniformly spaced at 12 inches on center.

3. Rungs shall be designed to support a 1,200-pound vertical load applied at midspan.

4. Rungs shall be both mechanically attached, and epoxy bonded to the side rails.

G. Fall prevention system and anti-climb guard shall be as specified in Section 05515, Ladders.

2.11 CONNECTIONS

A. All connections shall be non-corrosive, non-staining, and concealed where practicable, as detailed on the Drawings or specified herein.

B. Fiberglass fasteners shall be "Fibrebolt", as manufactured by Strongwell, Inc., or equal.

C. All metal fasteners shall be Type 316 stainless steel, except for sodium hypochlorite and hydrofluosilicic acid applications, Hastelloy C-276 or fiberglass fasteners where manufacturer recommends shall be used unless noted otherwise.

D. Holes for bolts and screws shall be drilled.

E. Joints exposed to weather shall be formed to exclude water.

F. Design and installation of fiberglass items shall provide for expansion and contraction, prevent shearing of bolts, screws and other fastenings, and provide close fitting of sections.

2.12 STRUCTURAL SHAPES AND FLAT SHEETS

A. Shapes shall conform to sizes indicated on Drawings and shall be ISOFR except for sodium hypochlorite applications where VEFR shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

B. Metal bolted connections shall be made with stainless steel bolts except for sodium hypochlorite and hydrofluosilicic acid applications where Hastelloy C bolts or fiberglass fasteners where manufacturer recommends shall be used. Bolts shall conform to Section 05050, Metal Fastening.

C. Adhesive bonded connections shall be made with a compatible epoxy adhesive following manufacturer's instructions. Adhesive bonded connections shall only be used where bolted connection are not feasible.

2.13 FRP HANDRAIL

A. Fiberglass reinforced plastic (FRP) handrail system shall be designed by the Contractor to meet or exceed OSHA requirements with a minimum safety factor equal to 2 and shall be furnished and installed as shown on the Contract Drawings. All rails, posts, kick plates, base plates, fasteners, and necessary appurtenances for a complete and rigid installation shall be provided and installed per manufacturer's recommendations. Handrail systems

shall be manufactured by Strongwell, Inc., Bristol, VA, R.W. Fowler Company, Atlantic Beach, FL, IMCO Reinforced Plastics, Inc., Moorestown, NJ, or equal.

B. The handrail system shall consist of pultruded fiberglass shapes manufactured with the following minimum properties:

Properties	Test Method	Value
Tensile Stress	ASTM D638	30,000 psi
Tensile Modulus	ASTM D638	2.5×10^6 psi
Compressive Strength	ASTM D695	30,000 psi
Compressive Modulus	ASTM D695	2.5×10^6 psi
Flexural Stress	ASTM D790	30,000 psi
Flexural Modulus	ASTM D790	2.0×10^6 psi
Shear Stress	ASTM D2344	4,500 psi
Density	ASTM D792	.070 lbs/in^3
24 hr. Water Absorption	ASTM D570	0.6% max
Coeff. of Thermal Expansion	ASTM D696	6×10^6 in/in/EF
Barcol Hardness		50

C. The handrail system shall have two (2) rails, unless otherwise noted on the Contract Drawings, with the top rail located 42 inches above the walking surface. Rails shall be 1-3/4” minimum square tubing and posts shall be 2" minimum square tubing with internal fittings for all connections. Kick plates shall be provided where required by OSHA. All rail and kick plate corner joints shall be mitered at a 45° angle and securely fastened to posts. Maximum horizontal spacing between posts shall be 4 feet. For stair rail, the top rail shall be not less than 34 inches nor more than 38 inches above the leading edge of the stair tread.

D. Handrails shall be erected with true horizontal and vertical alignment and shall be smooth and free of surface defects. All cut edges and holes shall be sealed with a compatible resin system.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All cut edges and holes shall be sealed with a compatible resin.

B. All FRP items shall conform to the dimensions indicated on the Drawings.

C. All fiberglass items described in this Section shall be supplied by a manufacturer that normally fabricates such items so that appearance and quality control are first class.

3.02 HANDLING, TRANSPORTING, AND STORING

A. All FRP items shall be properly packed, labeled and stored in accordance with Divisions 1 and 11, and where directed by the Engineer.

3.03 INSTALLATION

A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.

B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.

C. Weirs and baffles shall be installed in full accordance with the manufacturer's recommendations. Joints between weir plates and concrete and butting weir plates shall be watertight. The Contractor shall seal all weirs with caulk approved by the Engineer after weirs are set, checked for level, and are within specified tolerances.

- END OF SECTION -

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SECTION 07100

WATERPROOFING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Waterproofing on the exterior sides of walls below grade as shown on the Drawings.

2. Crystalline waterproofing as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1.	ASTM D146	Sampling and Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use in Waterproofing and Roofing
2.	ASTM D412	Tests for Rubber Properties in Tension
3.	ASTM E96	Tests for Water Vapor Transmission of Materials in Sheet Form

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturers product literature, specification data sheets and installation instructions.

2. Samples of composite drainage panel and waterproofing.

3. Complete layout and installation drawings and schedules with clearly indicated dimensions.

4. Detail drawings showing all anchoring details and construction details at corners, penetrations and flashing.

1.05 DELIVERY, STORAGE AND HANDLING

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A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.

B. Store materials in dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have been damaged and remove from the job site.

PART 2 -- PRODUCTS

2.01 CRYSTALLINE WATERPROOFING

A. Crystalline Waterproofing: Concrete waterproofing material of the cementitious crystalline type that chemically and permanently fixes non-soluble crystalline growth throughout the capillary voids of the concrete. Apply at a rate of 2 lb./sq. yd. Apply second coat while first coat is still green. Crystalline waterproofing shall be as manufactured by Xypex Chemical Corporation, Vandex, HEY'DI K11 by Tamms, or equal.

PART 3 -- EXECUTION

3.01 EXAMINATION OF SURFACES

A. Examine all surfaces and installation of work done by other trades.

B. Coordinate all work under this Section with contiguous work of other trades.

3.02 APPLICATION

A. Crystalline waterproofing shall be applied to "green" or existing concrete which has been thoroughly saturated with clean water. Prepare surfaces in strict accordance with manufacturer's recommendations and instructions. Mix and apply in accordance with manufacturer's literature.

- END OF SECTION -

SECTION 07150

DAMPPROOFING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of work as shown on Drawings and specified herein.

B. Principal items of work include:

1. Dampproofing on exterior side of interior wythe of masonry cavity walls above grade.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. ASTM D 449 Standard Specification for Asphalt Used in Dampproofing and Waterproofing

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the Section 01300, Submittals, submit the following:

1. Manufacturers product literature, specification data sheets and installation instructions.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.

B. Store materials in dry location to prevent damage or intrusion of foreign matter. Remove damaged materials from the job site.

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PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject with compliance with the Specifications provide products from one of the following:

1. Karnak Corp.

2. W.R. Meadows

3. Koch Materials Co.

4. BASF Master Builders Solutions

2.02 MATERIALS

A. Asphalt Primer: Type recommended by manufacturer.

B. Dampproofing: Non-asbestos, fibrated mastic conforming to ASTM D-1227, Type II, Class 1, compatible with cavity wall insulation.

PART 3 -- EXECUTION

3.01 EXAMINATION OF SURFACES

A. Examine all surfaces and installation of work done by other trades.

3.02 APPLICATION

A. Prime surfaces with manufacturers recommended primer. Apply dampproofing at the rate of 6 gallons per 100 square feet.

B. Apply dampproofing to substrates to provide a complete moisture resistant coating.

3.03 PROTECTION

A. Protect building from damage resulting from spillage, dripping and dropping of materials. Repair work damaged during dampproofing operations.

B. Take precautions against fire and other hazards during delivery, storage and installation of flammable materials. Comply with local ordinances and fire regulations in the installation of hazardous materials.

3.04 CLEANING

A. Clean adjacent materials and finishes which have been soiled.

- END OF SECTION -

SECTION 07190

VAPOR BARRIER

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, material, equipment and appliances required for complete execution of Work.

B. Principal items of work include:

1. Vapor barrier below structural slabs on grade.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's data and installation instructions.

PART 2 -- PRODUCTS

2.01 VAPOR BARRIER

A. Vapor Barrier: A reinforced laminate membrane with a minimum tensile strength of 75 lbs/in. in accordance with ASTM D-882, vapor transmission rating of 0.02 perms in accordance with E-96, and a puncture resistance of 25 lbs in accordance with ASTM D-4833.

B. Adhesive/Tape: Type approved by the Manufacturer of the vapor material.

C. Penetration sealing: Provide manufacturer’s recommended penetration seals at all pipe, conduit, and similar penetrations.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Viper Vapercheck 10 by Insulation Solutions, Inc.

2. Griffolyn Type-85, by Reef Industries, Inc.

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3. Or Equal

PART 3 -- EXECUTION

3.01 VAPOR BARRIER

A. Vapor barrier shall be placed on top of 4 inches minimum of compacted structural fill stone, free of debris and protrusions for structural slabs.

B. Lap edges 12 inches and seal with adhesive tape. Lay with seams perpendicular to and lapped in the direction of placement. Do not penetrate vapor barrier.

C. Protect from damage until concrete is placed. Punctures and tears in vapor barrier shall be repaired using patches of the material which overlaps puncture or tear a minimum of 12 inches; seal with tape or adhesive.

D. Penetrations through vapor barrier, such as pipe, drains, conduits and similar penetrations, shall be sealed in strict accordance with manufacturer's recommended instructions.

- END OF SECTION -

SECTION 07210

BUILDING INSULATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to applicable requirements of the following documents:

1.	HH-I-526C	Insulation Board, Thermal (Mineral Fiber).
2.	HH-I-1972/1	Insulation Board, Thermal, Polyurethane or Polyisocyanurate, Faced with Aluminum Foil On one side.
3.	TT-S-001657	Sealing Compound Single Component, Butyl Rubber Based, Solvent Release Type (For Buildings and other Types of Construction).
4.	ASTM C 578	Specification for Preformed, Block Type Cellular Polystyrene Thermal Insulation
5.	ASTM C 665	Specification for Mineral fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature, specifications, installation instructions, technical data, and general recommendations.

2. Samples of each type of insulation specified.

1.05 DELIVERY, STORAGE AND HANDLING

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A. Deliver materials in unopened, undamaged original packaging with bearing the manufacturer's name.

B. Store materials in clean, dry, protected areas. Do not leave materials exposed to the weather or sunlight, except to the extent necessary to perform the work.

C. Protect against ignition.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, provide products as manufactured by the following:

1. Manufacturers of Extruded Polystyrene Board Insulation

a. Amoco Foam Products Company

b. Dow Chemical U.S.A.

c. UC Industries

3. Manufacturers of Polyisocyanurate Foam Insulation

a. Apache Products Company.

b. Atlas Energy Products.

c. The Celotex Corporation.

5. Manufacturers of Sprayed Polyurethane Foam (Gap Sealant):

a. The Dow Company
b. Or approved equal

2.02 MATERIALS

A. Unit Masonry Insulation: Fill ungrouted cells of masonry with foamed in place two component thermal insulation. Insulation shall be a Class A material with an R value of 4.9 per inch. Provide masonry insulation as manufactured by CORE-FILL 500 as manufactured by Tailored Chemical Products, Hickory, NC, or acceptable equal.

B. Cavity Wall Insulation: Extruded polystyrene insulation boards meeting or exceeding the requirements of ASTM C578, Type IV, and with a "K" factor of 0.20 or less when tested in accordance with ASTM C 518. Provide insulation 1-1/2 inches thick unless otherwise shown.

C. Roof Insulation: Provide a minimum of 2" polyisocyanurate insulation. Provide a minimum of two staggered layers, unless otherwise indicated. Provide tapered insulation where roof structure does not slope. Roof insulation shall be approved by roofing manufacturer in accordance with the requirements of the roofing warranty. Roof insulation shall meet the requirements of a UL Class A and FM Class 1 roof. Insulation shall have an aged R-value of 5 per inch. Secure insulation as required by the roofing manufacturer to achieve an FM 90 installation. Install ½" glass faced gypsum board where insulation is installed over metal deck.

D. Adhesive and Fasteners: Type compatible with insulation, masonry, concrete, or other substrate and as recommended or produced by the insulation manufacturer.

E. Sealer and Tape: Type recommended by insulation manufacturer and having perm rating and fire resistance characteristics similar to that of the insulation.

F. Gap Sealant: General Purpose Type: single-component polyurethane sealant. Gun-applied and Straw-applied products, Thermal Value R3.5 per inch. Provide GREATSTUFF PRO™ Gaps & Cracks Insulating Foam Sealant as manufactured by The Dow Chemical Company or approved equal. Provide Substrate Cleaner as recommended by foam sealer manufacturer.

PART 3 -- EXECUTION

3.01 GENERAL

A. Insulation shall be provided in walls, slabs and ceilings and where shown on Drawings.

3.02 INSTALLATION OF INSULATION

A. Install in accordance with the manufacturer's printed installation instructions to provide maximum sound and thermal benefits for material specified. Install to fill or cover voids. Cut neatly to snugly fit angles, corners and irregular areas and carefully wrapped around pipes, conduits, outlets, switches, beams, etc., to maintain continuity of insulation. Avoid gaps or bridges.

B. Cavity Wall Insulation

1. On vertical surfaces of masonry adhere to inner wythe of block.

2. Joints between insulation board units shall coincide with masonry joint reinforcing.

C. Block Insulation: Install foamed in place two component thermal insulation in all ungrouted cells of masonry in exterior walls.

D. Roofing Insulation: Install roofing insulation in accordance with insulation and roofing manufacturer printed instructions and recommendations.

E. Gap Sealant: Seal all gaps at perimeter of walls and penetrations and openings. Install in strict accordance with manufacturer's recommendations. Remove excess gap sealant to finish flush with the adjacent materials where visible or required to allow installation of finish materials.

3.03 ADJUSTMENT AND CLEANING

A. Adequately protect Work from damage resulting from subsequent construction operations. Replace damaged or soiled Work.

- END OF SECTION -

SECTION 07540

SINGLE PLY MEMBRANE ROOFING (PVC OR KEE)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Preparation of roof deck to receive new roofing materials.

2. Application of insulation, and accessories.

3. Fully adhered roofing system with applied battens.

4. Twenty year "Total Roofing System Warranty".

5. Removal and cleanup of excess materials and debris.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM Designations; Stipulated under PART 2 - PRODUCTS.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, submit the following:

1. Manufacturer's Data.

2. Manufacturer's Installation Instructions.

3. Total System Warranty.

4. Dimensioned shop drawings which shall include:

a. Outline of roof with roof size and elevations shown.

b. Profile details of flashing methods for penetrations.

c. Technical acceptance from manufacturer.

5. Certification that all materials submitted are acceptable for warranty coverage indicated.

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1.04 QUALITY ASSURANCE

A. The installer must be skilled and experienced and approved by roofing membrane manufacturer for type of roofing and associated work required, and equipped to perform workmanship in accordance with recognized standards.

B. Provide periodic inspections by an official manufacturer's technical representative on all roofing and flashing. Inspections to be made at the beginning of the job and a minimum of one more while the roofing and/or flashing work is in progress to insure workmanship is in accordance with the manufacturer's specifications.

1.05 CODE REQUIREMENTS

A. Installed system shall meet all State and local codes, approved and listed to meet the following: UL class A and FM 1-90.

B. Inform all personnel working on roof of fall protection requirements. Provide all necessary equipment and training for proper use to comply.

1.06 GUARANTEE

1. Furnish to the Owner a twenty (20) year written Manufacturer's Warranty covering materials and workmanship for the entire "Roofing System", including repair and replacement of roofing components which are deemed faulty or in disrepair during the guarantee period. Such items in disrepair shall be repaired at no cost to the Owner. Cover both labor and materials necessary to effect watertightness, including that required to repair roof leaks caused by standing water, defective material or workmanship, without limit as to amount required to effect watertightness.

1.07 JOB CONDITIONS

A. Roofing products shall be installed in accordance with manufacturer’s recommended job conditions including environmental and physical.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, type, grade, class and all other qualifying information, including UL and other specified insurance agency's labels.

B. Store materials in a dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have once been wet or damaged and remove from the job site.

PART 2 -- PRODUCTS

2.01 MEMBRANE

A. Membrane shall conform to ASTM D4434-12 (or latest revision), "Standard for Polyvinyl Chloride Sheet Roofing". Classification: Type II.

1. Sarnafil $_{6}$G410-15 feltback, 59 mil (1.5 mm), thermoplastic membrane with fiberglass reinforcement and a factory applied 9 oz geotextile felt backing.

2. Sure-Flex FRS PVC Fleece BACK Membrane as manufactured by Carlisle SynTec: 115 membrane incorporating 60 mil thick fiberglass reinforced PVC membrane laminated to 55 mil non-woven fleece backing for a total thickness of 115 mils.

3. Or approved equal.

B. Color of Membrane

1. White with a Solar Reflectance Index of 78 or greater.

2.02 FLASHING MATERIALS

A. Provide flashing approved for use with manufacturer's system warranty and in accordance with manufacturer's details.

2.03 INSULATION/OVERLAYMENT/RECOVER BOARD

A. Polyisocyanurate Insulation

A rigid isocyanurate foam insulation with black mat facers.

2.04 UNDERLAYMENTS

A. Provide Dens-Deck, a siliconized gypsum, fire-tested hard board with glass mat facers or equal.

2.05 VAPOR BARRIER

A. Two layers of bituminous vapor retarder as recommended by manufacturer.

2.06 ATTACHMENT COMPONENTS

A. Membrane and Underlayment Adhesive

1. Use manufacturer's recommended adhesives for materials and substrates to be fastened.

B. Insulation Board Adhesive

1. Type III hot asphalt or other adhesive recommended by manufacturer.

C. Fasteners

1. Use manufacturer's recommended fasteners for materials and substrates to be

fastened.

2.07 MISCELLANEOUS ACCESSORIES

A. Provide all accessories recommended by the manufacturer to provide a watertight system.

2.08 RELATED MATERIALS

A. Wood Nailer

Treated wood nailers shall be installed at the perimeter of the entire roof and around such other roof projections and penetrations as specified on Project Drawings. Thickness of nailers must match the insulation thickness to achieve a smooth transition. Wood nailers shall be treated and be #2 quality or better lumber. Creosote, CCA, or asphalt-treated wood is not acceptable. Wood nailers shall conform to Factory Mutual Loss Prevention Data Sheet 1-49. All wood shall have a maximum moisture content of 19% by weight on a dry-weight basis.

PART 3 -- EXECUTION

3.01 SURFACE PREPARATION

A. Installer shall notify Design/Builder, in writing, of defects in the substrate, and work shall not proceed until defects have been corrected. The starting of work implies the acceptance of such surfaces.

B. Construction work on the roof shall be complete before the roofing operations commence. The roof surfaces shall be clean, smooth, dry, and free from loose and foreign materials, dirt, oil, grease, and holes.

C. Surface joints (including walls and substrate) shall be 1/4-inch or less in width. Repair all joints wider than 1/4-inch with approved joint filler before proceeding with installation.

D. Vents and all other projections through the roof shall be secured in position before roofing is commenced.

3.02 INSTALLATION

A. Roofing shall be furnished and installed in compliance with U.L. Class "A" requirements. Manufacturer's instructions for the installation of such roofing system shall be strictly adhered to. All accessories necessary to complete the installation shall be provided.

B. The roofing shall be applied and finished in one area in a continuous operation. Care shall be taken to insure that water does not flow beneath any completed sections of roof. Loose edges of membrane shall be temporarily sealed with an approved night seal when the weather is threatening. When work is resumed, the sheet shall be pulled free before continuing installation.

C. Roofing and flashing installation at the junction of all parapet walls, curbs, and other roof

openings shall be in accordance with the roof membrane manufacturer's standard details unless shown otherwise on the Drawings. Typical details of all actual roof conditions shall be submitted for approval prior to membrane installation.

3.03 WOOD NAILER INSTALLATION

A. Install continuous wood nailers at the perimeter of the entire roof and around roof projections and penetrations as shown on the Detail Drawings.

B. Nailers shall be anchored to resist a minimum force of 300 pounds per lineal foot in any direction. Individual nailer lengths shall not be less than 3 feet long. Nailer fastener spacing shall be at 12 inches on center. Fasteners shall be staggered 1/3 the nailer width and installed within 6 inches of each end. Two fasteners shall be installed at ends of nailer lengths. Nailer attachment shall meet this requirement and that of the current Factory Mutual Loss Prevention Data Sheet 1-49.

C. Thickness shall be as required to match substrate or insulation height to allow a smooth transition.

3.04 VAPOR BARRIER INSTALLATION

A. Conduct moisture and adhesion tests in accordance with industry guidelines. If test requirements are met, prime the deck with asphalt primer, let dry and then adhere a base sheet with full mopping of Type III hot asphalt at a minimum rate of 25 lbs. per 100 square feet (1.2 kg/m²). Install a second ply in the same manner and then seal with an asphalt glaze coat. The base sheet and asphalt shall be installed in accordance with the manufacturer's instructions. The new insulation board shall be attached with additional Type III hot asphalt or by mechanical fasteners to the roof deck.

3.05 INSULATION INSTALLATION

A. Insulation shall be installed according to insulation manufacturer's instructions.

B. Insulation shall be neatly cut to fit around penetrations and projections.

C. Install tapered insulation in accordance with insulation manufacturer's shop drawings.

D. Do not install more insulation board than can be covered by the roofing membrane by the end of the day or the onset of inclement weather.

3.06 INSTALLATION MEMBRANE

A. Inspect the surface of insulation prior to install of the roof membrane. The substrate shall be clean, dry, free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation boards shall be removed and replaced.

B. Apply adhesive and membrane in strict accordance to roofing manufacturer’s instructions and recommendations. Membrane shall be applied with no air pockets or wrinkles.

C. Mechanically fasten roof system 4’-0” from all roof edges along the entire perimeter

using manufacturer recommended termination bar fastened 12” o.c. and with a welded cover strip.

3.07 HOT-AIR WELDING OF SEAM OVERLAPS

A. Welding: All seams shall be hot-air welded. Seam overlaps should be 3 inches (75 mm) wide when automatic machine-welding and 4 inches (100 mm) wide when hand-welding, except for certain details. All membrane to be welded shall be clean and dry. Welding shall be accomplished in strict accordance with manufacturer’s recommendations.

B. Quality Control of Welded Seams: Applicator shall check all welded seams for continuity using a rounded screwdriver. Visible evidence that welding is proceeding correctly is smoke during the welding operation, shiny membrane surfaces, and an uninterrupted flow of dark grey material from the underside of the top membrane. On-site evaluation of welded seams shall be made daily by the applicator including taking one inch (25 mm) wide cross-section samples of welded seams. Correct welds display failure from shearing of the membrane prior to separation of the weld. Each test cut shall be patched by the Applicator at no extra cost to the Owner.

3.08 MEMBRANE FLASHINGS

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and manufacturer’s representative. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at no expense to the Owner. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution to ensure adhesive fumes are not drawn into the building. Apply flashing in strict accordance with manufacturer’s instructions.

B. All flashings shall extend a minimum of 8 inches (0.2 m) above roofing level.

C. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded into place. No bitumen shall be in contact with the Sarnafil membrane.

3.09 METAL FLASHINGS

A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:

1. Factory Mutual Loss Prevention Data Sheet 1-49 (latest issue).

2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

B. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.

C. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.

D. Metal joints shall be watertight.

E. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood nailer a minimum of 1 inch (25 mm).

F. Hook strips shall extend past wood nailers over wall surfaces by 1½ inch (38 mm) minimum and shall be securely sealed from air entry.

3.10 COMPLETION

A. The Owner and manufacturer's representative shall review the work at completion. All defects noted and non-compliances with the Specifications or the recommendations of manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Installer to the satisfaction of the Owner and manufacturer. All work shall comply with warranty including necessary reviews prior to installation.

- END OF SECTION -

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SECTION 07600

FLASHING AND SHEET METAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 - Unit Masonry

B. Section 07450 – Single Ply Membrane Roofing

C. Section 07700 – Roof Specialties and Accessories

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCES SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1.	OF-506C	Flux, Soldering, Paste, and Liquid
2.	ASTM A176	Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip
3.	ASTM B32	Specifications for Solder Metal
4.	ASTM D1187	Test Method for Asphalt-Base Emulsions for use as Protective Coatings for Metal
5.	"Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association.	

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and installation instructions.

2. Complete layout and installation Drawings and schedules with clearly indicated dimensions.

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3. Color samples.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a clean dry protected area in such manner to preclude damage by denting, warping, or other distortion.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Metal Flashing

1. Exposed to View: Provide prefinished 0.050 inches aluminum. Finish shall be dark bronze anodized in accordance with AA-C22A44, Class 1. Provide a full-strength Kynar 500 baked-on paint finish with a 20 year warranty where additional color selections are required.

2. Concealed from View: Provide a minimum of 22 ga. galvanized. steel sheet, stainless steel sheet, or mill-finished aluminum sheet.

B. Nails, screws, rivets, bolts and other fasteners: same material as sheet metal being attached. Nails shall be 18 gauge diameter shank, 1/4 inch diameter flat head, annular-thread, diamond point, long enough to penetrate backing by at least 1 inch. Nails shall be spaced 3 inches on center unless other spacing is indicated. Exposed fasteners shall match finish of metal being fastened.

C. Reglets shall be formed of 300 series stainless steel, minimum of 0.020 inch. Reglets shall be Model CO for insertion in concrete, MA-4 for insertion in masonry as manufactured by FRY Reglet Corporation. Corners shall be factory made, mitered and sealed. Furnish reglets to proper trade in sufficient time to be incorporated into the masonry or concrete work.

D. Plastic cement shall conform to ASTM D4586.

E. Sealants shall be silicone type.

F. Sealer tape shall be polyisobutylene tape specifically manufactured for setting flanges on bituminous roofing such as Morrison and Company CL-50.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Shop fabricate Work to greatest extent possible. Comply with details shown and applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry standards. Fabricate for waterproof and weather resistant performance; with expansion

provisions for running work, sufficient to permanently prevent leakage, and damage or deterioration of the work. Comply with material manufacturer's instructions and recommendations for forming material. Form exposed work without excessive oil-canning, buckling and tool marks, true to line and levels as indicated, with exposed edges folded back to form hems.

B. Roof penetration sheet metal work shall be provided and coordinated with the roofing system. The design and details shall conform to SMACNA "Architectural Sheet Metal Manual". Sheet metal items shall be built into roofing in strict accordance with the instructions of the roofing manufacturer.

- END OF SECTION -

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SECTION 07700

ROOF SPECIALTIES AND ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 06100 – Rough Carpentry

B. Section 07415 – Standing Seam Metal Roofing and Wall Panels

C. Section 07600 - Flashing and Sheet Metal

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. TT-P-641 (1) Primer Coating, Zinc Dust - Zinc Oxide (for galvanized surfaces

2. ASTM A 525 Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.

3. ASTM A 526 Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

4. ASTM B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

5. Sheet Metal and Air Conditioning Contractors National Association "Architectural Sheet Metal Manual" (ASMM).

6. The Aluminum Association "Specification for Aluminum Sheet Metal Work in Building Construction."

7. American Welding Society (AWS).

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1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Manufacturers literature and installation instructions.

2. Samples, of each material listed.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in factory packed unopened cartons and crating bearing the manufacturer's labels.

B. Store materials in clean, dry protected area in such manner to preclude damage of any nature.

C. Handle all materials with proper care to avoid denting, marring, warping or other distortions during delivery, storage and handling.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. General: Provide roof specialties and accessories of design and construction compatible and approved for use with roofing manufacturer.

B. Fasteners: Provide all fasteners and attachments required to secure item to substrate and support loads required by applicable Building Code. Use only non-corrosive fasteners which are compatible with materials being joined.

C. Colors: Colors shall be selected by Owner.

2.02 ROOF CURBS

A. Material: 18 gauge, G-90 galvanized steel, 12 inches high with mitered and continuous welded corners and seams, factory installed pressure treated wood nailers, and rigid fiberglass insulation.

B. Design: Provide roof curb units manufactured to fit manufactured roof panels. Provide integral water diverter. Design roof curb to support weight of equipment. Coordinate roof curb unit with roof panel manufacturer to ensure proper fit. Roof curb shall be approved for use by manufacturer.

C. Accessories: Provide interior liner, flashing, trim and other items required for a complete installation.

2.03 GRAVEL STOPS

A. Fascia: 0.050 inches extruded aluminum of 6063-T5 alloy.

B. Cant Dam: Commercial 24 gauge galvanized steel.

C. Concealed Splice Plates: 0.032 inches aluminum and finished to match fascia. Allow 1/4" at ball butt joints per twelve feet of length for expansion.

D. Accessories

1. Prefabricated Corners: Provide manufacturer's standard mitered and welded units.

2. Scuppers: Manufacturer's standard.

E. Finish: Color Anodized in accordance with AA-C22A44, Class 1 or Clear Anodized in accordance with AA-C22A41 or "Baked" on Kynar, with 20 year warranty.

2.04 COPINGS

A. Material: 0.050 inches aluminum with smooth surfaces.

B. Splice Plate: Aluminum and finished to match coping. Provide six inch wide units at twelve foot centers with extruded butyl seal strips.

C. Anchor Plate: Galvanized steel. Anchor to substrate with anchors as recommended by manufacturer.

D. Finish: Color Anodized in accordance with AA-C22A44, Class 1. *** or Clear Anodized in accordance with AA-C22A41 or “Baked" on Kynar, with 20 year warranty.

E. Guarantees: Twenty year performance guarantees relative to blow-off, leaktightness and finish.

PART 3 -- EXECUTION

3.01 INSTALLATION - GENERAL

A. Install roof accessories and specialties in accordance with the manufacturer's instructions. Provide a complete watertight and weatherproof installation. Install with provision for expansion and contraction.

3.02 DAMAGED MATERIAL

A. Repair or replace materials damaged during installation.

3.03 ADJUSTING AND CLEANING

A. Check levels and adjust as necessary after roofing and flashing is complete.

B. Protect materials from damage by other trades. Remove protective coatings at completion of project.

- END OF SECTION -

SECTION 07900

JOINT FILLERS, SEALANTS AND CAULKING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03250 - Concrete Accessories

B. Section 03290 - Joints in Concrete

C. Section 08800 - Glass and Glazing

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C-920 Elastomeric Joint Sealants

2. ASTM D-1056 Flexible Cellular Materials - Sponge or Expanded Rubber

3. SWRI Sealant and Caulking Guide Specification

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:

1. Manufacturers literature and installation instructions.

2. Color samples of each type of sealant.

1.05 QUALITY ASSURANCE

A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years experience.

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1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in unopened labeled packages.

B. Store materials in location protected from freezing or damages.

C. Reject and remove from the site materials within broken or damaged packaging.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Sealants

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.

2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by BASF Construction Chemicals.

3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by BASF Construction Chemicals.

4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by BASF Construction Chemicals.

5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by BASF Construction Chemicals.

6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.

7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.

8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, Sonolastic Ultra by BASF Construction Chemicals.

B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.

C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.

D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.

E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.

F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 -- EXECUTION

3.01 QUALITY CONTROL

A. Coordinate work with details shown on approved shop drawings prepared by other trades.

B. Verify conditions in the field.

C. Schedule work to follow closely the installation of other trades.

D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.

E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

3.02 PREPARATION

A. Protect finished surfaces adjoining by using masking tape or other suitable materials.

B. Clean and prime joints before starting any caulking or sealing work.

C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.

D. Joint Requirements

1. All joints and spaces to be sealed in exterior work shall be less than 1/2 inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.

2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the

surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4 inch deep, the back-up material may be omitted, a bond breaker substituted and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4 inch depth of the open space in any joint. The following width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

	Sealant Depth	
Joint Width	Minimum	Maximum
¼ inch	1/4 inch	1/4 inch
Over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
Over 1/2 inch to 1 inch	1/2 inch	Equal to width
Over 1 inch to 2 inch	1/2 inch	1/2 of width

3.03 APPLICATION

A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.

B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.

C. All joints shall be waterproof and weathertight.

D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.

E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.

F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.04 ADJUSTMENT AND CLEANING

A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.

B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

3.05 SCHEDULE

Schedule of Sealants

Application	Sealant	Color
Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings.	Type 1	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural stone or other porous building material, unless noted otherwise herein or on Drawings.	Type 2	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints less than 1¼" wide.	Type 2	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints equal or greater than 1¼ inches wide and not to exceed 2”.	Type 1	To closely match adjacent surfaces and as selected by the Owner.
Interior – wood trim and finish joints.	Type 5	Color to be selected by Owner
Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes. See Note 1.	Type 4	To closely match adjacent surfaces and as selected by the Owner.
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. See Note 2.	Type 2 OR Type 3	To closely match adjacent surfaces and as selected by the Owner.
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. See Note 4.	Type 1	Manufacturer's standard
Submerged in liquids with high concentration of chlorine (> 2 ppm).	Type 7	Manufacturer’s standard
Horizontal Joints exposed to vehicular or pedestrian traffic.	Type 8	To closely match adjacent surfaces.

Application	Sealant	Color
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the Owner.

Note 1. Sealant for Laboratory Countertop shall be as recommended by countertop manufacturer.

Note 2. Provide UL approved sealants for penetrations thru fire-rated walls and as specified in Section 07270.

Note 3. Sealants which will come in contact with potable water shall meet the requirements of NSF 61.

Note 4. Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

- END OF SECTION -

SECTION 08110

STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, material, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 - Unit Masonry

B. Section 08710 - Finish Hardware

C. Section 08800 - Glass and Glazing

D. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications, the work shall conform to the applicable requirements of the following documents:

1.	ANSI/DHI A115	Series Specifications for Steel Door and Frame Preparation for Hardware
2.	ANSI/SDI 100	Recommended Specifications: Standard Steel Doors and Frames
3.	ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4.	ASTM A366/A 366M	Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality
5.	ASTM A525	Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
6.	ASTM E152	Standard Methods of Fire Tests of Door Assemblies
7.	NFPA 80	Standard for Fire Doors and Windows

1.04 SUBMITTALS

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A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Manufacturer's product data.

2. Complete layout and installation drawings and schedules with clearly marked dimensions. Indicate details of construction, profiles, gauges, reinforcing and location of doors and frames.

3. Certify that shop applied primer is compatible with finish coats specified in Section 09900, Painting.

1.05 QUALITY ASSURANCE

A. Comply with ANSI/SDI 100.

B. Locations where fire-rated door and frame assemblies are required, provide assemblies which comply with NFPA 80 and have been tested and labeled in accordance with ASTM E152 by agency acceptable to governing authorities.

C. Provide certificate or label for fire-rated doors which exceed sizes tested from a independent testing and inspection agency. Certificate or label shall indicate that door and frame assembly conforms to the requirements of the design.

D. Provide stairwell doors which have temperature rise rating of 450 degrees F maximum in 30 minutes of fire exposure.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products boxed or crated suitable for storage.

B. Store products under cover, raised above ground level, and stacked to prevent warping and damage.

C. Replace items damaged during delivery, storage, or handling.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Curries Company, Mason City, Iowa

2. Amweld Building Products, Inc.

3. Steelcraft, Cincinnati, Ohio

2.02 MATERIALS

A. Steel Sheets: Commercial quality hot or cold rolled. Galvanize sheet steel in accordance with ASTM A525, commercial quality, A60 zinc coating, mill phosphatized.

B. Anchorages: Galvanized steel, minimum 18 gauge.

C. Fasteners and Inserts: Galvanized units standard with manufacturer.

D. Primer: Rust-inhibitive coating, suitable to receive finish coatings specified in Section 09900, Painting.

2.03 FABRICATION, GENERAL

A. Shop-fabricate assemblies to greatest extent possible.

B. Fabricate exterior and interior doors, frames and louvers from hot-dip galvanized steel.

C. Where exposed screws and fasteners are used, provide countersunk, flat Phillips-head fasteners.

D. Fabricate exterior, vestibule and other doors indicated to be insulated in the schedule with foam in place insulation. Door and frame assembly shall have a maximum calculated core U-Value of 0.10 BTU per hour per square foot per degree F in accordance with ASTM C518.

E. Comply with ANSI/DHI A115 series specifications for door and frame hardware preparation. Prepare door and frame using final hardware schedule and templates from hardware supplier.

F. Shop Painting

1. Clean surfaces thoroughly before beginning painting operations, removing rust, scale, oil, grease and other contaminants.

2. Apply primer evenly to provide full protection of all exposed surfaces.

2.04 STEEL (HOLLOW METAL) DOORS

A. Provide doors of size and style indicated.

1. Exterior Doors: SDI-100, Grade III, extra heavy-duty, Model 4, seamless, 16 gauge for doors less than four feet wide and 14 gauge for doors greater than four feet wide.

2. Interior Doors: SDI 100, Grade II, heavy-duty, Model 3, seamless, 18 gauge for doors less than four feet wide and 16 gauge for doors greater than four feet wide.

B. Top and bottom closures on all doors and a weather tight cap on all exterior doors.

C. Where indicated, provide doors with sightproof and weatherproof louvers formed of 24 gauge galvanized steel. Provide louvers with 50% free area, Exterior doors indicated to have louvers shall include an 18x14 aluminum insect screen.

D. Glass lite kits shall be provided to accommodate glass shown or specified. Fame material shall be 20 gauge (minimum) cold rolled steel with mitered corners.

2.05 STEEL (HOLLOW METAL) DOOR FRAMES

A. Fabricate door frames with mitered and welded corners.

B. Provide concealed fastenings, unless otherwise indicated.

C. Provide galvanized plaster guards or mortar boxes at back of finish hardware cutouts.

D. Drill frames to receive three silencers on strike jamb of side swinging doors, and two silencers on heads of double doors, unless doors are to receive weatherstripping.

E. Provide a minimum of three jamb anchors per jamb for doors 96 inches or less in height and one additional anchor for each additional 24 inches of height.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All doors and frames specified herein shall be neatly installed in designated locations indicated on Drawings.

B. Install frames in accordance with SDI-105 and as herein specified.

C. Install doors in accordance with SDI-100 and as herein specified.

D. Install fire-rated doors and frames in accordance with NFPA 80.

3.02 PROTECTION AND CLEANING

A. Provide protection against stains, dirt or damage to the finished installation. Adjust doors for proper operation.

B. Immediately after erection and prior to finish painting, remove rusted or damaged prime coat and apply touch-up primer compatible with original primer and final coats.

- END OF SECTION -

SECTION 08710

FINISH HARDWARE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 08110 – Steel Doors and Frames

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:

1. ANSI/BHMA 156

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturers data for each item of hardware. Include installation and maintenance instructions.

2. Furnish templates to fabricators of other work which is to receive hardware.

3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules and similar information has been completed and accepted.

4. Prepare a keying schedule in consultation with the Owner.

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1.05 QUALITY ASSURANCE

A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.

B. Replace any item of finish hardware which cannot be installed or will not function properly.

C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.

D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.

E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

1.06 DELIVERY, STORAGE AND HANDLING

A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.

B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.

C. Provide secure storage area for hardware.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FABRICATION

A. Hand of Door

1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.

B. Manufacturer's Name Plate

1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.

C. Base Metals

1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.

D. Fasteners

1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self tapping sheet metal screws, except as specifically indicated.

2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.

3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion of deterioration of finish hardware, base material or fastener.

E. Tools for Maintenance

1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builder’s hardware.

F. Hardware Finishes

1. Stainless steel, US32D unless otherwise noted.

2. Closers shall have a USP finish unless otherwise noted.

G. Field Checks

1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

2.02 DESCRIPTION OF PRODUCTS

A. Hinges

1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.

2. Sizes and weights of hinges:

a. Doors up to 36 inches – 4-1/2 inches regular weight.

b. Doors 36 inches to 40 inches – 5 inches regular weight.

c. Doors 40 inches to 48 inches – 5 inches heavy weight.

d. Fire Rated Doors up to 36 inches – 5 inches regular weight.

3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.

4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware

B. Locksets and Latchsets

1. Stainless steel, heavy-duty mortise type conforming to ANSI A156.13 Series 1000, Grade 1.

2. Wrought steel box strikes.

3. Stainless steel deadbolt with 1" throw approval.

4. 2 3/4 inch back set, 3/4 inch throw, two-piece anti-friction latchbolt.

5. Non-ferrous critical internal parts.

6. Cylinders shall be manufactured to conform to grand master key program.

7. Trim Design: LWM with wrought escutcheon by Corbin\Russwin or equal lever with return. Provide knurling on all levers leading into hazardous rooms and electrical rooms.

8. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage

C. Keys and Keying

1. Provide construction keyed, removable core master key system as directed by the Owner.

2. Furnish four core removal keys and a quantity of master keys as directed by the Owner, not to exceed ten each per group. Furnish a minimum of 15 change keys per cylinder.

3. Furnish cylinders with six pin cores.

4. Provide a key schedule showing all key numbers and spaces to which each permits entry. The schedule, along with key gathering envelopes containing keys for each lock endorsed with lock number and space designation, shall be turned over to the Owner. Establish a construction master key, and apply to locks and cylinders.

5. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage

D. Panic Hardware

1. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction.

2. ANSI A156.3, Grade 1.

3. Exterior trim to closely match locksets.

4. Single/active doors: mortise type.

5. Double doors: concealed verticle rod.

6. ANSI Function 08.

7. Acceptable manufacturer's: Von-Duprin, Adams Rite Manufacturing Company, Corbin/Russwin

E. Closers

1. Cast iron case with seamless one-piece forged steel spring tub.

2. Heavy duty forged steel arm.

3. Non-sized fully adjustable from size 1-6.

4. Backcheck intensity and location valves.

5. Delayed action closing.

6. Full metal cover.

7. Mechanical hold open device, except at fire rated doors.

8. ANSI 156.4, Grade 1.

9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.

10. Provide mounting brackets, and fasteners required for proper attachment.

11. Provide closers at fire rated doors.

12. Acceptable manufacturers: Corbin/Russwin, LCN, Norton

F. Overhead Door Holder

1. Heavy duty bronze, surface mounted with positive grip holder.

2. Track: extruded bronze.

3. Degree of opening: 85 - 110.

4. Finish: Satin Chrome Plated.

5. Acceptable manufacturers: Corbin/Russwin, Glynn-Johnson, Norton.

G. Door Stops and Bumpers

1. Finish: Satin chrome plated.

2. Floor mounted door stops.

   a. Acceptable manufacturers and products: H.B. Ives 444, Hager Hardware Model 267F, and Glynn-Johnson Model FB36.

3. Wall bumpers

   a. Acceptable manufacturers and products: H.B. Ives Model 407, Hagar Hardware Model 234W, and Glynn-Johnson Model 60C.

H. Automatic Flush Bolts

1. U.L. listed.

2. Forged brass or stainless steel construction, 1/2" diameter flattened bolt tip, 12" long rod.

3. Fully automatic.

4. Operation shall incorporate an override function.

5. Tested for a minimum of 100,000 cycles.

6. Provide dust proof strikes.

7. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

I. Coordinator

1. U.L. labeled and tested for 100,000 cycles.

2. Stop mounted, provide filler strips to fully cover stop.

3. Adjustable holding power and override feature.

4. Acceptable manufacturers: Gylnn-Johnson, Hager Hardware, and H.B. Ives.

J. Kickplates

1. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.

2. Acceptable manufacturers: H.B. Ives, Hagar Hardware, and Builders Brass Works.

K. Silencers

1. Rubber silencers: 3 for each single door and 2 for each double doors.

2. Rubber Silencers at fiberglass door locations shall be self-adhesive type.

3. Acceptable manufacturers and products: (Hollow metal doors and frames): Glynn-Johnson Models 64 or 65, Hager Hardware Models 308D or 307D, H.B. Ives Models 20 or 21.

4. Acceptable manufacturers and products: (Fiberglass doors and frames): H. B. Ives Model SR66 or equal.

L. Thresholds

1. Extruded aluminum saddle type and fiberglass for opening with fiberglass door and frames. Provide with stainless steel fasteners. Six inches wide or as shown on drawings.

2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, and Zero International. Fiberglass threshold by fiberglass door and frame manufacturer.

M. Door Bottom Seal

1. Extruded aluminum with neoprene seal.

2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96.

N. Weatherstripping

1. Extruded aluminum with neoprene seal.

2. U.L. Labeled.

3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328.

PART 3 -- EXECUTION

3.01 GENERAL

A. Templates

1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

3.02 INSTALLATION

A. Install hardware in a manner which will eliminate cracks on surfaces.

B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, except as otherwise indicated or required to comply with governing regulations.

C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.

E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.

F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.

H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

3.03 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.

B. Final Adjustment

1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.

C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.04 HARDWARE SETS

A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Provide hardware required to meet Code requirements. Consult Drawings for set number required.

B. Hardware shall be as follows:

Hardware Sets

1. Hinges
Entrance Lockset
Overhead Door Closer Holder (each leaf)
Flush Bolts
Coordinator
Kickplate
Threshold
Door Bottom Seal
Weatherstripping
Astragal w/Weatherstripping

2. Hinges
Entrance Lock Set
Door Closer
Kickplate
Threshold
Door Bottom Seal
Weatherstripping

3. Hinges
   Panic Hardware
   Door Closer (each leaf)
   Coordinator
   Automatic Flush Bolts
   Kick Plate
   Weatherstripping
   Threshold
   Door Bottom Seal

4. Hinges
   Panic Hardware
   Door Closer
   Kick Plate
   Weatherstripping
   Threshold
   Door Bottom Seal

5. Hinges
   Passage Set
   Door Closer/Holder
   Kickplate
   Floor Mounted Door Stop

- END OF SECTION -

SECTION 08800

GLASS AND GLAZING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 08110 – Steel Doors and Frames

B. Section 08400 – Aluminum Storefront

C. Section 08520 – Aluminum Windows and Frames

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the requirements of these specifications the Work shall conform to the applicable requirements of the following documents:

1. CPSC 16 CFR1201 "Safety Standard for Architectural Glazing Materials."

2. ANSI Z97.1 "Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings."

3. North American Glazing Association "Glazing Manual."

4. Underwriters' Laboratories "Building Materials Directory."

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Sample of each type of glass and color chart.

2. Complete layout and installation drawings and schedules with clearly marked dimensions.

3. Manufacturer's technical descriptions and reports for glass and glazing.

1.05 JOB CONDITIONS

A. Check openings to verify that frames are plumb and true, square and secure.

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B. Take field dimensions for cutting glass and fabricating units.

C. Do not install glazing when ambient temperature is less than 50 degrees F.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in the manufacturer's original unopened labeled containers, clearly marked with their name and brand. Transport large panes of glass in vertical position with spacers to prevent contact between panes and edges.

B. Store glass in a dry, well ventilated location at a constant temperature, maintained above dew point. Handling shall be kept to a minimum. Protect glass from soiling, condensation or moisture of any kind.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. PPG Industries

2. Libby - Owens - Ford

3. Cardinal IG

2.02 MATERIALS

A. Primary glass shall meet the requirements of ASTM C1036-90. Heat treated glass shall meet the requirements of ASTM C1048-90.

B. Tempered glass shall be plate or float glass tempered by a special heat process and 1/4-inch thick or as noted on Drawings. Tempered glass shall meet the requirements of ANSI Z97.1 and Consumer Product Safety Commission 16 CFR 1201. Tempered glass shall be used for all applications, unless otherwise noted.

C. Insulating glass shall be Low-E preassembled units of glass enclosing a hermetically sealed dehydrated air space and certified through the Insulating Glass Certification Council (IGCC) in accordance with ASTM E-2190, E-2188. Glass shall be made from tempered glass, or heat-strengthened glass where recommended by manufacturer for application indicated. The unit shall consist of a tinted 1/4" thick exterior light, 1/2" air space and 1/4" thick clear interior light. Sealing system shall consist of metal spacer with bent or soldered corners, butyl primary and silicone secondary seal. Desiccant shall be manufacturer's standard. Exterior pane shall be tinted and color shall be selected by the Owner from manufacturer's full range of colors. Exterior glass shall be insulated.

D. Glazing materials shall be a resilient, non-hardening glazing compound of either a polysulfide or a silicone type. Materials shall not contain any solvents and shall be 100% solids. Oil base putty shall not be used. Glazing compounds shall not be thinned with chlorinated solvents or benzene related compounds. Glazing tape may be used where, and as, recommended by the manufacturer. The color of all exposed glazing materials shall harmonize with the window units.

E. Setting blocks and spacer shims shall be a non-staining material as recommended by the glass manufacturer.

PART 3 -- EXECUTION

3.01 GENERAL

A. Determine glass sizes by measuring the frames to receive the glass at the site. Comply with the manufacturer's specified tolerances for each type of glass including cutting tolerance, minimum edge clearance, minimum face clearance, and cover on glass.

B. The edges of all tempered and insulating glass shall be protected from damage and edges shall not be modified in any way after the glass leaves the factory. Nipping of any glass to reduce size shall not be permitted.

C. Deliver glass with manufacturer's labels showing type, thickness and quality of material (and U.L. label as required). These labels shall not be removed until the glass is set and final approval has been secured.

3.02 INSTALLATION

A. Sheet glass shall be cut and set with waves running horizontally.

B. All glass shall be set in such manner as to avoid possibility of breakage.

C. Rabbets shall be thoroughly cleaned and shall have been prime coated before glass is set.

D. Glass shall be well bedded and back glazed and all surplus compound and markings shall be carefully removed from doors, sash and adjoining work, while still fresh. Compound shall be finished in true, even lines, neatly and smooth faced. Set glass in strict accordance with the manufacturer's printed directions.

E. All glass when set and glazed shall be free from rattle and be watertight.

F. Glazing molds shall be removed and replaced in their correct locations in such a manner as not to mar molding or the screws securing same.

G. Install fire rated glass in strict accordance with manufacturer’s requirements to meet fire rated assembly shown on Drawings.

3.03 PROTECTION AND CLEANING

A. Before and after installation, all work shall be properly protected against damage.

B. On completion and prior to turning the project over to the Owner, all metal work and glass shall be cleaned and left in perfect condition. Glass shall be washed outside and inside.

- END OF SECTION -

SECTION 09900

PAINTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and Specified herein.

B. Section Includes:

1. Paint Materials
2. Shop Painting
3. Field Painting
    a. Surface Preparation
    b. Piping and Equipment Identification
    c. Schedule of Colors
    d. Work in Confined Spaces
    e. OSHA Safety Colors

1.02 RELATED SECTIONS

A. Section 15030 - Piping and Equipment Identification Systems

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications the Work shall conform to the applicable requirements of the following documents:

1. SSPC – The Society for Protective Coatings Standards

a.	SSPC-Vis 1	Pictorial Surface Preparation Standards for Painting Steel Structures
b.	SSPC-SP2	Hand Tool Cleaning
c.	SSPC-SP3	Power Tool Cleaning
d.	SSPC-SP5	White Metal Blast Cleaning

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e. SSPC-SP6 Commercial Blast Cleaning

f. SSPC-SP10 Near-White Metal Blast

g. SSPC-SP13/NACE6 Surface Preparation of Concrete

2. NACE - National Association of Corrosion Engineers

3. ASTM D1737 - Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus

4. ASTM B117 - Method of Salt Spray (Fog) Testing

5. ASTM D4060 - Test Method for Abrasion Resistance of Organic Coating by the Taber Abrader

6. ASTM D3359 - Method for Measuring Adhesion by Tape Test

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and Material Safety Data Sheets for each product.

2. Painting schedule identifying surface preparation and paint systems proposed. Cross-reference with Tables 9-1 and 9-2. Provide the name of the paint manufacturer, and name, address, and telephone number of manufacturer's representative who will inspect the work. Submit schedule for approval as soon as possible following the Award of Contract, so approved schedule may be used to identify colors and specify shop paint systems for fabricated items.

1.05 SYSTEM DESCRIPTION

A. Work shall include surface preparation, paint application, inspection of painted surfaces and corrective action required, protection of adjacent surfaces, cleanup and appurtenant work required for the proper painting of all surfaces to be painted. Surfaces to be painted are designated within the Painting Schedule and may include new and existing piping, miscellaneous metals, equipment, buildings, exterior fiberglass, exposed electrical conduit and appurtenance.

B. Perform Work in strict accordance with manufacturer's published recommendations and instructions, unless the Engineer stipulates that deviations will be for the benefit of the project.

C. Paint surfaces which are customarily painted, whether indicated to be painted or not, with painting system applied to similar surfaces, areas and environments, and as approved by Engineer.

D. Piping and equipment shall receive color coding and identification. Equipment shall be the same color as the piping system.

1.06 QUALITY ASSURANCE

A. Painting operations shall be accomplished by skilled craftsman and licensed by the state to perform painting work.

B. Provide a letter indicating that the painting applicator has five years of experience, and 5 references which show previously successful application of the specified or comparable painting systems. Include the name, address, and the telephone number for the Owner of each installation for which the painting applicator provided services.

1.07 STORAGE AND DELIVERY

A. Bring materials to the job site in the original sealed and labeled containers.

B. Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

PART 2 -- MATERIALS

2.01 GENERAL INFORMATION

A. The term "paint" is defined as both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.

B. Purchase paint from an approved manufacturer. Manufacturer shall assign a representative to inspect application of their product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion the Work identifying products used and verifying that surfaces were properly prepared, products were properly applied, and the paint systems were proper for the exposure and service.

C. Provide primers and intermediate coats produced by same manufacturer as finish coat. Use only thinners approved by paint manufacturer, and only within manufacturer's recommended limits.

D. Ensure compatibility of total paint system for each substrate. Test shop primed equipment delivered to the site for compatibility with final paint system. Provide an acceptable barrier coat or totally remove shop applied paint system when incompatible with system specified, and repaint with specified paint system.

E. Use painting materials suitable for the intended use and recommended by paint manufacturer for the intended use.

F. Require that personnel perform work in strict accordance with the latest requirements of OSHA Safety and Health Standards for construction. Meet or exceed requirements of regulatory agencies having jurisdiction and the manufacturer's published instructions and recommendations. Maintain a copy of all Material Safety Data Sheets at the job site of each product being used prior to commencement of work. Provide and require that personnel use protective and safety equipment in or about the project site. Provide respiratory devices, eye and face protection, ventilation, ear protection, illumination and other safety devices required to provide a safe work environment.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Tnemec Company Inc.

2. Ameron

3. CARBOLINE

4. Sherwin-Williams

5. International

PART 3 -- EXECUTION

3.01 SHOP PAINTING

A. Shop prime fabricated steel and equipment with at least one shop coat of prime paint compatible with finish paint system specified. Prepare surface to be shop painted in strict accordance with paint manufacturer's recommendations and as specified. Finish coats may be shop applied, if approved by the Engineer. Package, store and protect shop painted items until they are incorporated into Work. Repair painted surfaces damaged during handling, transporting, storage, or installation to provide a painting system equal to the original painting received at the shop.

B. Identify surface preparation and shop paints on Shop Drawings. Verify compatibility with field applied paints.

3.02 SURFACE PREPARATION

A. General

1. Surfaces to be painted shall be clean and dry, and free of dust, rust, scale, and foreign matter. No solvent cleaning, power or hand tool cleaning shall be permitted unless approved by the Engineer.

2. Protect or remove, during painting operations, hardware, accessories, machined surfaces, nameplates, lighting fixtures, and similar items not intended to be painted prior to cleaning and painting. Reposition items removed upon completion of painting operations.

3. Examine surfaces to be coated to determine that surfaces are suitable for specified surface preparation and painting. Report to Engineer surfaces found to be unsuitable in writing. Do not start surface preparation until unsuitable surfaces have been corrected. Starting surface preparation precludes subsequent claim that such surfaces were unsuitable for the specified surface preparation or painting.

4. Surface preparation shall be in accordance with specifications and manufacturer's recommendations. Provide additional surface preparation, and fill coats where manufacturer recommends additional surface preparation, in addition to requirements of specification.

5. Touch-up shop or field applied coatings damaged by surface preparation or any other activity, with the same shop or field applied coating; even to the extent of applying an entire coat when required to correct damage prior to application of the next coating. Touch-up coats are in addition to the specified applied systems, and not considered a field coat.

6. Protect motors and other equipment during blasting operation to ensure blasting material is not blown into motors or other equipment. Inspect motors and other equipment after blasting operations and certify that no damage occurred, or where damage occurred, the proper remedial action was taken.

7. Field paint shop painted equipment in compliance with Color Coding and as approved by Engineer.

B. Metal Surface Preparation

1. Conform to current The Society for Protective Coatings Standards (SSPC) Specifications for metal surface preparation. Use SSPC-Vis-1 pictorial standards or NACE visual standards TM-01-70 or TM-01-75 to determine cleanliness of abrasive blast cleaned steel.

2. Perform blast cleaning operations for metal when following conditions exist:

   a. Moisture is not present on the surface.

   b. Relative humidity is below 80%.

   c. Ambient and surface temperatures are 5°F or greater than the dew point temperature.

   d. Painting or drying of paint is not being performed in the area.

e. Equipment is in good operating condition.

f. Proper ventilation, illumination, and other safety procedures and equipment are being provided and followed.

3. Sandblast ferrous metals to be shop primed, or component mechanical equipment in accordance with SSPC-SP5, White Metal Blast.

4. Sandblast field prepared ferrous metals in accordance with SSPC-SP10, Near White Metal Blast, where metal is to be submerged, in a corrosive environment, or in severe service.

5. Sandblast field prepared ferrous metals in accordance with SSPC-SP6 Commercial Blast, where metal is to be used in mild or moderate service, or non-corrosive environment.

6. Clean nonferrous metals, copper, or galvanized metal surfaces in accordance to SSPC-SP1, Solvent Cleaning, or give one coat of metal passivator or metal conditioner compatible with the complete paint system.

7. Prime cleaned metals immediately after cleaning to prevent rusting.

8. Clean rusted metals down to bright metal by sandblasting and immediately field primed.

C. Concrete Surface Preparation

1. Cure concrete a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete for moisture content, pH and salts using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.

3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities using blasting or grinding. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall achieve profile as required by manufacturer or where not defined by manufacturer similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or other approved method.

4. Surface defects, such as hollow areas, bugholes, honeycombs, and voids shall be filled with polymeric filler compatible with painting system. Complete fill coats may be used in addition to specified painting system and as approved by the Engineer. Fins, form marks, and all protrusions or rough edges shall be removed.

5. Repair existing concrete surfaces which are deteriorated to the point that surface preparation exposes aggregate with fill coats or patching mortar as recommended by paint manufacturer and as directed by the Engineer.

6. Clean concrete of all dust, form oils, curing compounds, oil, tar, laitance, efflorescence, loose mortar, and other foreign materials before paints are applied.

D. Wood

1. Clean wood surfaces free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Remove sap and resin by scraping and wipe clean with rags dampened with mineral spirits.

2. Saturate end grain, cut wood, knots, and pitch pockets with an appropriate sealer before priming.

3. Prime and backprime wood trim before setting in place.

4. After prime coat has dried, fill nailholes, cracks, open joints, and other small holes with approved spackling putty. Lightly sand wood trim prior to applying second coat of paint.

E. Castings

1. Prepare castings for painting by applying a brush or a knife-applied filler. Fillers are not to be used to conceal cracks, gasholes, or excessive porosity.

2. Apply one coat of primer with a minimum thickness of 1.2 mils in addition to coats specified. Allow sufficient drying time before further handling.

F. Masonry

1. Cure for a minimum of 30 days prior to paint application.

2. Clean masonry surfaces free from all dust, dirt, oil, grease, loose mortar, chalky deposits, efflorescence, and other foreign materials.

3. Test masonry for moisture content. Use test method recommended by paint manufacturer. Do not begin painting until moisture content is acceptable to manufacturer.

G. Gypsum Drywall

1. Sand joint compound with sandpaper to provide a smooth flat surface. Avoid sanding of adjacent drywall paper.

2. Remove dust, dirt, and other contaminants.

H. Previously-Painted Surfaces

1. Totally remove existing paint when: surface is to be submerged in a severe environment, paint is less than 75% intact, brittle, eroded or has underfilm rusting.

2. Surfaces which are greater than 75% intact require removal of failed paints and then spot primed. Spot priming is in addition to coats specified.
3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.

4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer's recommendations.

5. Check existing paints for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coat recommended by the paint manufacturer. Remove existing paints of undetermined origin. Prepare a test patch of approximately 3 square feet over existing paint. Allow test patch to dry thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 APPLICATION OF PAINT

A. Apply paint by experienced painters with brushes or other applicators approved by the Engineer, and paint manufacturer.

B. Apply paint without runs, sags, thin spots, or unacceptable marks.

C. Apply at rate specified by the manufacturer to achieve at least the minimum dry mil thickness specified. Apply additional coats, if necessary, to obtain thickness.

D. Special attention shall be given to nuts, bolts, edges, angles, flanges, etc., where insufficient film thicknesses are likely. Stripe paint prior to applying prime coat. Stripe painting shall be in addition to coats specified.

E. Perform thinning in strict accordance with the manufacturer's instructions, and with the full knowledge and approval of the Engineer and paint manufacturer.

F. Allow paint to dry a minimum of twenty-four hours between application of any two coats of paint on a particular surface, unless shorter time periods are a requirement by the manufacturer. Longer drying times may be required for abnormal conditions as defined by the Engineer and paint manufacturer. Do not exceed manufacturer's recommended drying time between coats.

G. Suspend painting when any of the following conditions exist:

1. Rainy or excessively damp weather.

2. Relative humidity exceeds 85%.

3. General air temperature cannot be maintained at 50°F or above through the drying period, except on approval by the Engineer and paint manufacturer.

4. Relative humidity will exceed 85% or air temperature will drop below 40°F within 18 hours after application of paint.

5. Surface temperature of item is within 5 degrees of dewpoint.

6. Dew or moisture condensation are anticipated.

7. Surface temperature exceeds the manufacturer's recommendations.

3.04 INSPECTION

A. Each field coat of paint will be inspected and approved by the Engineer or his authorized representative before succeeding coat is applied. Tint successive coats so that no two coats for a given surface are exactly the same color. Tick-mark surfaces to receive black paint in white between coats.

B. Use magnetic dry film thickness gauges and wet fiber thickness gauges for quality control. Furnish magnetic dry film thickness gauge for use by the Engineer.

C. Coatings shall pass a holiday detector test.

D. Determination of Film Thickness: Randomly selected areas, each of at least 107.5 contiguous square feet, totaling at least 5% of the entire control area shall be tested. Within this area, at least 5 squares, each of 7.75 square inches, shall be randomly selected. Three readings shall be taken in each square, from which the mean film thickness shall be calculated. No more than 20 percent of the mean film thickness measurements shall be below the specified thickness. No single measurement shall be below 80 percent of the specified film thickness. Total dry film thickness greater than twice the specified film thickness shall not be acceptable. Areas where the measured dry film thickness exceeds twice that specified shall be completely redone unless otherwise approved by the Engineer. When measured dry film thickness is less than that specified additional coats shall be applied as required.

E. Holiday Testing: Holiday test painted ferrous metal surfaces which will be submerged in water or other liquids, or surfaces which are enclosed in a vapor space in such structures. Mark areas which contain holidays. Repair or repaint in accordance with paint manufacturer's printed instructions and retest.

1. Dry Film Thickness Exceeding 20 Mils: For surfaces having a total dry film thickness exceeding 20 mils: Pulse-type holiday detector such as Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the specified coating thickness.

2. Dry Film Thickness of 20 Mils or Less: For surfaces having a total dry film thickness of 20 mils or less: Tinker & Rasor Model M1 non-destructive type holiday detector, K-D Bird Dog, shall be used. The unit shall operate at less than 75-volts. For thicknesses between 10 and 20 mils, a non-sudsing type wetting agent, such as Kodak Photo-Flow, shall be added to the water prior to wetting the detector sponge.

F. Paint manufacturer or his representative shall provide their services as required by the Engineer. Services shall include, but not be limited to, inspecting existing paint, determination of best means of surface preparation, inspection of completed work, and final inspection of painted work 11 months after the job is completed.

3.05 PROTECTION OF ADJACENT PAINT AND FINISHED SURFACES

A. Use covers, masking tape, other method when protection is necessary, or requested by Owner or Engineer. Remove unwanted paint carefully without damage to finished paint or surface. If damage does occur, repair the entire surface adjacent to and including the damaged area without visible lapmarks and without additional cost to the Owner.

B. Take all necessary precautions to contain dispersion of sandblasting debris and paint to the limits of the work. Take into account the effect of wind and other factors which may cause dispersion of the sandblasting debris and paint. Suspend painting operations when sanding debris or paint cannot be properly confined. Assume all responsibilities and cost associated with damage to adjacent structures, vehicles, or surfaces caused by the surface preparation and painting operations.

3.06 PIPING AND EQUIPMENT IDENTIFICATION

A. Piping and equipment identification shall be in accordance with Section 15030, Piping and Equipment Identification Systems.

3.07 SCHEDULE OF COLORS

A. Match colors indicated. Piping and equipment colors are indicated in Section 15030. Colors which are not indicated shall be selected from the manufacturer's full range of colors by the Engineer. No variation shall be made in colors without the Engineer's approval. Color names and numbers shall be identified according to the appropriate color chart issued by the manufacturer of the particular product in question.

3.08 WORK IN CONFINED SPACES

A. Provide and maintain safe working conditions for all employees. Supply fresh air continuously to confined spaces through the combined use of existing openings, forced-draft fans and temporary ducts to the outside, or direct air supply to individual workers. Exhaust paint fumes to the outside from the lowest level in the contained space. Provide explosion-proof electrical fans, if in contact with fumes. No smoking or open fires will be permitted in, or near, confined spaces where painting is being done. Follow OSHA, state and local regulations at all times.

3.09 OSHA SAFETY COLORS

A. Paint wall around wall-mounted breathing or fire apparatus with the appropriate safety red color; area not exceed 2-feet wide by 3-feet high, unless apparatus covers the area. Fire apparatus include fire hoses, extinguisher, and hydrants.

B. Paint hazardous areas and objects in accordance with OSHA regulations.

TABLE 9-1
PAINTING SCHEDULE

SURFACE	APPLICATION	PAINTING SYSTEM & NO. OF COATS	PRODUCT REFERENCE (TABLE 9.2)	TOTAL MIN. DRY FILM THICKNESS (MILS)
Concrete and Masonry				
Interior masonry and concrete walls and ceilings	All new structures	1 coat sealer 2 coats acrylic epoxy	101 116	75-85 sq.ft./gal. 4-6/coat
Exterior masonry cavity walls on cavity face of inner wythe	All new structures	Dampproofing	See Section 07150	
Exterior below grade if interior is dry	Accessible areas (e.g. pipe galleries, pump rooms, basements, etc.)	Waterproofing	See Section 07100	
Exterior CMU and Conc Parapet, Roof Facing Side	Parapet surfaces adjacent to roof systems	2 coats	122	Per mfr
Metals				
Interior and exterior nonsubmerged (gloss)	All new blowers, pumps, motors and mechanical equipment, piping, etc.	1 coat epoxy polyamide primer 1 coat epoxy polyamide 1 coat aliphatic polyurethane	104 102 115	4-6 4-6 3-5
Interior insulated		1 coat acrylic latex	103	4
Submerged water	All metal piping, and mechanical equipment, etc.	2 coats NSF approved epoxy polyamide	105	4-6/coat
Steel doors, windows and door frames, steel stairs, monorails, structural steel, misc. metals (steel)		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4
Aluminum surfaces in contact with concrete		2 coats coal tar	107	26
Interior: Tar-dipped piping where color is required		2 coats epoxy resin sealer 2 coats epoxy polyamide	112 102	5-8/coat 5-8/coat
PVC Piping		1 coat epoxy polyamide 1 coat aliphatic polyurethane	102 115	5-8 3-4

TABLE 9-2

PRODUCT LISTING

REF.	SYSTEM	PURPOSE	PRODUCT			
			Tnemec Series	PPG/AMERON	CARBOLINE	Sherwin-Williams
101	Acrylic filler	Primer-sealer	130-6601	BLOXFIL 4000	Sanitile 100	Cement-Plex 875
102	Epoxy polyamide	Finish coat semi-gloss or gloss	N69	AMERLOCK 2	Carboguard 890	Dura-Plate 235
103	Acrylic latex	Sealer	1028/1029	PITT TECH PLUS	Carbocrylic 3359DTM	DTM Acrylic Primer/Finish
104	Epoxy Polyamide – metal	Primer	66	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
105	Epoxy	Primer/Finish	20	AMERLOCK 2	Carboguard 561/56LT	Macropoxy 646 PW
106	Coal tar epoxy	Finish high-coat build	46H-413	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
107	Coal tar	Sealer	46-465	AMERCOAT 78HB	Bitumastic 300M	Hi-Mil Sher Tar Epoxy
108	Alkyd-medium oil	Finish coat	2H	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
109	Alkyd-long oil	Finish coat	1029	DEVGUARD 4308	Carbocoat 8215	Industrial Enamel
110	Epoxy polyamide	Primer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 646
112	Epoxy polyamide	Sealer	66-1211	AMERCOAT 385	Carboguard 893SG	Macropoxy 920 Pre-Prime
113	Urethane	Barrier coat	530	AMERLOCK SEALER	Rustbond	--
114	Polyamine Epoxy	Intermediate coat	27	AMERLOCK 385	Carboguard 893SG	--
115	Aliphatic Polyurethane	Finish coat	1074 or 1075	AMERCOAT 450 HS	Carbothane 134HG	Acrolon 218HS
116	Acrylic epoxy	Finish coat	113 or 114	AQUAPON WB	Sanitile 255	Water-Based Catalyzed Epoxy
117	Epoxy block filler	Sealer	1254	AMERLOCK 114	Sanitile 600	Kem Cati-Coat HS Epoxy Filler
118	Catalyzed epoxy	Finish coat	84	AMERLOCK 2/400	Carboguard 890	Macropoxy 646
119	High solids epoxy	Finish coat	104	AMERLOCK 400	Carboguard 890	Dura-Plate 235
120	Epoxy	Top coat	N69	AMERLOCK 2/400	Carboguard 890	--
121	Modified Polyamine Epoxy	Primer/Finish Coat	237SC			
122	Parapet Roofside	Primer/Finish Coat	156 or 157			Sherflex

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SECTION 10400

IDENTIFYING DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Plastic engraved door and informational signs as indicated on the Drawings.

2. Safety signs

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Color and finish samples for all nameplates, signs and building name letters.

2. Shop Drawings shall include, but not be limited to:

a. Complete details for all signs and building name letters giving sizes and styles of lettering and colors.

b. Complete schedules for all nameplates, signs, and building name letters giving location, message, letter, size, color, and method of attachment.

c. Details of fabrication and attachment of all items.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in unopened, unbroken and undamaged original packaging bearing the manufacturer's label and identification for installation.

B. Handle all materials with care to prevent defacement of any nature.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

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1. Andco Industries Corporation

2. Innerface Architectural Signage Incorporated

3. Environmental Sign Systems

2.02 MATERIALS

A. Signs

1. Interior signs shall be self extinguishing plastic with raised letters meeting the requirements of the American with Disabilities Act of 1990; total thickness minimum of 0.125 inch; rounded corners.

2. Exterior signs shall be aluminum with vinyl lettering and numbering.

B. Character size and style shall be 3/4 inch high minimum upper case Helvetica. Spacing and proportions of letters shall be in strict accordance with the Americans with Disabilities Act of 1990.

C. Colors shall be as selected by the Owner from the manufacturer standard colors.

D. Materials shall be suitable for exterior or interior exposure as applicable.

2.03 ACCESSORIES

A. Mounting Hardware: Stainless steel screws.

B. Tape Adhesive: Double sided tape, permanent adhesive.

2.04 FABRICATION

A. All items specified herein to be factory fabricated to the extent practicable.

B. Provide all attachments and anchors necessary for concealed installments for door numbers, room name plates, and bulletin boards.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All materials specified herein shall be installed in compliance with the approved manufacturer's printed specifications. Mounting devices, bolts, screws, nuts and the like shall be of high strength aluminum or stainless steel. The final location of each sign shall be as determined by the Engineer.

B. Plastic door numbers and room name plates shall be attached stainless steel oval Phillips head screw at each corner.

1. Submit a schedule of door numbers and name plates to the Engineer for approval.
2. Install door and name plates after final field finish has been applied and thoroughly dried.

3.02 ADJUSTMENT AND CLEANING

A. After completion of project, remove all protective devices, touch up as necessary and clean all exposed surfaces with a mild solution of detergent and warm water. Leave all surfaces in a neat and clean condition.

3.03 SCHEDULES

A. FIRE RELATED SIGNS provide each sign with wording and pictogram. Signs shall have red background and white letters and pictogram.

Wording	**Size**	**Quantity**
FIRE EXTINGUISHER	7x7	5

B. CAUTION SIGNS shall have a yellow background with the word CAUTION 2 inches high with white letters and black background centered above wording below in black letters. Each sign shall be provided with pictogram showing figure in compliance with sign (i.e. a figure wearing glasses)

Wording	**Size**	**Quantity**
EAR PROTECTION MUST BE WORN IN THIS AREA	7x17	1
EYE PROTECTION MUST BE WORN IN THIS AREA	7x17	1

C. SAFETY SIGNS. Signs shall comply with ANSI Z S35 requirements.

Wording	**Size**	**Quantity**
EMERGENCY SHOWER (with pictogram)	7x7	1
EMERGENCY EYEWASH (with pictogram)	7x7	1

D. DANGER SIGNS shall have a white background with the word DANGER 2 inches high with white letters and red oval on a black background centered above wording below in black letters.

Wording	**Size**	**Quantity**
CONFINED SPACE AUTHORIZED PERSONNEL ONLY	7x7	1

- END OF SECTION -

SECTION 10522

FIRE EXTINGUISHERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install fire extinguishers as shown on the Drawings and specified herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these Specifications the Work shall conform to the applicable requirements of the following documents:

1. NFPA 10 - Portable Fire Extinguishers

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Complete detail and installation drawings for Fire Extinguisher Cabinets.

2. Manufacturer's data sheets and verification of U.L. ratings.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products from one of the following manufacturers:

1. Kidde Fire Extinguisher Company

2. Ansul Fire Protection

3. Potter - Roemer

4. J. L. Industries

2.02 MATERIALS

A. Dry Chemical (DC) Fire Extinguishers

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1. Provide where indicated on drawings, 10 lb. capacity, hand portable, with wall mount, tri-class dry chemical type, with Underwriters' Laboratories rating of 4-A: 60 BC.

B. Carbon Dioxide (CO_2) Fire Extinguishers

1. Provide where indicated on drawings, 10 lb. capacity, portable carbon dioxide type with wall mounts, having Underwriters' Laboratories rating of 10-BC.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Fire extinguishers shall be installed where directed by the Engineer.

B. Wall mounts for extinguishers shall be securely mounted to masonry with lag bolts and shields.

C. Fire extinguishers shall be installed so that the top of the fire extinguisher is not more than 5 feet above the floor.

- END OF SECTION -

SECTION 10523

FIRST AID CABINETS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install first aid cabinets as shown on the Drawings and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.02 SUBMITTALS

A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.03 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

PART 2 -- PRODUCTS

2.01 FIRST AID CABINET

A. The first aid cabinets shall be a Global Industrial First Aid Kit, 2 Shelf Steel Cabinet, ANSI Compliant, 50-75 Person, Item# T9FB2024169, or equal. First aid cabinets shall be provided as shown on the Drawings. Mounting brackets for masonry mounting shall be provided. Cabinets shall be field located as directed by the Engineer.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. First aid cabinets shall be installed where shown on the Drawings or as directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

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- END OF SECTION -

SECTION 10524

EMERGENCY SHOWER/EYEWASH STATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install emergency shower/eyewash stations as shown on the Drawings and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.02 SUBMITTALS

A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

1.03 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

PART 2 -- PRODUCTS

2.01 EMERGENCY SHOWER/EYEWASH STATIONS

A. Combination shower and eyewash stations shall be installed where shown on the Contract Drawings.

B. For exterior shower/eyewash units, the drench shower and the eyewash shall be operated independently by hand actuated flag type handles or push down plates that remain open until manually closed. All exterior shower/eyewash stations shall be freeze proof and shall be Model S19-310NN as manufactured by Bradley, Model 8300FP as manufactured by Haws, or equal. Dual automatic pressure compensation devices shall provide steady water flow under pressures varying from 30 to 75 psi.

C. For interior combination shower/eyewash units, the drench shower shall be operated by pull rod with triangular handle that remains open until manually closed, and the eyewash shall be operated by hand actuated flag type handle or foot treadle that remains open until

manually closed. All interior combination shower/eyewash stations shall be Model S19-310UU as manufactured by Bradley, Model 8300 as manufactured by Haws, or equal. Dual automatic pressure compensation devices shall provide steady water flow under pressures varying from 30 to 75 psi.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Emergency shower/eyewash stations shall be installed where shown on the Drawings or as directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

- END OF SECTION -

SECTION 11000

EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in acceptable operation all mechanical equipment and all necessary accessories as specified herein, as shown on the Drawings, and as required for a complete and operable system.

B. The mechanical equipment shall be provided complete with all accessories, special tools, spare parts, mountings, and other appurtenances as specified, and as may be required for a complete and operating installation.

C. It is the intent of these Specifications that the Contractor shall provide the Owner complete and operational equipment/systems. To this end, it is the responsibility of the Contractor to coordinate all interfaces with related mechanical, structural, electrical, instrumentation and control work and to provide necessary ancillary items such as controls, wiring, etc., to make each piece of equipment operational as intended by the Specifications.

D. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.

E. The requirements of this section shall apply to equipment furnished under Divisions 11, 13, 14, and 15.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

1.03 PERFORMANCE AFFIDAVITS

A. When required in the individual equipment Specifications, the Contractor shall submit manufacturer's Performance Affidavits for equipment to be furnished.

B. By these affidavits, each manufacturer must certify to the Contractor and the Owner, jointly, that he has examined the Contract Documents and that the equipment, apparatus, or process he offers to furnish will meet in every way the performance requirements set forth or implied in the Contract Documents.

C. The Contractor must transmit to the Engineer three (3) original copies of the affidavit given him by the manufacturer or supplier along with the initial Shop Drawing submittals.

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D. The Performance Affidavit must be signed by an officer of the basic corporation, partnership, or company manufacturing the equipment and witnessed by a notary public.

E. The Performance Affidavit shall have the following format:

Addressed to: (Contractor) and Public Works Commission of the City of Fayetteville, North Carolina

Reference: P.O. Hoffer WTF and Glenville Lake WTF Reliability Improvements, Contract No. 55

Text: (Manufacturer's Name) has examined the Contract Documents and hereby state that the (Product) meets in every way the performance requirements set forth or implied in Section _____ of the Contract Documents.

Signature: Corporate Officers shall be Vice President, or higher. (Unless statement authorizing signature is attached.)

1.04 SHOP DRAWINGS

A. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with Section 01300, Submittals and shall include the following information in addition to the requirements of Section 01300, Submittals:

1. Performance characteristics and descriptive data.

2. Detailed equipment dimensional drawings and setting plans.

3. General lifting, erection, installation, and adjustment instructions, and recommendations.

4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.

5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

6. Details on materials of construction of all components including applicable ASTM designations.

7. Information on bearing types and bearing life.

8. Gear box design and performance criteria and AGMA service factor.

9. Piping schematics.

10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

12. Equipment shop coating systems, interior and exterior.

13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

14. A list of spare parts and special tools to be provided.

15. Any additional information required to show conformance with the equipment specifications.

16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

B. SHOP DRAWINGS ON ITEMS REQUIRING PERFORMANCE AFFIDAVITS WILL NOT BE REVIEWED UNTIL ACCEPTABLE PERFORMANCE AFFIDAVITS ARE RECEIVED.

1.05 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01300, Submittals.

B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram, complete spare parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

C. Each set of instructions shall be bound together in appropriate three-ring binders with a detailed Table of Contents.

D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.

E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.

F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.

G. Extensive pictorial cuts of equipment are required for operator reference in servicing.

H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.06 GENERAL INFORMATION AND DESCRIPTION

A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.

B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.

C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.

D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.

E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.

H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.

I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

1.07 EQUIPMENT WARRANTIES

A. Warranty requirements may be added to or modified in the individual equipment specifications.

B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

C. The Contractor shall provide an equipment warranty log book prepared specifically for this project and submit two (2) copies of the document to the Engineer prior to final payment. The equipment warranty log book shall include a summary listing of all equipment warranties provided, date received, and start date and end date of warranty period. A copy of each equipment warranty and equipment start-up certification shall also be provided in the document.

D. The Equipment Supplier shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Equipment Supplier, by submitting his bid, agrees to hold and save the Owner and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Contractor shall, upon request of the Engineer, furnish the names of not less than 5 successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and

shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

2.02 ANCHORS AND SUPPORTS

A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.

B. Anchor bolts and fasteners shall be furnished in accordance with Section 05050, Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.

C. The Contractor shall provide all concrete pads or pedestals required for equipment furnished. All concrete equipment pads shall be a minimum of 6” high, unless otherwise shown on the Drawings and shall be doweled.

D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated or required. Equipment shall be leveled by first using sitting nuts on the anchor bolts, and then filling the space between the equipment base and concrete pedestal with non-shrink grout, unless alternate methods are recommended by the manufacturer and are acceptable to the Engineer (such as shim leveling pumps, or chemical grout). Non-shrink grout shall be as specified in Section 03600, Grout.

2.03 STRUCTURAL STEEL

A. Structural steel used for fabricating equipment shall conform to the requirements of Section 05120, Structural Steel.

B. All materials shall conform to applicable provisions of the AISC Specifications for the design and fabrication of structural steel, and to pertinent ASTM Standard Specifications.

2.04 DISSIMILAR METALS

A. All dissimilar metals shall be properly isolated to the satisfaction of the Engineer.

2.05 GALVANIZING

A. Where required by the equipment specifications, galvanizing shall be performed in accordance with Section 05035, Galvanizing.

2.06 STANDARDIZATION OF GREASE FITTINGS

A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

2.07 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16 specifications and the latest National Electric Code.

B. Motors shall conform to the applicable requirements of Section 15170, Electric Motors.

C. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor and shall upgrade the electrical service (conduit, wires, starters, etc.) at no additional cost to the Owner.

D. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between equipment supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Variable Frequency Drive Systems.

E. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.08 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.

B. Spare parts shall be identical and interchangeable with original parts.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer.

F. The Contractor shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturers operation and maintenance manual.

G. The Contractor shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of

these materials shall be properly packed, labeled and stored where directed by the Engineer.

2.09 EQUIPMENT IDENTIFICATION

A. All mechanical equipment shall be provided with a substantial stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.

C. Nameplates shall not be painted over.

PART 3 -- EXECUTION

3.01 SHOP TESTING

A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.

B. No equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.

C. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Engineer for review.

D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Owner.

E. Shop testing of electric motors shall be in accordance with applicable requirements of Section 15170, Electric Motors and Section 16000, Basic Electrical Requirements.

3.02 STORAGE OF EQUIPMENT AND MATERIALS

A. Contractor shall store his equipment and materials at the job site in strict accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction. Equipment and materials shall not be delivered to the site prior to 90 days in advance of the scheduled installation. Partial payment requests will not be

processed for materials delivered prior to 90 days before installation or for materials that are not properly stored.

B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner. Stored electrical equipment is to be protected from the elements and shall have space heaters energized.

C. Contractor shall not store unnecessary materials or equipment on the job site and shall take care to prevent any structure from being loaded with a weight which will endanger its security or the safety of persons.

D. Contractor shall observe all regulatory signs for loadings on structures, fire safety, and smoking areas.

E. Contractor shall not store materials or encroach upon private property without the written consent of the owners of such private property.

3.03 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall arrange for a qualified Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Engineer and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Contractor shall schedule multiple Technical Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.

B. For each site visit, the Technical Representative shall submit jointly to the Owner, the Engineer, and the Contractor a complete signed report of the results of his inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.

C. The manufacturer's Technical Representative shall provide the following services.

1. Installation: The Technical Representative shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Technical Representative shall also supervise the installation of the equipment.

2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Technical Representative shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the

requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall include date of final acceptance field test, as well as a listing of all persons present during tests.

3. Startup: The Technical Representative shall start up the equipment for actual service with the help of the Contractor. In the event that equipment or installation problems are experienced, the Contractor and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

4. Training: The Technical Representative shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance of the training and shall be provided while the respective Technical Representative's equipment is fully operational. The Contractor shall have submitted, and had accepted, the O&M Manuals prior to commencement of training.

5. Services after Startup: Where required by the individual equipment specifications, the Technical Representative shall return to the project site thirty (30) days after the start up date to review the equipment performance, correct any equipment problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Technical Representative prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Technical Representative will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.

D. Services of the Technical Representative will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Engineer but will not be less than the number of days specified in individual equipment sections.

E. The Contract amount shall include the cost of furnishing the Technical Representative for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Technical Representative in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

F. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.

G. The Technical Representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

3.04 INSTALLATION

A. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.

B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.

C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.

D. All equipment sections and loose items shall be match-marked prior to shipping.

E. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base. Alignment shall be as specified herein.

F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

3.05 ALIGNMENT

A. Set equipment to dimensions shown on drawings. Dimensions shall be accurate to +/- 1/16 inch unless otherwise noted on the drawings. Wedges shall not be used for leveling, aligning, or supporting equipment.

B. General Equipment Leveling: Non-rotating equipment shall be set level to +/- 1/16 inch per 10 foot length (.005 inch per foot) unless otherwise noted on the drawings. Shims shall be used unless equipment is furnished with leveling feet. Set shims flush with equipment baseplate edges. When grouting is required, equipment shall be shimmed to allow a minimum of one inch grout thickness. Grout shall cover shims at least 3 inches. Final level check shall be held for inspection and approval by Engineer before proceeding.

C. Grouting

1. Fill anchor bolt holes or sleeves with grout, after bolt alignment is proven, and prior to placing grout under equipment bases.

2. Surface Preparation. Roughen surface by chipping, removing laitance, and unsound concrete. Clean area of all foreign material such as oil, grease, and scale. Saturate area with water at least 4 hours prior to grouting, removing excess water ponds.
3. Application. Place grout after the equipment base has been set and its alignment and level have been approved. Form around the base, mix grout, and place in accordance with the grout manufacturers published instructions. Eliminate all air or water pockets beneath the base using a drag chain or rope.

4. Finishing. Point the edges of the grout to form a smooth 45 degree slope.

5. After grout has cured (not before 3 days after placement) paint exposed surfaces of grout with shellac.

6. Level Verification. After grout has cured, and immediately prior to drive alignment, recheck equipment for level and plumb. Re-level and square as necessary. Hold final checks for inspection and approval by Engineer.

D. Inspect for and remove all machining burrs or thread pulls in female holes on mating surfaces of mounting frame and machine feet.

E. Inspect and clean equipment mounting base pads, feet, and frames to remove all grease, rust, paint and dirt.

F. Assembled equipment shafts shall be set level to .0015 inches per foot of shaft length (+/- .0005 inches) up to a maximum of 0.015 inches for any length shaft unless the manufacturer's requirements are more stringent or unless otherwise noted in the equipment specifications. Use the machined surfaces on which the equipment sets for the base/mounting frame leveling plane. Use the machined shaft surface for equipment leveling plane.

G. Sprocket and Sheave Alignment. Check shaft mounted components for face runout and eccentricity (outside diameter) runout by magnetically mounting a dial indicator on a stationary base and indicating over 360 degrees on a continuous machined surface at the outside diameter of the component. Maximum allowable total indicated face runout and eccentricity for sprockets and sheaves will be per ANSI Standard B29.1-1975.

H. Belt tensioning. Set drive belt tension to manufacturer's specification for the belt type. Recheck alignment after drive tensioning.

I. Thermal/Mechanical Growth. Thermal/mechanical growth corrections for driver and driven machines will be used in vertical and horizontal alignment where applicable. The equipment manufacturer will determine thermal/mechanical growth applicability for any machine and provide the correction offsets to be used.

J. Rotating Shaft Alignment

1. Fixtures will be set up on the driver and driven machine, machines shaft surfaces. Machined coupling hubs may be used only if there is no clearance to mount fixtures directly on the shafts.

2. Primary alignment method for direct drive machines is when coupled. Uncoupled alignment will be used only when approved by the Engineer.

3. Account for possible coupling flex by always rotating coupled machines in the same direction during alignment.

4. Uncoupled machines must be connected so that both shafts turn together without relative motion during alignment.

5. Indicator bar sag will be measured and included for each reverse indicator alignment setup.

6. Reverse Dial Indicator. The final maximum allowable misalignment: vertical and horizontal from the desired targets of .000 inches (for a non-thermal growth machine) or from the given target readings (for a thermal growth machine) must meet BOTH of the following conditions simultaneously: 1/2 the final total indicator reading at each indicator will be no more than shown in the table below AND the final remaining correction at each machine foot be no more than .001 inches of required movement.

Machine Speed (RPM)	Total Misalignment* (inches)
Up to 1800	.002
1800 and greater	.001

* 1/2 indicator reading

3.06 FIELD TESTING

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions. Provide all necessary calibrated instruments to execute performance tests. Submit report certified by the pump manufacturer’s representative.

B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall:

a. Verify that the equipment is free from defects.

b. Check for alignment as specified herein.

c. Check for direction of rotation.

d. Check motor for no load current draw.

2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.

3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.

4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag

1. Upon completion of the above, and at a time approved by the Engineer, the equipment will be tested by operating it as a unit with all related piping, ducting, electrical and controls, and other ancillary facilities.

2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.

3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Operating field tests shall consist of the following:

a. Check equipment for excessive vibration and noise as specified herein.

b. Check motor current draw under load conditions. The rated motor nameplate current shall not be exceeded.

c. Recheck alignment with dial indicators where applicable, after unit has run under load for a minimum of 24 hours.

D. In addition to the above described field tests, any other tests specifically required by Section 11100, Pumps-General, the individual equipment Specifications, or by the manufacturer shall be performed.

E. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.

F. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.

G. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.

H. All costs in connection with field testing of equipment such as lubricants, temporary instruments, labor, equipment, etc., shall be borne by the Contractor. Power, fuel,

chemicals, water, etc. normally consumed by specific equipment shall be supplied by the Owner unless otherwise specified in the individual equipment specifications.

I. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

J. Field testing of electric motors shall be in accordance with Section 15170, Electric Motors and Section 16000, Basic Electrical Requirements.

3.07 VIBRATION TESTING

A. Unless specified otherwise in the detailed equipment specifications, each pump, mixer, motor or similar item of stationary rotating equipment having a rated power of 40HP or greater shall be tested after installation for acceptable vibration levels.

B. Vibration testing shall be performed by an experienced factory-trained and authorized third-party analysis expert (not a sales representative) retained by the Contractor and approved by the Engineer. Each unit or pump system shall be tested separately without duplicate equipment running. All field testing shall be done in the presence of the Engineer. The Engineer shall be furnished with four (4) certified copies of vibration test data for each test performed.

C. For systems with variable speed drives, tests shall be conducted at various speeds between maximum and minimum. For systems with two-speed drives, tests shall be conducted at both speeds. For systems with constant-speed drive, tests shall be conducted under various loading conditions as determined by the Engineer.

D. All field vibration tests shall be performed with the equipment operating on the product for which it is intended, or a substitute acceptable to the Engineer.

E. The term displacement, as used herein, shall mean total peak-to-peak movement of vibrating equipment, in mils; velocity or speed of the vibration cycle, measured in G's. Displacement and velocity shall be measured by suitable equipment equal to IRD Mechanalysis, Bentley, Nevada.

E. Frequency of vibration, in cycles per minute (cpm), shall be determined when vibration exceeds specified levels or as otherwise necessary. Vibration shall be measured on the bearing housing, unless other locations are deemed necessary by the vibration analysis expert and Engineer.

F. For all equipment tested, vibration shall be checked in the radial and axial directions. Unless otherwise specified elsewhere, axial vibration shall not exceed 0.1 in/sec; and radial vibration shall not exceed 0.2 in/sec. For pumps radial vibration shall not exceed that permitted by the Hydraulic Institute Standards except that, at vibration frequencies in excess of 8,000 cpm, the velocity shall not exceed 0.2 in/sec.

G. Copies of test results shall be submitted to the Engineer for review. Should the vibration field test results exceed shop test results, the manufacturer's recommendations, or the limits

specified herein, the Contractor shall correct the deficiencies within thirty (30) days. After corrections have been completed, the vibration testing shall be re-run and the results re-submitted to the Engineer for review.

H. Noise or vibration in any rotating equipment which the Engineer judges to be excessive or damaging, shall be cause for rejection.

3.08 FAILURE OF EQUIPMENT TO PERFORM

A. Any defects in the equipment, or failure to meet the guarantees or performance requirements of the Specifications shall be promptly corrected by the Contractor by replacements or otherwise.

B. If the Contractor fails to make these corrections, or if the improved equipment shall fail again to meet the guarantees or specified requirements, the Owner, notwithstanding his having made partial payment for work and materials which have entered into the manufacture of said equipment, may reject said equipment and order the Contractor to remove it from the premises at the Contractor's expense.

C. The Contractor shall then obtain specified equipment to meet the contract requirements or upon mutual agreement with the Owner, adjust the contract price to reflect not supplying the specific equipment item.

D. In case the Owner rejects said equipment, then the Contractor hereby agrees to repay to the Owner all sums of money paid to him for said rejected equipment on progress certificates or otherwise on account of the lump sum prices herein specified.

E. Upon receipt of said sums of money, the Owner will execute and deliver to the Contractor a bill of sale of all his rights, title, and interest in and to said rejected equipment; provided, however, that said equipment shall not be removed from the premises until the Owner obtains from other sources other equipment to take the place of that rejected.

F. Said bill of sale shall not abrogate Owner's right to recover damages for delays, losses, or other conditions arising out of the basic contract.

3.09 PAINTING

A. All surface preparation, shop painting, field repairs, finish painting, and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.

B. All shop coatings shall be compatible with proposed field coatings.

C. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

D. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be

maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.10 WELDING

A. The Equipment Manufacturer's shop welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirement of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

B. The Contractor's welding procedures, welders, and welding operators shall be qualified and certified in accordance with the requirements of AWS D1.1 "Structural Welding Code - Steel" or AWS D1.2 "Structural Welding Code - Aluminum" of the American Welding Society, as applicable.

C. The Contractor shall perform all field welding in conformance with the information shown on the Equipment Manufacturer's drawings regarding location, type, size, and length of all welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society, and special conditions, as shown by notes and details.

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SECTION 11100

PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.

B. All pumping equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.

D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 11000, Equipment General Provisions.

1. Details of shaft sealing system

2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.

3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.

4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).

5. Submersible pump submittals shall also include:

a. Product data sheets for power and control cables and length of cables.
b. Details on pump guide rail system and mounting requirements.

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PART 2 -- PRODUCTS

2.01 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 584, “G” bronze.

3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.

B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.02 APPURTENANCES

A. Pressure Gauges

1. The Contractor shall furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible pumps and vertical turbine pumps.

2. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.

3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.

4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.

5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.

6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.

B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.02 ELECTRICAL REQUIREMENTS

A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.

B. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating between pump supplier and VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Low Voltage Variable Frequency Drive Systems.

C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.03 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of Section 11000, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with galvanized steel pipe or copper tube, properly supported with brackets.

B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.02 SHOP TESTING

A. Shop tests shall be performed in accordance with Section 11000, Equipment General Provisions, and except where stated otherwise herein, shall be conducted in accordance with the latest version of Hydraulic Institute Standard 14.6, Hydraulic Performance Acceptance Tests.

B. Pump testing shall be witnessed by the Owner/Engineer where specified in the individual pump specifications. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.

C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps (as specified in Sections 11133 and 11136) with motors less than 5 hp.

D. Pumps shall be within the tolerances specified for Acceptance Grade 1U, in accordance with the latest version of Hydraulic Institute Standards 14.6.

E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.

F. Where required in the individual pump specifications, each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a registered professional ENGINEER. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

3.03 FIELD TESTING

A. Field tests shall be performed in accordance with in Section 11000, Equipment General Provisions and additionally as specified below and in the individual pump specifications.

B. Final acceptance tests shall demonstrate the following:

1. The pumps have been properly installed and are in proper alignment.

2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.

3. The pumps can meet the specified operating conditions. All pumps shall be checked at maximum speed for a minimum of four points on the pump curve for capacity, head, and amperage. The rated motor nameplate current shall not be exceeded at any point. Pumps with drive motors rated at less than five horsepower shall only be tested for overcurrent when overheating or other malfunction becomes evident in general testing.

- END OF SECTION -

SECTION 11180

COMPRESSED AIR EQUIPMENT

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation a rotary screw air compressor system complete with appurtenances as specified herein, shown on the Drawings, and as required for a complete operable system.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

C. For compatibility of equipment and controls, all equipment for the air compressor system shall be furnished by a single supplier who shall assume complete responsibility through the Contractor for proper operation of the equipment, including that of coordinating power supply and controls, and furnishing all appurtenant equipment. Valves and air piping not specified in this Section shall be provided in accordance with the requirements of Division 15.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. The air compressor system shall take suction air from the building ventilation air and discharge moisture-free and oil-free air for the operation of the intake screen air burst system and pneumatically operated pump control valves. Equipment locations and identification numbers are as shown on the Contract Drawings.

B. Performance requirements for the rotary screw air compressor system shall be as follows:

Air Compressor:	
Number of Units	2
Minimum Discharge Pressure (psig)	58-65
Maximum Discharge Pressure (psig)	125-135
Capacity at Maximum Discharge Pressure (scfm)	51
Minimum Ambient Operating Temperature (ºF)	32-35
Maximum Ambient Operating Temperature (ºF)	104-115

1.03 SUBMITTALS

A. Shop Drawings shall be submitted in accordance with the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions.

PART 2 -- EQUIPMENT

2.01 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per the air compressor system Manufacturer's recommendations. The rotary screw air compressor system shall be as manufactured by Gardner-Denver, Ingersoll-Rand, Quincy Compressor, or equal.

2.02 GENERAL

A. The air compressor system provided under this section shall be assembled, erected, and placed in proper operating condition. All equipment and materials shall be designed and constructed in accordance with the applicable requirements of the standard specifications and codes of ANSI, ASTM, NEMA, applicable provisions of the ASME Boiler and Pressure Vessel Code, and other such regularly published and accepted standards, except where modified or supplemented by these Specifications.

B. Air compressor system shall include, but not be limited to, an air compressor with gear driven electric motor and safety air relief valve, integral air dryer, coalescing filters, pressure regulator, a common control panel with motor starter, piping, wiring, and all other appurtenances required to provide a complete package unit ready for installation.

2.03 AIR COMPRESSOR

A. Air compressor shall be of the single-acting, single-stage, air-cooled type, with automatic unloading. Compressor shall be unloaded every time the unit stops, regardless of the cause of shutdown. The air compressor shall consist of an enclosure, baseplate, inlet air filter, airend, electric motor with belt drive, cooling system, coolant/air separation system, piping, controls, wiring, and all other accessories required to provide a complete air compressor. Compressors shall be suitable for continuous operation without overheating. All components of the air compressor system package shall be the standard products of the air compressor system Manufacturer.

B. Enclosure

1. Compressor enclosure shall be a NEMA 4 rated enclosure, constructed of sheet metal, providing effective sound attenuation and easy access for maintenance purposes. Enclosure shall include a removable, hinged front door. Sound level shall be limited to 75 dB in accordance with PNEUROP/CAGI test codes within a ± 3 dB tolerance.

C. Baseplate

1. A one-piece, folded, mild steel baseplate shall be furnished supporting all components within the air compressor unit. Baseplate shall be protected from corrosion with a high-grade, powder-coated paint finish. The baseplate shall be provided with fork truck slots to enable easy handling from front or end of the package.

D. Inlet Air Filter

1. The inlet air filter shall be of the oil-wetted or dry type, mounted in suitable steel housing, arranged to permit easy removal of the filter medium for servicing. Inlet air filter shall be 99.9% efficient at the 3 micron particle size and above and shall be furnished with a pressure differential indicator.

E. Airend

1. Airend shall consist of male and female rotors identical in diameter. Rotor shaft shall be precision ground within a ± 12 micron tolerance. Rotor housing shall be made of high quality, close-grain cast iron.

2. Discharge end of the male and female rotors shall each be equipped with a pair of tapered, roller thrust bearings offset at opposing axis for maximum absorption of thrust and radial loads. Bearing housing shall be constructed of close-grain cast iron. Inlet end of the rotors shall be furnished with high quality, cylindrical, roller bearings used to carry radial loads. All bearings shall be degassed providing truer, harder running surfaces for both inner and outer bearing races. Coolant dams shall be machined at the thrust bearing locations providing an area for coolant collection ensuring the bearings are immediately lubricated at start-up.

3. A triple-lip shaft seal shall be fitted to the male rotor that returns all coolant to the inlet end ensuring a leak-free airend.

F. Cooling System

1. Cooling system shall include a full capacity, 5-micron coolant filter with replaceable spin-on element with pressure bypass.

2. A thermostatic control valve shall be mounted downstream of the oil cooler. The temperature sensitive element controls the flow of coolant through the oil cooler providing proper injection temperature and fast warm-up.

3. The coolant shall be injected through ports near the airend inlet and directed back toward the inlet cover ensuring the best possible pre-sealing of the rotors, and an optimum mix of coolant with air. The differential pressure between the separator tank and the airend inlet shall induce coolant flow.

G. Coolant/Air Separation System

1. A separator shall be used to remove the coolant from the air stream through a three-stage separation system. Air passages and the separator cartridge shall be of a conservative design to minimize pressure drop and the power required to move the air through the compressor system.

   a. In the first stage, the air and coolant mixture from the airend discharge directly enters the separator tank through a nozzle, directing the mixture flow to the end of the vessel. This action forces heavier coolant particles to the periphery of the tank combining these particles with the main liquid body in the sump.

   b. The airflow then passes through the separator cartridge coalescing element, combining the second and third stage of separation. The separator cartridge is two-stage with reinforced construction. Coolant, which has collected at bottom of the separator cartridge shall be drawn back to the airend inlet through a scavenge system.

2. Compressed air shall then pass to the air-cooled aftercooler where coolant vapor carryover shall be further removed as it is condensed and drained together with water condensate. Aftercooler shall be of an aluminum tube and fin design, capable of operating in ambient temperatures from 35°F up to 104°F. The aftercooler shall cool the compressed air to 18°F above ambient air temperature at 104°F and 60% RH. A centrifugal cooling fan shall be mounted in an internal segregated cooling compartment. A partial vacuum shall form within a plenum, drawing cooling air across the cooler with even velocity over the full surface area of the cooler matrix. Carryover after the aftercooler shall be less than 3 ppm. The aftercooler assembly shall be accessed through a single simple opening, providing access to both sides of the cooler. The cooling airflow shall be pre-filtered through an easy to clean filter panel, protecting the cooler matrix from heavy dirt ingress.

3. A separator tank shall be mounted horizontally and close-coupled to the airend forming one module. A pressure relief valve mounted on the tank shall protect the separator tank. Tank shall be provided with a drain located at the bottom of the tank and a coolant filler point, located to prohibit overfilling the compressor. A coolant level indicator shall also be furnished on the side of the tank. The highly efficient separation system, combined with suitably sized sump volumes, provides for normal coolant top-up intervals of 500 hours.

5. A combined minimum pressure check valve shall regulate the air discharge from the separator ensuring that when the unit is unloaded sufficient pressure is maintained in the tank to propel the coolant through the system. Discharge check valves shall be suitable for the maximum compressor discharge air temperature anticipated.

6. Compressors shall be supplied with an inclusive factory fill of coolant. Coolant shall be a Polyol Ester synthetic lubricant, with a 2 year (8,000 hours) service life. Condensate containing traces of the coolant fluid should be processed to meet local environmental requirements before disposal in an approved manner.

2.04 REFRIGERATED AIR DRYER

A. A refrigerated air dryer shall be integral to the air compressor, installed on the discharge side of the compressor. Pressure drop across the unit shall not exceed 3.8 psig at operating conditions.

B. The refrigerated air dryer shall be factory-tested and packaged and shall consist of a cabinet, condenser-evaporator, refrigeration section and automatic condensate discharge. The air dryer shall efficiently remove vaporized and entrained moisture from the compressed air. The motor shall conform to the applicable requirements of Section 15170, Electrical Motors.

2.05 IN-LINE FILTERS

A. A general-purpose filter (1.0 microns) shall be installed upstream and internal to the air compressor package.

B. A high efficiency, coalescing filter shall be installed downstream before the existing air receivers to remove oil and condensed water from the air stream. The filter housing shall be a T-type pressure vessel of all-metal construction with stainless steel internals and Buna N seals. The element shall not pass particle solids or droplets larger than 0.01 microns at 99.99% efficiency. Filters shall be rated for an air stream flow of 105 scfm at 100 psig. The filter shall be equipped with an automatic float drain with manual override and differential pressure indicator. The filter shall be model F178IH, as manufactured by Ingersoll-Rand, model CPNT00150 as manufactured by Quincy Compressor, or equal.

2.06 AIR PRESSURE REGULATOR

A. Air pressure reducing and regulating valves shall be installed in the compressed air system where shown on the Contract Drawings and as recommended by the air compressor system Manufacturer. The regulator shall be equipped with an adjusting screw or key to reduce an initial pressure to a resultant pressure control range of 7 to 145 psig. Regulating valves shall have bronze or cast iron bodies with NPT threaded ends. The valves shall be properly sized for supplying the full flow of air required at reduced pressure. The valve shall be stainless steel or bronze fitted and suitable for a maximum inlet pressure and air flow of 232 psig and 250 scfm, respectively. Valve shall be designed to operate over a temperature range of -4 ºF to 176 ºF. Valves shall be provided with a mounting bracket where required. Valves shall be constructed so that repairs can be made without removing the valve from the line.

2.07 ACCESSORIES

A. Safety/Pressure Relief Valves

1. Safety/pressure relief valves shall be furnished for installation in the compressor discharge piping and as recommended by the air compressor system Manufacturer. The safety/pressure relief valves in the compressor discharge piping shall be capable of protecting the compressors from damage when operating with closed discharge valves. The safety/pressure relief valves in the compressor discharge

piping shall be suitable for the maximum compressor discharge air temperature anticipated.

B. Thermometers

1. Thermometers shall be constructed of 300 series stainless steel case, bezel and fittings with external recalibration adjustment. Thermometers shall be accurate to ±1% of the scale range. The head assembly shall be a minimum of 5-inch in diameter with a white aluminum scale plate with permanent black figures and graduations, and dished for "in-line" readings to eliminate parallax errors and a balanced black pointer. The head assembly shall be sealed against dust, fumes and moisture. The window shall be shatterproof glass. The stem and connectors shall be stainless steel with all joints welded. The thermometer shall have a NPT fixed connection. Installation arrangements shall be in accordance with manufacturer's recommendations. Thermometers shall be either straight or back angle style as required for the installation. Thermometers shall be graduated from 0° to 250°F or higher, depending on the maximum anticipated temperature. Thermometers shall be as manufactured by Crosby Valve and Gage Company, or equal. Thermometers shall be provided between the compressor discharge and the existing receiver intake.

F. Valves

1. Ball valves shall be used for shut-off valves where indicated on the Contract Drawings and recommended by the air compressor system Manufacturer. Valves in the compressor discharge piping shall be suitable for maximum compressor discharge air temperature anticipated. Ball valves shall be as specified in Section 15104, Ball Valves.

G. Piping

1. SAE hoses with JIC fittings, rigid steel piping, Bundy weld tubing, flexible connectors and nylon tubing shall be furnished as appropriate to provide vibration free operation. SAE "O" Ring fittings are applied on all connections larger than 3/8-inch in diameter. After manufacturing and assembly, each air compressor unit shall be 100% inspected and tested to provide a piping system with minimum potential for leaks. Flexible connections or couplings shall be installed on piping connected to the compressed air equipment to absorb expansion and contraction, isolate vibration, absorb noise, correct misalignment and relieve piping stresses. Lengths of flexible connectors shall be as recommended by the manufacturer.

2.08 ELECTRICAL AND CONTROL REQUIREMENTS

A. Air Compressor Motor and Drive

1. A TEFC, low speed, four-pole electric motor shall be designed in accordance with torque and load requirements to ensure peak efficiency and power factor at full load. Double shaft construction with the cooling blower provides motor cooling. Motor

frame shall be of a standard NEMA design. Motor shall conform to the applicable portions of Section 15170, Electric Motors.

2. Motor shall be supplied with vacuum degassed, grease-lubricated ball bearings for the drive end and non-drive end.

3. Transmission of power from the motor to the airend male rotor shall be via a belt drive designed for 50 percent overload. Belt drive shall be adjustment-free, under constant tension, and shall protect against motor and airend bearing overload and slippage. Belts and sheaves shall be of the heavy-duty "V" type. Belts for each compressor shall be matched sets. All exposed rotating shafts, couplings, flywheels, sheaves, and belts shall be provided with guards in accordance with OSHA regulations.

B. Motor Schedule

	Air Compressor	**Refrigerated Air Dryer**
Rating	460V, 3 ph, 60 Hz	115V, 1 ph, 60 Hz
Horsepower	15	2/3
Rated Speed, rpm	3,560	-
Enclosure	TEFC	ODP
Insulation	Class F	Class F
Inverter Duty	No	No
Service Factor	1.15	1.15
Space Heater	No	No
Motor Winding Temperature Switches	No	No
Separate Cooling Fan	No	No

2.09 CONTROL EQUIPMENT

A. All control equipment for each air compressor system shall be furnished as required for a complete installation and shall be designed and constructed in accordance with National Electrical Code (NEC) guidelines.

B. Each air compressor system shall be furnished with an integral NEMA 4 control panel which shall start and stop the compressors as required and shall unload the compressor on stopping and while coming up to speed on starting. Unloading shall be accomplished through intake valve control. All components of the control panel shall be UL and/or CSA approved and shall include, but not be limited to, the following:

1. One (1) star-delta reduced voltage non-reversing magnetic motor starter.
2. One (1) control voltage transformer.
3. One (1) Compressor Discharge pressure gauge.
4. One (1) hour meter.
5. One (1) Start-Stop selector switch.
6. One (1) Fault/High Air Temperature indicating light.

7. One (1) Power On indicating light.
8. One (1) Auto Restart indicating light.
9. One (1) Emergency Stop pushbutton.
10. One (1) Reset pushbutton.
11. Dry contacts for Run and Fault/High Air Temperature status.

C. Control panel shall be furnished with circuitry to alternate the operation of the two air compressor system. In lieu of integral circuitry to the control panel, a NEMA 4, 115V/1Ph/60Hz powered pneumatic alternating sequencer shall be utilized for alternating operation of the compressors, mounted locally in the air system room as indicated on the Drawings. If one compressor/dryer unit should be temporarily out of operation, the other shall operate continuously.

D. The compressor control shall start and stop the compressors at receiver pressure setpoints currently utilized in the field.

E. A protection control system shall be provided for each compressor for stopping the compressor on low oil pressure, low oil level, air dryer malfunction, and high discharge air temperature.

F. Equipment shall include all solenoid valves, control switches, pressure gauges, pressure switches, timing relays, auxiliary relays, unloaders, circuit breaker combination magnetic motor starters, and other accessory equipment as required for control of each compressor. A control transformer shall be provided with a 120 volt secondary, one secondary lead fused and the other grounded. Starter overloads (one per phase) shall be matched to motor current. Electrical Subcontractor shall furnish a thermal magnetic circuit breaker with external operating handle for each motor starter, housed in a NEMA 4 enclosure and mounted as indicated on the Contract Drawings.

G. All system wiring shall be installed to terminal blocks in the control panel. Wiring from the panel to system components shall be completely enclosed in liquid tight flexible conduit. All field connections shall be to terminal strips within the panel. Electric schematics, wiring diagrams and panel layout drawings for compressor controls shall be included.

H. All pneumatic tubing between electro-pneumatic instruments shall be furnished with the appropriate fittings and accessories. All pneumatic tubing to the control panel shall be installed to bulkhead fittings. All field connections shall be made to the fittings within the panel. All control devices shall be rigidly mounted within the integral panel except pressure gauge, hour meter, selector switches, indicating lights, and pushbuttons which shall be mounted on the panel face.

I. Internal panel tubing, where required, shall be run in the horizontal and vertical plane, rigidly supported to withstand handling and shipment. Compression type bulkhead fittings shall be provided for all connections. Compression nuts and sleeves shall be provided for field connections.

J. Internal panel wiring shall be neatly bundled and tied and identified with suitable wire markers. Terminal blocks for external connections shall be fabricated complete with

marking strips, covers, and pressure connectors. A terminal shall be provided for each conductor of external circuits. All wiring shall be grouped or cabled and firmly supported to the panel. Clearance shall be provided between the terminal strips base for field wiring space.

K. Temperature switches shall be stainless steel thermal well assemblies and armored capillaries. Switches shall be 5 ampere for 120 volt AC service. Capillary length shall be sufficient for convenient mounting. Switches shall be of the manual reset type. Temperature switch shall be provided between the compressor and the existing receiver intake and shall be pre-wired to the control panel.

L. Pressure gauges shall be provided as required in the air compressor system and shall be in accordance with the requirements of Section 17650, Pressure Gauges.

M. Pressure switches shall be provided as required in the air compressor system and shall be in accordance with the requirements of Section 17675, Pressure Switches.

N. Air compressor system shall automatically restart following restoration of an interrupted power supply returning the compressor to its mode of operation that it was in prior to power interruption. The restart time delay shall be adjustable with an audible alarm sounding during the restart time delay period after which the compressor shall automatically start.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions. Field services shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.02 INSTALLATION

A. The Contractor shall furnish and install the air compressor system in accordance with the manufacturer's instructions and in accordance with Section 11000, Equipment General Provisions.

B. Compressor/dryer units and motors shall be installed on concrete pads, unless otherwise shown on the Contract Drawings. The concrete pads shall be finished smooth and level to the satisfaction of the Engineer. The Contractor shall anchor the compressors to the pad with Type 316 stainless steel expansion bolts. All piping, valves, fittings, conduit, wiring, etc. required to interconnect system components shall be furnished and installed by the Contractor. Unless otherwise shown on the Contract Drawings or specified in Division 15, air piping shall be constructed of standard weight galvanized steel pipe.

3.03 TESTING AND START-UP

A. Testing of the air compressor system shall be as specified herein, and in accordance with Section 11000, Equipment General Provisions.

B. Shop Tests - For the service air compressor, certified performance information based on previous testing of an identical unit may be submitted in lieu of a shop test and certified test curve for the unit being furnished.

C. Field Tests - Preliminary field tests shall be performed as soon as possible after installation of equipment. Final acceptance tests shall include, but not be limited to, the following:

1. That the air compressor system has been properly installed and is in proper alignment.

2. That the air compressor system operates without overheating or overloading of any parts and without objectionable noise or vibration.

3. That there are no mechanical defects in any of the parts.

4. That the inlet valve opens at start-up.

5. Motor amperage measurement at start-up.

6. That all controls and safety devices operate as specified or intended.

D. The Contractor shall check the functioning of all equipment as specified or otherwise directed by the Engineer. If the inspection or test shows defects, such defective work or materials shall be replaced and the system test shall be repeated. Repairs to the system shall be made with new materials. Caulking of screwed joints or holes shall not be acceptable. After testing, all parts of the system shall be thoroughly cleaned and all connections to equipment and valve operators shall be adjusted for the proper air flow and pressure.

3.04 TOOLS, SUPPLIES AND SPARE PARTS

A. The Contractor shall furnish all accessories, spare tools, and spare parts as recommended by the equipment Manufacturer in accordance with Section 11000, Equipment General Provisions. Spare parts shall include the following:

Part Description	Number Required
Air intake filter elements	2
Oil filter	2
V-belt drive set (matched)	2
In-line filter elements	2 (each type)
Lubricating oil (5 gal)	2

3.05 PAINTING

A. All surface preparation, shop painting, field repairs, field painting and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting, and Section 11000, Equipment General Provisions.

3.06 EQUIPMENT IDENTIFICATION

A. The equipment shall be provided with a substantial stainless steel nameplate in accordance with Section 11000, Equipment General Provisions.

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SECTION 11240

VERTICAL TURBINE MIXERS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, adjust, and place in satisfactory operation all vertical turbine mixers as shown on the Drawings and specified herein. This includes two (2) variable speed mixers and tank baffles (as recommended) for the powdered activated carbon (PAC) slurry tanks. The Contractor shall furnish, install, adjust, and placed in satisfactory operation all baffle walls as recommended by the Manufacturer and specified herein.

B. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions.

C. The vertical mixer assemblies shall be complete with motor, flexible coupling, gear reducer, mixer shaft, impellers, and all accessories and appurtenances as specified herein and as indicated on the Contract Drawings.

D. The Manufacturer and Contractor shall thoroughly review the conditions of service and mounting arrangements for the proposed mixers including basin geometry, flow path, baffling requirements, freeboard, baseplate/anchorage, and support and shall select mixing equipment suitable for the proposed application.

1.02 CONDITIONS OF SERVICE AND PERFORMANCE REQUIREMENTS

A. The PAC mixers shall be mounted on the closed-top PAC storage tanks and shall maintain a homogeneous carbon slurry. The equipment shall be designed and selected by the equipment manufacturer for the specific conditions of service and installation arrangements indicated on the Contract Drawings. Materials of construction for the mixers shall be in conformance with the specifications and shall minimize corrosion of the equipment in the presence of the specified chemical slurry.

B. Mixer Schedule

Location	Powdered Activated Carbon Slurry Tanks
Total Number of Mixers	2
Mounting Arrangement	Refer to Drawings
Tank Volume	18,000 gallons
Slurry Concentration	1 to 2 pounds PAC / gallon water
Tank Dimensions	Refer to Drawings
Operating Platform Top Elevation	Refer to Drawings
Max. Water Surface Elevation	Refer to Drawings
Minimum Shaft Diameter	4” upper, 3.5” lower
Number of Impellers	2
Upper Impeller Diameter	Minimum of 43”

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Location	Powdered Activated Carbon Slurry Tanks
Upper Impeller Elevation	Minimum of 148” above tank bottom
Upper Impeller Type	Pitched Blade
Lower Impeller Diameter	Minimum of 43”
Lower Impeller Elevation	Maximum of 23” above tank bottom
Lower Impeller Type	Pitched Blade
Baffle Configuration	per Manufacturer’s Recommendation
Maximum Impeller RPM	70
Motor Horsepower, HP	15
Vapor Seal Assembly	Yes
Desiccant Breather	Yes

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

1. Dimensional drawings indicating mixer size, shaft length, impeller type, impeller speed and diameter, motor horsepower, motor speed and frame size, and gear ratio and dimensions.

2. Motor performance data sheet.

3. Calculations for gear reducer AGMA service factor. Calculations shall be submitted with shop drawings. Calculations shall be based upon the specific load encountered and forces experienced by the mixer in this specific application. The calculations shall demonstrate that the loads used in the calculations are the actual loads encountered in this specific installation. Calculations shall be sealed by a Professional Engineer in the State in which the project is located. Contractor shall also submit gear reducer materials of construction, efficiency, bearing ratings, and lubrication details.

4. Calculations showing mixing energy imparted to fluid, including water horsepower at minimum and maximum temperatures and power number and ratio of impeller loading to nameplate horsepower. Calculations shall be specific to these installations.

5. Complete lubricant schedule, including manufacturers of recommended lubricant and a cross reference table of alternative lubricant manufacturers and brand names for each lubricant recommended. Schedule shall include frequency of lubricant application, type of lubricant, and comments / remarks regarding lubricant application.

6. Manufacturer’s recommendations on baffles. If recommended, Manufacturer to provide dimensional drawings.

7. Description of coating system, surface preparation and shop painting, including certification that the shop paint is compatible with the finish paint.

8. PAC Mixers

a. Manufacturer’s recommendations on supports and anchorage.

b. Templates or certified setting plans, with tolerances for anchor bolts.

c. Upon request, the following additional items shall be submitted:

- Bearing life calculations. Calculations shall be based upon the specific load encountered and forces experienced by the mixer in this specific application. Calculations performed by the bearing manufacturer which do not account for the axial and radial loads encountered in this specific application will not be accepted.

- Calculations supporting shaft and impeller design criteria (stresses and critical speed). Calculations shall be based upon the specific load encountered and forces experienced by the mixer in this specific application. Any additional condition factors resulting from the specified configuration shall be incorporated into these calculations. All loads shown shall be demonstrated to be the loads expected to be encountered in this application.

1.04 MANUFACTURER'S AND CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall install, anchor, test, and align the mixing equipment such that mixing of the chemicals is achieved with vibration levels which are within specified tolerances. The Contractor shall provide all supports, stiffeners, baffles, etc., that may be required to provide mixing systems that operate reliably and in accordance with the Contract Drawings and Specifications.

B. Mixer variable frequency drives (VFDs) shall be furnished under Division 16. Mixer equipment manufacturer shall provide information to Contractor for coordination with VFD manufacturer as required.

C. To ensure system responsibility and design integration, the gear reducer, impeller, and impeller shaft shall be designed, manufactured and tested by the mixer supplier. Second party manufactured gear drives are not allowed. The mixer supplier shall have a complete after sale service program; which would include service personnel for on-site repairs and an inventory of spare gear reducers available for shipment from the manufacturer’s inventory within 24 hours notice. The intent of this is to establish unit responsibility and after market support for the complete mixer assembly.

D. Manufacturer shall have the capabilities to verify the impeller selections with an in-house Laser Doppler Anemometer (LDA) or Velocimeter (LDV) and Computational Fluid Dynamics (CFD) software. Manufacturer shall submit velocity map of the specific basin geometry and inlet and outlet conditions for this Project through use of the CFD program. Manufacturer shall submit recommended impeller elevation and dimensions of any required deflector and baffle plate(s).

1.05 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 11000.

PART 2 -- MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

A. The mixers shall be manufactured by Philadelphia Mixing Solutions Limited or Lightnin (SPX FLOW).

2.02 VERTICAL MIXER CONSTRUCTION

A. Gear Reducer

1. The mixer gear reducer shall be mounted on a pedestal base a minimum of 12-inches above the tank or channel deck with the output shaft rigid coupling below the base of the mixer to allow the disassembly of the coupling above the tank or channel deck. The pedestal shall be integral to the gear reducer. I-beam type channels will not be allowed in place of pedestal mount.

2. Gear reducer housing and pedestal base shall be constructed of ductile iron, close grained cast iron, or fabricated steel, stress relieved and reinforced, and shall be provided with lifting lugs or holes.

3. The gear reducer for each mixer shall be directly connected through a flexible coupling to the electric motor driver. The gear reducer shall be specifically designed for the applications detailed in Section 1.02 and shall be capable of 24-hour/day continuous operation.

4. The gear reducer shall be designed in accordance with AGMA Standard 6013-B16 requirements for 24-hour/day operation with a minimum AGMA service factor of 2.0 based upon motor nameplate horsepower. Service factors shall not be calculated based on brake horsepower loads. The basic rating of the gear reducer shall adhere to appropriate AGMA standards and the gear reducer shall bear an AGMA nameplate, or the manufacturer shall certify, in writing, that the gear reducer is designed to the applicable AGMA standards.

5. The gear reducer shall be of the horizontal, right angle design with a combination of helical and spiral bevel gearing. Gear reducers with vertically mounted motors are not acceptable. Worm gear or planetary gear assemblies are not acceptable.

6. All gearing must be contained in a single housing. Auxiliary gear boxes to obtain double or triple reduction are not acceptable. The driven gear in any gearset shall be supported by bearings on both sides of the gear.

7. Gearing shall be of AGMA quality No. 10 or better per AGMA Standard 013-B16, 390.03A, and 2000-A88.

8. All gearing shall be immersed in a common bath of lubricating oil. All rotating parts and bearings, with the exception of the output shaft and output shaft

bearings, shall be immersed in oil or splash lubricated by means of the gears or a slinger rotating on the horizontal gear shafts in the oil bath. Oil leakage down the impeller shaft shall be prevented by means of an oil dam around the shaft. The gear reducer shall be provided with a dipstick and/or a sight glass to observe oil level. Lubrication systems requiring oil pumps are not acceptable. Grease packed gear reducers are not acceptable.

9. A single oil drain shall be provided at the low point of the gear reducer to allow oil drainage. The oil drain shall be extended from the gear reducer to prevent leakage and spillage during oil changes. No oil seals will be permitted below the operating oil level for rotating elements. The gear reducer openings below the operating oil level shall be positively sealed with compressible gaskets. All oil fill and drain lines and grease fittings shall be located so as to be easily accessible.

10. All gear reducer bearings shall be anti-friction type ball or roller bearings and shall have a minimum rated B-10 life of 100,000 hours. Reducer bearings shall be oil lubricated and shall be submerged in the lubricating oil. All low speed tapered roller bearings must be indirectly mounted. All other bearings shall be of the size and type appropriate given the torsional, thrust and lateral loads encountered. All oil lubricated bearings shall be located above the top of the main lubricant drain, and at least 3 inches above the bottom of the gear reducer to prevent premature bearing wear due to sludge and metal particle accumulation in the bearings.

11. Gear reducer shall have an oversized solid output shaft equal or larger than the mixer shaft. Output shaft bearings shall be grease lubricated and shall be furnished with a high quality lipseal to retain grease. Output shaft bearings shall be sized based on the actual (not average) thrust and bending loads generated by the agitator shaft and impeller assembly. The output shaft shall be installed through a drive sleeve, enabling it to be removed without disturbing the gear mesh.

12. To prevent moisture from contaminating the oil, the gear reducer shall be furnished with a disposable desiccant breather. The breather shall have a disposable 3-micron polyester filter for solid particulate and a hygroscopic agent to prevent water vapor from entering the gear reducer. The gear reducer breather shall be located above possible oil foam level.

13. The full load operating noise levels of the gear reducer and motor shall meet current OSHA occupational noise standards, and/or AGMA Standard 914-B04, and not exceed 85 dB at a distance of 3 feet from any part of the unit.

14. The thermal rating of the gear reducer shall exceed the design mechanical rating to eliminate the need for external coolers. External cooling devices are not acceptable.

15. Where required in the mixer schedule, the mixer base and output shaft shall be furnished with a vapor seal assembly which shall include either a V-ring seal, clamping collar and Teflon wear plate or a 316 stainless steel ANSI 150 pound

flange and Teflon lip seal and Teflon wear plate to prevent foul air from escaping through the shaft openings in the slab.

B. Mixer Shaft

1. The mixer shaft shall be connected to the flange of the reducer output shaft by means of a rigid shaft or split removable coupling in the pedestal of the gear reducer above the mounting deck or tank. If required, the mixer shaft shall be provided in two sections (middle shaft and lower shaft) connected by a rigid coupling. Coupling(s) shall be an AISI Type 316 stainless steel or 316L rigid rabbeted coupling with an epoxy resin encapsulated key, or equal.

2. The mixer shaft and all materials located below the operating deck shall be constructed of 316 stainless steel.

3. Shaft diameter shall be determined by an analysis of torques, bending moment, thrust, pressure, temperature, and critical speed. The shaft shall be designed such that the maximum stress shall not exceed 8,000 psi under maximum operating loads. It shall be of the overhung design. The use of in-tank steady bearings is not permitted.

4. The shaft-impeller system design shall be such that its operating speed shall not exceed 70% of its first lateral critical speed. The use of stabilizing rings or fins will not influence this limitation.

5. Mixer shaft straightness, rigid coupling squareness, and gear reducer output shaft accuracy must be such that the maximum total indicated runout at the lower end of the mixer shaft does not exceed 1/8-inch per every 10 ft of shaft length, as measured when turning over by hand.

C. Mixer Impeller

1. The PAC mixers shall have a dual impeller system. The upper impeller shall be a pitched blade or axial flow, down-pumping impeller designed to produce high volume pumping capacity with a minimum of turbulence. A keyway shall be furnished providing an adjustment of 12 inches downward and 12 inches upward with 3-inch increments. The lower impeller shall be a pitched blade or axial type impeller.

2. Maximum tip speed shall not exceed 17 ft/s for all mixing applications.

3. Impellers shall be connected to the mixer shaft with a hook key. PAC mixer impeller blades shall be removable for installation using 30” side tank manway as shown in the Drawings.

4. Mixer impeller diameters and speed shall be selected by the manufacturer for the pertinent conditions of service.

5. Each impeller shall be constructed of AISI Type 316 stainless steel. Bolts for impellers shall be double-nutted.

6. The mixer impellers shall be loaded to a maximum of 80 percent of the motor's nameplate rating.

7. The impeller shall be dynamically and hydraulically stable and shall not cause the equipment to overload over the specified range of liquid levels with up to the specified flow rates through the basins.

8. The use of stabilizer rings will not be permitted.

9. The impellers shall be designed as to not allow Vortex formation.

D. Guards

1. All rotating shafts above the deck shall be provided with guards in accordance with OSHA.

E. Mounting Arrangements and Anchorage

1. Where the Drawings and Specifications indicate that the mixer pedestal base is to be mounted directly to a concrete slab, the Contractor shall coordinate with the mixer manufacturer to provide an opening in the slab of adequate size for the mixer shaft and rigid coupling.

2. Where Drawings and Specifications indicate that the mixer pedestal base is to be mounted on a baseplate, the Contractor shall coordinate with the mixer manufacturer to provide an opening/baseplate of adequate size for removal of the entire mixer assembly without removing the mixer shaft or impellers and without dewatering the tank or channel. The baseplate shall be designed to withstand all dead and live loads associated with the mixer plus a live load of 50 lb/sf over the area of the baseplate.

3. The Contractor shall provide a steel baseplate and installation arrangement subject to review and approval by the equipment manufacturer for the mixers furnished. The installation arrangements shall be reviewed by the manufacturer for support and prevention of vibration for the mixing equipment furnished. Plate stiffeners, added plate thickness, additional anchor bolts, modified impeller design, etc., shall be provided as required for a complete system that operates smoothly and reliably.

4. Anchor bolts for the mixers shall be supplied by the Contractor, the number and size of which shall be determined by the equipment manufacturer as required for mounting in accordance with the details shown and sufficient to withstand the torque and other loadings transmitted by the gear reducer. Anchor bolts shall be manufactured from 316 stainless steel, provided in accordance with the requirements of Section 05050, and shall comply with the manufacturer's recommendations for anchoring to concrete or structural support members (as applicable).

2.03 SIDEWALL BAFFLES

A. The Contractor shall furnish sidewall baffles as recommended by the Manufacturer. Baffles shall be of the dimensions as recommended by the mixer manufacturer and shall include side and bottom gap spacing requirements.

B. The sidewall baffles, support plates and anchorage shall be constructed of 316 stainless steel as shown on the Drawings and specified in Section 05050 – Metal Fastening and Section 05010 – Metal Materials.

2.04 ELECTRICAL AND CONTROL REQUIREMENTS

A. Motors shall conform to the applicable requirements of Section 15170, Electric Motors. Motors shall be furnished as follows:

	PAC Slurry Tank
Motors	
Rating	460V, 3 ph, 60 Hz
Horsepower	15
Speed, rpm	1170
Enclosure	TEFC
Insulation	Class H
Inverter Duty	Yes
Service Factor	1.0
Space Heater	Yes
Motor Winding Temperature Switches	Yes

B. The mixer manufacturer shall coordinate torque and speed requirements with the motor vendor to ensure that the motor matches the torque and speed requirements of the driven load over the entire range of operation. In addition, the mixer manufacturer shall coordinate with the drive manufacturer the settings of the variable frequency drive with the mixer to ensure proper operation. A written transmittal of the drive settings shall be sent to the Contractor prior to start-up of any equipment.

C. If the mixer manufacturer requires a larger drive motor than the horsepower indicated in the table above, then the manufacturer shall furnish the larger motor. The cost of any additional design work or equipment cost (including the cost of modifying the motor starters, conduit, wiring, etc.) shall be borne by the Contractor.

D. Variable Frequency Drives shall be provided by the Electrical Subcontractor as specified in Section 16495 to control the mixer.

E. The mixer motor shall be provided in accordance with all applicable requirements of Section 15170 – Electric Motors.

2.05 TOOLS, SUPPLIES AND SPARE PARTS

A. The Contractor shall furnish all special tools necessary to disassemble, service, repair and adjust the equipment and shall furnish a one-year supply of all recommended lubricating oils and grease. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required.

B. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions, and the Manufacturer shall provide the cost of the following spare parts as a separate bid item:

- One spare gear box
- One set of spare impeller blades, with impeller hubs and hardware
- One spare agitator shaft
- One set of bearings and seals for each type and size of mixer supplied

2.06 SHOP PAINTING

A. Shop Painting: The gear reducer and motor shall be prepared and shop painted with the Manufacturer's paint system. The coating system shall comply with the requirements of Section 09900 and consist of 3 layers with a total dry film thickness not less than 6 mills.

- 1 x Severe Duty Primer
- 2 x Heavy Duty Acrylic Top Coat

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for the mixers supplied:

Service	Number of Trips	Number of Days/Trip
Installation, Testing, and Start-up	1	1
Services after Startup	1	1

B. At least one trip of one (1) day shall be provided for training providing instruction to the Owner's personnel in proper operation and maintenance of all equipment.

3.02 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:

1. Each gear reducer shall be run with a polarizing, rust-inhibiting oil before shipment during the reducer spin test at the manufacturer's facility. Each unit shall receive a vapor phase inhibitor sprayed into the reducer housing interior at the factory to further guard against internal corrosion during field storage of the

equipment. A specifically prepared paper treated with vapor phase inhibitor and covered with water repellent tape shall be applied to all external couplings and bearings that could be exposed to corrosion. All openings in the equipment shall be covered with the vapor phase inhibitor impregnated paper and water repellent tape. Water repellent tape and vapor phase inhibitor treated paper will be applied over any adapter sleeves, locknuts, dipsticks, breather assemblies, and other areas or openings requiring special protection.

3.03 FIELD TESTING

A. Field Testing shall be in accordance with Section 11000, Equipment General Provisions. Field testing shall include a complete check of the mixer drive. The PAC mixer unit shall be tested with carbon slurry in the storage tank. Testing shall be conducted over the full range of mixer speeds up to the rated horsepower of the mixer motor. Field test shall be run for 30 minutes within 15 percent of the rated capacity of the motor.

B. The entire installation shall operate with a vibration of less than 0.5 inch/sec and 3 mils measured on any plane in accordance with AGMA standards. The Manufacturer shall make modifications that may be required to provide vibration within specified tolerances in accordance with the Manufacturer’s and/or Engineer’s recommendations without additional cost to the Owner

C. The Contractor shall make modifications that may be required to provide vibration within specified tolerances in accordance with the manufacturer's and/or Engineer's recommendations without additional cost to the Owner.

- END OF SECTION -

SECTION 11320

SAMPLE PUMPS

PART 1 -- GENERAL

1.01 WORK INCLUDED

A. Furnish and install sample pumps as specified herein and as shown on the Contract Drawings. The sample pumps shall be provided by one manufacturer with sole responsibility for the satisfactory manufacture, and performance of the systems.

B. The following is a list of pumping equipment to be provided under this Section:

Pump Identification	Pump Service	Sample Location
PCWM-SP01	Filtered Water	Filtered Water Mixing Vault
PCWM-SP02	Filtered Water (Standby)	Filtered Water Mixing Vault

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 11000 - Equipment, General

C. Section 11100 – Pumps, General

E. Section 15000 - Piping, General

F. Division 16 - Electrical

G. Division 17 - Instrumentation and Control Systems

1.03 SUBMITTALS

A. Submit in accordance with Section 01300 - Submittals and Section 11000 - Equipment, General.

1.04 QUALITY ASSURANCE

A. The sample pumps shall be in accordance with Section 11000 and Section 11100.

1.05 OPERATION AND MAINTENANCE

A. Comply with the requirements of Section 11000 and Section 11100.

1.06 WARRANTY

A. Comply with the requirements of Section 11000 and Section 11100.

PART 2 -- PRODUCTS

2.01 SAMPLE PUMPS

A. Type of Pump: Self priming, close-coupled, shallow well jet pump, continuous duty.

B. Performance Requirements:

Number of Units	2
Total Design Capacity (gpm)	4.8
Discharge Pressure (ft)	112
Maximum Pump Speed (rpm)	3,450
Minimum Motor Horsepower	1/2
Temperature of Liquid Pumped	Ambient
Minimum Suction Port Diameter (inch)	1-1/4"
Minimum Discharge Port Diameter (inch)	1”
Self-Priming Capacity (ft)	25

C. Materials: Pumps body shall be constructed of close grained cast iron and shall include an integral drain port. Impeller shall be precision molded Noryl. Pump seal shall be carbon-ceramic, stainless steel mechanical shaft seal with continuous internal water lubrication.

2.02 MANUFACTURERS

A. Pump shall be as manufactured by Sta-Rite Model SNC, or Engineer approved equal. Pump motor shall be provided with the pump.

B. Motor: The pump motors shall be designed for 115 volt, 60 hertz, single phase electrical power. All motors shall have TENV enclosure, NEMA 56C frame, and shall be U.L. approved, and designed for continuous duty operation.

C. Accessories: Provide universal mounting bracket and 316 stainless steel mounting hardware. Contractor shall provide any additional accessories required for a complete installation. A 316 stainless steel wall mounting bracket shall be provided where indicated on the drawings.

PART 3 -- EXECUTION

3.01 GENERAL

A. Pumps shall be installed and adjusted in such a manner that connecting piping will not impose any strain on any pump.

B. Pump installation shall be as indicated on the drawings. All wall mounting brackets or pump support tables shall be provided as shown on the Drawings.

3.02 SHIPPING AND HANDLING

A. Comply with requirements of Section 11000 and Section 11100.

3.03 EQUIPMENT SHOP TESTS

A. Perform under provisions of Section 11000 and Section 11100.

3.04 FIELD TESTS

A. Perform under provisions of Section 11000 and Section 11100.

3.05 INSTALLATION AND STARTUP

A. The Contractor shall install the equipment in accordance with the manufacturers' recommendations, shop drawings, and under provisions of Section 11000 and Section 11100.

- END OF SECTION -

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SECTION 11335

PERISTALTIC HOSE-TYPE CHEMICAL METERING PUMPS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, adjust, and place in satisfactory operation positive displacement peristaltic hose-type chemical metering pumps as specified herein and as shown on the Drawings. All pumps shall be supplied by the same manufacturer.

B. Equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions and Section 11100, Pumps - General.

C. The metering pumps shall consist of motor, pump, and all accessories and appurtenances as specified herein and as indicated on the Contract Drawings.

1.02 CONDITIONS OF SERVICE AND PERFORMANCE REQUIREMENTS

A. Chemical Properties

	Powdered Activated Carbon Slurry
Concentration	0.9 to 2 lb PAC/gal slurry
Specific Gravity	Up to 1.18
Freezing Point	32°F

B. Pump Performance Requirements

	Powdered Activated Carbon Slurry
No. of Units	6
Pump ID	PACMP-1, 2, 3, 4, 5, 6
Minimum Required Pump Feed Rate	2 gph
Maximum Required Pump Feed Rate	55 gph
Maximum Pump Speed	70 rpm
Required Discharge Pressure	90 psig
Suction Connection	3/4” ANSI 150# Flanges
Discharge Connection	3/4” ANSI 150# Flanges
Maximum Motor Speed	1,725 rpm
Minimum Motor Horsepower	1 HP
Drive Type	AC, Variable Speed
Application Points	See Schematic

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1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

1. A pump characteristic performance curve showing flow rate as a function or rpm and pressure

2. Details on materials of construction of all components including applicable ASTM designations

3. Chemical resistance data for all wetted parts of pumps and accessories

4. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

5. Dimensional drawings, including recommended location of anchor bolts

6. Recommended location and mounting of backpressure valves and pulsation dampening devices

7. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels

8. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; running, full load, and locked rotor current values; and safe running time-current curves

9. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

10. Complete wiring diagrams

11. Complete control descriptions for pump operation

12. Complete erection, installation, and adjustment instructions and recommendations

13. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues

14. Complete lubricant schedule, including manufacturers of recommended lubricant and a cross reference table of alternative lubricant manufacturers and brand names for each lubricant recommended. Schedule shall include frequency of lubricant application, type of lubricant, and comments / remarks regarding lubricant application.

15. Hose design information (chemical resistance, life cycle, wall thickness, pressure rating, etc.) and recommended hose replacement schedule

B. Shop drawings shall include all pumps and accessories and shall be submitted as a complete system. Partial submittals will be unacceptable.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The Manufacturer shall be a company specializing in manufacture, assembly, and field performance of positive displacement peristaltic metering pumps with a minimum of five years experience.

B. The metering pumps shall be Dura 15 pumps as manufactured by Verderflex or Bredel 15 as manufactured by Watson Marlow.

2.02 GENERAL

A. The pump supplier is responsible for the coordination of corrosion- and abrasion-resistant materials for the chemical solutions specified. The manufacturer shall include all features as necessary for satisfactory operation of the pumping systems for chemical solutions specified. All pumps shall be capable of handling the designated process fluids in their full commercial strengths. Pumps, motors and accessories shall be coated with a heady duty protective epoxy coating resistant to the specified chemical to prevent corrosion.

2.03 POSITIVE DISPLACEMENT PERISTALTIC HOSE-TYPE METERING PUMPS

A. Pump shall be of the positive displacement, peristaltic hose type utilizing a flexible hose and a rotor with 2 integral pressing shoes. Pump rotor shall be directly bolted onto an internal drive shaft, and the complete assembly shall be mounted in the pump casing via sealed for life deep groove 304L stainless steel ball bearings to ISO 15-1998. These bearings shall be press fitted into the pump casing and the bearings shall be protected by a Viton shaft seal. Alternately, pump rotor shall be independently supported on its own set of heavy duty ball bearings such that the bearings are located directly under the rotor's load. Bearings shall be supported by the bearing hub located within the pump housing and shall be sealed via a dynamic seal. Bearings shall be sealed and greased for life.

B. The gear reducer shall be vertically mounted and shall lock onto to the drive shaft by an ISO standard key. The exterior of the pump casing shall be connected to the gearbox by a 4-bolt adaptor. The gear reducer shall be physically isolated from the pump casing via a minimum ½" air gap separation and shall have zero risk of contamination from the pumped fluid. Alternately, gearing shall be direct coupled to the back of the pump housing and shall be completely isolated from the process fluid and pump fluid through the sealed bearing hub. Gear unit and drive components shall be serviceable without removal of the pump rotor.

C. Each pump shall consist of a sealed lubricant filled housing, bolted housing cover, pump hose, rotor assembly, and one-piece connectors. The lubricant shall be a compounded

food-grade glycerin/propylene glycol blend. Lubrication shall be filled to 40-50 percent of pump housing capacity.

D. The hose shall be constructed from an appropriate elastomer re-enforced by two or more braided nylon layers. Hose shall normally be constructed from a combination of a Natural Rubber outer and an inner made from Natural Rubber, Nitrile Buna Rubber or Hypalon. Where EPDM material is required, the hose shall be constructed totally from this material. Exterior surface of hose shall be textured to increase adhesion of lubricant on the portion of hose not otherwise submerged, in order to better cool and lubricate the upper half of the hose. All hoses regardless of size shall be rated for a minimum of 175 psig continuous operation and have a minimum burst pressure of 800 psig.

E. The hose shall be held in place on the suction and discharge ports by individual one-piece 316 SS flanges to ANSI 150# standards. Hose and flanges shall be compatible with the pumped fluid; for aggressive chemicals, flanges shall include a wetted insert compatible with the process fluid. Flanges shall be secured to the pump hose via a compression fitting or band clamp that must be visually verified as secure without disassembly of the pump. The hose shall be replaceable without removing the pump or the pump housing cover.

F. The rotor shall be constructed of cast iron to ASTM A48 with two integral pressing shoes, located 180-degrees apart, for compression of the hose against the track twice per rotor revolution. One roller shall at all times be fully engaged with the hose providing complete compression to prevent backflow or siphoning.

G. Flow through the hose shall be in the direction of the rotor rotation, which can be reversed.

H. Each pump shall be completely self-priming with a suction lift capability of up to 27 feet of water.

I. The pump shall be capable of running dry without damaging effects to the pump or hose.

J. The pump shall be valveless and without diaphragms and not utilize any dynamic seals in contact with the pumpage.

K. The pump housing shall be cast iron to ASTM A48 and the housing cover shall be cast iron or steel with plexiglass window to view pump rotation. The seal between the housing and the cover shall be a Buna-N or EPDM.

L. A fill port and a threaded drain plug shall be provided on the pump housing. The fill port shall be easily accessible. The drain shall be located at the lowest point in the housing and allow for complete removal of all liquid from within the housing.

M. Pump support frames shall be formed carbon steel and shall have a powder coated paint finish.

N. Pump assemblies shall be provided with painting system that provides protection from the pumped chemicals.

2.04 LEAK DETECTION

A. Provide each pump with an over-pressure/hose burst device or float type magnetic reed switch above the normal lubricant level to detect high pressure and/or leakage of pumped product into the pump housing for indication of hose failure.

B. Device shall be a field selectable NO/NC two-wire switch, with relay outputs to monitor high pumping chamber pressures caused by hose failure.

2.05 GEAR REDUCERS

A. Gear reduction shall match output speed requirement of the pump using two or three-stage gearing and matching torque rating of pumping equipment. Gearing shall be classified for continuous heavy shock, 24-hour, duty, with a minimum of 1.4 service factor.

B. Bearings shall be of heavy-duty construction and exceed AFBMA standards.

C. Gear reducer bearings and gears to be greased-for-life and not require any re-lubrication or other maintenance for the life of the pump.

2.06 ELECTRICAL AND CONTROL REQUIREMENTS

A. The AC drive motor shall be provided in accordance with Section 15170 – Electric Motors. The horsepower shall be adequate to drive the pump when the pump is operating at its maximum capacity and maximum head condition for its prescribed application. Motor shall be supplied with sufficient turndown capability to meet specified range of flow.

B. Motor Requirements:

Motor	
Rating	230-460V, 3 ph, 60 Hz
Horsepower	1.0
Speed, rpm	1725
Enclosure	TENV
Insulation	Class F
Service Factor	1.0
Space Heater	No
Motor Winding Temperature Switches	No
NEMA MG1 Part 31 Inverter Duty Rated	Yes

C. Variable Frequency Drives

1. The Contractor shall retain full responsibility for the complete peristaltic pump drive system and shall also retain overall responsibility for coordination between the pump manufacturer and the variable frequency drive manufacturer. VFD shall take a 120V single phase input, and create a 230/460V 3 phase output for the motor.

2. The peristaltic pump manufacturer shall coordinate torque and speed requirements with the motor vendor to ensure that the motor matches the torque and speed requirements of the driven load over the entire range of operation. In addition, the

pump manufacturer shall coordinate the settings of the VFD with the peristaltic pump to ensure proper operation. A written transmittal of the drive settings shall be sent to the Contractor prior to start-up of any equipment.

3. VFD panels shall be provided with the following local control devices, at a minimum:

   a. Manual speed control function with digital speed indication in revolutions per minute
   b. Hand-Off-Auto selector switch
   c. Start and Stop pushbuttons
   d. Run, Fail and Leak indicating lights
   e. Externally operable main circuit breaker style disconnect switch

4. The panels shall accept external current sources (4-20 mA) for primary speed control. The panels shall also accept local speed adjustment by using the speed control potentiometers. Speed regulations shall be ±1% with 95% load change. Panels shall include a fail dry output contact for remote fault indication to the PLC such as power supply failure or loss of pacing signal and relay contacts to indicate run status, ready status, and hose leak. The panels shall accept remote dry contact closure for remote start/stop control, forward/reverse control, and leak detection device run/stop control. The panels shall provide a 4-20 mA output signal corresponding to pump motor speed.

2.07 METERING PUMP ACCESSORIES

A. The metering pump supplier shall furnish accessory equipment as specified herein and as shown on the Drawings including but not limited to the following:

1. Pressure gauges shall be provided on the discharge of metering pumps as shown on the Schematic. Gauges shall be as specified in Section 17650. Each gauge shall have a range of zero to 100 psi. Each gauge shall be provided with a diaphragm seal as specified in Section 17650 constructed of materials which are completely resistant to corrosion by the chemicals referred to in this section. Each pressure gauge shall also be provided with an isolation valve. Isolation valves shall be PVC with seals that are resistant to the chemical applications.

2. Calibration columns shall be supplied by the pump manufacturer as shown on the Drawings. Calibration column shall be constructed of clear PVC and provided with a top cap for connection to a vent / return line. Calibration column shall have threaded inlet and vent connections. Graduations shall be in mL and gallons per hour. Each calibration column shall be sized such that at 50% pump capacity, the calibration column will be emptied in 60 to 90 seconds. Calibration columns shall be manufactured by Blacoh Fluid Control, Plast-o-Matic, or equal.

3. Pressure relief valves shall be supplied by the pump manufacturer as shown on the Drawings. Valve body and diaphragm materials shall be selected by the pump manufacturer as required for chemical compatibility and operating pressure. Valve shall be provided with threaded connections. Valve shall be flow-through or three-port as shown on the Drawings. Relief setting shall be field-adjustable from 5 psi to 125 psi via an adjustment screw. Sizing of the valve shall be the responsibility of the

pump manufacturer. Pressure relief valves shall be manufactured by Blacoh Fluid Control, Plast-o-Matic, or equal.

4. Backpressure / anti-siphon valves shall be supplied by the pump manufacturer as shown on the Drawings. Valve body and diaphragm materials shall be selected by the pump manufacturer as required for chemical compatibility and operating pressure. Valve shall be provided with threaded connections. Pressure setting shall be field-adjustable from 5 psi to 125 psi via an adjustment screw. Sizing of the valve shall be the responsibility of the pump manufacturer. Backpressure / anti-siphon valves shall be manufactured by Blacoh Fluid Control, Plast-o-Matic, or equal.

5. Pulsation dampeners and suction accumulators shall be supplied by the pump manufacturer as shown on the Drawings and as recommended by the pump manufacturer based on the system operating conditions. Pulsation dampener body, bladder, and bellows materials shall be selected by the pump manufacturer as required for chemical compatibility and operating pressure. Inlet connection shall be threaded. The pump manufacturer shall size the dampener to remove a minimum of 90% of the pulsation from the metering pump. Dampeners shall be provided with a pressure gauge with an operating range of 0-100 psig and a charging valve. Pulsation dampeners and suction accumulators shall be manufactured by Blacoh Fluid Control, Plast-o-Matic, or equal.

B. Piping on the suction and discharge of each metering pump shall be as specified in the Piping System Schedule at the end of Section 15390. Materials of construction shall be completely compatible with the specified chemical. Contractor shall provide transition fittings for metal pipe connected to PVC accessories or for PVC pipe connected to metal accessories.

2.07 SPARE PARTS

A. Provide initial lubrication for gear drives and hose lubricant as required for start-up and two hose changes per pump.

B. Provide two (2) replacement hoses per pump.

C. Provide all special tools required for normal maintenance. Package tools and clearly mark on exterior to indicate equipment for which tools are intended.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided as follows:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.02 INSTALLATION

A. All metallic fasteners, brackets, mounting hardware, and accessories located in the storage and feed areas shall be constructed of materials completely resistant to the specified chemicals.

3.03 TESTING, CLEANING, AND START-UP

A. Testing shall be in accordance with Section 11000 - Equipment General Provisions.

B. All pumps shall be shop tested for capacity at rated pressure prior to shipment, with documented results provided.

C. After chemical storage tanks are hydrostatically tested and the tanks and piping system are cleaned, complete system hydrostatic tests and operational tests shall be completed with potable water. The functioning of all pump accessories, valves, and feed points shall be checked, and all malfunctioning or unsatisfactory components shall be repaired or replaced.

D. After all pumps have been completely installed, conduct in the presence of the Engineer tests to indicate that each item of equipment conforms to this Section. The manufacturer's representative shall oversee field testing:

1. Functional Test: Check for proper alignment, rotation, excessive or unusual noises, overheating, lubrication, and satisfactory performance, demonstrating the pumps' ability to deliver the rated capacity and operating pressure. Testing of the pumps will be at 0.5%, 2%, 4%, 50% and 100% of rated speeds. The functioning of all system components including pump accessories shall be checked.

2. Vibration test: Check and verify that each operating pump does not have excessive vibration or movement during operation over the specified speed range.

If the performance of any item of equipment does not meet the specified requirements, take corrective measures or remove the unit and replace with one which satisfies the conditions specified.

- END OF SECTION -

SECTION 11340

CHEMICAL INJECTION ASSEMBLIES

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, adjust, and place in satisfactory operation chemical injection assemblies as shown on the Drawings and/or as specified herein.

B. Equipment shall be provided in accordance with Section 11000, Equipment General Provisions, and Division 15.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Chemical Injection Assemblies

Service	**PAC Slurry to Raw Water**
No. of Assemblies	3
Type of Feed Device	Injector
Maximum Concentration	20%
Chemical Pipe Diameter	1”
Chemical Pipe Material	PVC
Maximum Chemical Feed Rate	20 gpm
Max Chemical Discharge Pressure	100 psi
Receiving Pipe Diameter	36”
Receiving Pipe Material	Ductile Iron
Maximum Receiving Pipe Pressure	60 psi
Maximum Receiving Pipe Velocity	5 fps
Application Points	North 36” Raw Water in RWPS, South 36” Raw Water in RWPS, and 36” Glenville Lake Raw Water in Doghouse Manhole

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to, the submittal requirements specified in Section 01300, Submittals, and Section 11000, Equipment General Provisions:

1. Equipment specifications and data sheets, with identification of all materials of construction.

2. Complete assembly, layout, installation and shop drawings, with clearly marked dimensions, tolerances, jointing and anchoring details.

3. Weights of equipment component parts.

4. Chemical resistance data for wetted parts

PART 2 -- PRODUCTS

2.01 GENERAL

A. The chemical injection assemblies shall be as manufactured by SAF-T-FLO Water Services, Inc., or approved equal.

2.02 CONSTRUCTION AND MATERIALS

A. Each injection assembly shall be specifically designed for the particular chemical service for which it is being supplied. The materials of construction for the assemblies shall be compatible with the chemicals being fed and shall be suitable for the pressure in the chemical solution line and receiving pipe, the maximum velocity in the receiving pipe, and the insertion length.

B. Acceptable materials of construction shall be as follows:

	PAC Slurry
Corp Stop/Compression Gland	Brass
Solution Tube	PVC or 316 SS
Flexible Tubing Assembly Valve Seal Tubing	 PVC Viton or EPDM Reinforced PVC

C. The injection assemblies shall be retractable and furnished with a corporation stop, self-sealing coupling, solution tube assembly including ball check valve, locking device, and safety chain. The locking device shall connect the solution tube to the corporation stop on the receiving pipe to prevent accidental withdrawal of the solution tube. The stainless steel safety chain shall prevent the solution tube from being withdrawn past the compression ring in the gland. Safety chain length shall be determined by the manufacturer of the equipment.

D. The assemblies shall be sized to match the pump discharge line or injection flow rate and shall be of the same diameter as the chemical piping. The injection assembly solution tubes shall penetrate into the pipe a distance equivalent to 1/3 to 1/2 of the pipe diameter into which the chemicals are being injected.

E. Each injector shall be furnished with a flexible hose assembly. Flexible hose assembly shall consist of flexible hose/tubing, connection fittings, seals and ball valve, specifically designed for the particular chemical service for which it is being supplied. Flexible hose assembly shall also be capable of withstanding maximum pump discharge line pressure.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish the chemical injectors and all associated equipment and accessories as required and specified herein in accordance with the manufacturer's instructions and in accordance with Section 11000, Equipment General Provisions.

B. Mounting racks shall be provided for chemical feed piping, valves, and appurtenances as shown on the Drawings and/or as specified herein. The racks shall be constructed of fiberglass channel members and shall allow valves and appurtenances to be mounted such that they are readily accessible by plant operations personnel for operation and maintenance. The mounting racks shall be as specified in Section 15020, Pipe Supports.

- END OF SECTION –

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SECTION 13450

DISINFECTION OF WATER TREATMENT FACILITIES

PART 1 -- GENERAL

1.01 GENERAL

A. The Contractor shall clean and disinfect the water treatment facilities that incorporate the Filtered Water Mix Vault, sample piping and valves, FLW and FW piping and City potable water piping prior to placing these systems, or part thereof, into service in accordance with the regulations of the North Carolina Department of the Environment and Natural Resources (NCDENR) and as specified herein. The cost of such service shall be borne by the Contractor.

B. Any existing potable water piping shall also be disinfected if it is taken out of service as part of the project. All new tanks, flumes, storage areas and piping described herein will be connected to and will become a part of the City of Fayetteville potable water system and will require proper disinfection. All piping and structures within the project that serve as part of the City's drinking water system shall be disinfected as described here prior to placing back into service in accordance with the regulations of NCDENR, Federal and local regulations, and as specified herein.

C. Before being placed into service and before Certification of Substantial Completion can be issued by the Engineer, all new or modified potable water systems shall be disinfected in accordance to the requirements of these Specifications and to specified AWWA Standards.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 11 – Equipment General Provision

B. Division 13 – Special Construction

C. Division 15 - Mechanical

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work hereunder shall conform to the applicable requirements of the following documents to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. AWWA C653 – Disinfection of Water Treatment Plants

2. AWWA C652 – Disinfection of Water Storage Facilities

3. AWWA C651 – Disinfecting Water Mains

4. AWWA B300 – Hypochlorites

5. North Carolina Administrative Code, Title 15A, Subchapter 18C

1.04 SUBMITTALS

A. Submit procedures for completing the disinfection of the plant facilities listed above, including the proposed methods of storing, handling and dispensing the disinfectant. The Contractor shall submit disinfection procedure details, including pressure testing, cleaning flushing, disinfection, and de-chlorination, to the Engineer and shall receive approval for these procedures prior to performing the work.

B. Submit a "Record of Compliance" to the Engineer and Owner stating that bacteriological testing had been accomplished and certifying that the water is free of coliform bacteria contamination, before bringing all potable water equipment and pipelines into service. Results of this testing shall meet NCDENR requirements and regulations.

C. Testing and disinfection shall be accomplished in the presence of the Engineer.

1.05 QUALITY ASSURANCE

A. Disinfection of facilities shall be performed by Contractor or Sub-Contractor that has at least ten years prior experience in disinfection or similar facilities at Water Treatment Plants.

PART 2 -- PRODUCTS

2.01 WATER SUPPLY

A. Reasonable quantities of water necessary for initial and subsequent flushing, testing, and disinfection of all facilities associated with this Project shall be provided by the Owner. Contractor shall notify the Owner two weeks in advance of withdrawing specified amount of water from the City's potable water (PW) system for filling, flushing, testing, and disinfection, and shall fully schedule and coordinate this work with the Owner.

B. All chemical equipment (pumps, testing kits, etc.) associated with leakage testing, cleaning, or rinsing of the facilities shall be furnished by the Contractor. The Owner has limited facilities for potable water use and reserves the right to limit the volume of water used per day and the times of the day when the use of water is permitted for the project. Disposal of water for leak testing, cleaning and rinsing shall be performed in accordance with all federal, state and local requirements in such a manner as to cause no adverse environmental effects such as fish kills or erosion.

C. No permanent piping connections shall be made to the potable water system for the purpose of flushing and disinfecting new water lines. A temporary connection with an Owner approved backflow prevention device to protect the City's potable water system shall be utilized to deliver potable water from the City's existing PW system to new waterlines, tanks, chambers and related structures. Utilizing a portable pump with a backflow preventer is one method of preventing backflow and the resulting contamination of the potable water system, and achieving the flows that are needed to adequately fill and/or flush waterlines for disinfection.

D. The Contractor shall have no claim for monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of disinfection.

E. All basins, pipes, vessels, and appurtenances shall be filled slowly either through an existing valve or through taps. Special care shall be exercised in loading lines and filling basins, vessels and pipes to prevent damage. The Contractor shall coordinate with the Owner the operation of all existing valves. All existing valve and sluice gate operations shall be performed by the Owner's personnel only.

2.02 DISINFECTION CHEMICALS

A. All chemicals and chemical feed pumps required for disinfection shall be furnished by the Contractor.

B. All chemicals used for disinfection and de-chlorination shall be NSF approved for use in potable water.

2.03 BACTERIOLOGICAL TESTING

A. The Contractor shall furnish bacteriological testing for verification of disinfection procedures from a North Carolina laboratory acceptable to the Owner. Results shall be sent to NCDENR before the disinfected system is returned to service.

PART 3 -- EXECUTION

3.01 GENERAL

A. Materials

1. Chlorine for disinfection shall be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

2. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of AWWA B300 and C653.

B. Contractors can utilize a qualified company to perform disinfection of all potable water pipelines, storage tanks, and facilities described herein. Qualified companies include Matt Chlor (El Monte, CA), or equal.

1. Acceptable companies to perform disinfection of potable water facilities must be of proven reliability and experience, having experience in disinfection of large diameter pipelines and other water plant facilities. Upon request by Engineer and Owner, companies shall submit a list of a minimum of three projects within the last 5 years, where they have disinfected a total of 5,000 Lineal Feet of minimum 54-inch potable water pipeline.

2. Disinfection firms shall have specific technical skills and certification to perform work in full compliance with applicable OSHA Standards and regulations. Firms are

required to have personnel on-site during disinfection procedures who have OSHA confined space certification in compliance with OSHA Standard 1910.146 for confined spaces.

3. Disinfection firms shall submit resumes for the specific personnel who will perform disinfection of Water Treatment Plant facilities, including pipelines, chambers and storage tanks, on the project.

C. Scheduling

1. The Owner and Engineer shall be provided with a detailed plan for approval for cleaning, flushing, testing, disinfecting, bacteriological sampling and testing, maintaining disinfected conditions in working areas, and disposal of super-chlorinated water. A disinfection plan shall be prepared by the Contractor and any disinfection Sub-Contractor, and shall be approved by the Owner and engineer prior to any on-site disinfection activities. **The Engineer reserves the right to adjust, modify, and/or alter the proposed plan to serve the best interests of the Owner to serve the best interests of the Owner and at no additional cost to the Owner.**

2. The Contractor shall coordinate all work with the Engineer at a time mutually agreeable to the Owner, and shall give the Owner through the Engineer, at least 2 week advance notice of his intent to begin flushing, testing and disinfecting any portion of the system.

3. All flushing, testing and disinfection shall be witnessed by the Engineer and a representative of the Owner. All work shall be coordinated with the Engineer at a time mutually agreeable to the Owner and shall give at least 72 hours advance notice prior to performing any work.

D. Cleaning and Flushing

1. Cleaning via physical means and/or flushing of all facilities will be required prior to disinfection. Cleaning by means of sweeping and high pressure wash shall be the preferred method for storage areas, flumes and mixing vaults, and flushing shall be the preferred method for smaller diameter piping. Engineer will inspect facilities after cleaning and flushing, and shall provide approval of work before Contractor proceeds with disinfection of facilities, as described herein

2. Clean and/or flush all facilities described herein in accordance with these Specifications and Part 3.10 of Section 15000. The times for washing and flushing shall be coordinated through the Engineer, with the Owner. There shall be no claim for monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of flushing. Compensation is limited to an extension of time to perform flushing activities.

3. Discharge of water used for cleaning and flushing shall be properly dechlorinated and disposed of, and shall be coordinated with, and approved by, the Owner and Engineer as part of the disinfection schedule and plan. Excessive water shall be prevented from flowing onto private property or into receiving streams. Waste water from cleaning and flushing shall be directed to on-site locations, as directed by the Owner and Engineer, for further treatment. Discharge of waste water shall be in compliance with all Federal, State, and City regulations. Care shall be exercised to

prevent the water from entering trenches or wetting backfill material. All materials required for cleaning and flushing shall be furnished by the Contractor.

E. Filling and Disposal

1. All pipelines, flumes, and tanks shall be filled slowly either through an existing valve or through taps. Special care shall be exercised in loading lines and filling the flumes and tanks to prevent damage. The Contractor shall coordinate with the Owner the operation of all existing valves. **All valve operations shall be performed by the Owner's personnel only**.

2. Any equipment used either for disinfection or dechlorination shall be either new or previously used only for disinfection or dechlorination. All chemicals used for disinfection and dechlorination shall be NSF approved for use in potable water.

3. The Contractor shall advise the Owner when the filter, storage area, flume, mixing vault, or pipe is ready for bacteriological sampling. The tank or pipe shall be sampled by the Contractor in accordance with AWWA C653, C652, and C651 (as applicable).

4. The chlorine disinfection solution shall be thoroughly flushed out prior to disinfection and later placing the facility or pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant or fish life. A NSF approved reducing agent may be added to the highly chlorinated water to reduce the chlorine residual to an acceptable level. A water disposal plan shall be submitted to the Engineer prior to tank or pipe cleaning, filling and disinfection. The Contractor shall pay all civil penalties, fines, costs, assessments, etc., associated with any discharge of spent chlorine solution associated with the Contractor's work. Chlorine residual tests shall be made after flushing to assure that the chlorine residual is not in excess of 1 ppm.

5. The Contractor shall have no monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of disinfection. Compensation is limited to an extension of time to the Contract only.

F. Disinfection

1. The Owner and Engineer shall be notified by the Contractor when the respective filters, storage areas, flumes, mixing vaults or pipeline segments are ready for bacteriological sampling after proper disinfection. All bacteriological analysis shall be performed by a North Carolina-certified laboratory acceptable to the City of Fayetteville. All facility components containing drinking water shall be sampled in accordance with AWWA C 651 and C652 and regulations of the NCDENR, and the City of Fayetteville regulations, and as specified herein.

2. Should the disinfection method generate chlorine solutions for disinfection, the chlorine disinfection solution shall be thoroughly flushed out and directed to an approved means of disposal (not to the drinking water distribution system) prior to bacteriologic testing, as described in AWWA Standard C651 and/or 652, and prior to placing the tank, chamber, or pipeline back into service. Spent chlorine solution

must be disposed of in such a way so as not to be detrimental to animal, plant or fish life. A NSF approved reducing agent may be added to the highly chlorinated water to reduce the chlorine residual to an acceptable regulatory level. A schedule and water disposal plan shall be submitted by the Contractor to the Owner and Engineer two months prior to cleaning, filling or disinfection. Wastewater disposal sites shall be approved by the Owner. All civil penalties, fines, costs, assessments, etc., associated with any discharge of spent chlorine solution associated with this work shall be paid accordingly by the Contractor.

3. Appropriate OSHA personal protective equipment and proper safety procedures shall be used when handling chemicals and for all disinfection activities described herein. Safety of all workers in the disinfection work area shall be ensured by the Contractor at all times, and shall fully comply with all OSHA, Federal, State and City rules and regulations. Contractor's safety plan shall be submitted to the Owner and Engineer for approval before disinfection and de-chlorination activities commence.

3.03 DISINFECTION OF FILTERED WATER MIXING STATION AND LARGE DIAMETER PIPES

A. Filtered Water Mixing Vault and Large Diameter Pipelines - Initial Filling

1. Before disinfection procedures commence, the Contractor shall thoroughly clean by sweeping, pressure washing and/or flushing all surfaces as described above in Section 3.01 D. and herein. Cleaning and flushing shall result in removal of all debris, particulates, dust and loose and foreign materials that are deleterious to potable drinking water.

2. All pipelines, chambers and the tanks shall be filled slowly with potable water either through an existing or new valve or gate and with proper backflow prevention, through pumping, or through pipeline taps.

3. Special care shall be exercised in loading lines and filling tanks to prevent damage to the new facilities.

4. The Contractor shall coordinate with the Owner the operation of all existing valves, gates and pumps for tank filling operations. The Owner will operate all existing valves and gates.

B. Filtered Water Mixing Vault Testing

1. The Contractor shall perform FLW mixing vault inspection, water-tightness testing and evaluation, tank cleaning, in accordance with Division 3 (Leak Testing) and as specified herein.

C. Filter Mixing Vault Disinfection

1. The filter mixing vault shall be disinfected in accordance with the procedures described in AWWA C652, Disinfection of Water Storage Facilities and as specified herein. Disinfection shall be in accordance with all requirements and regulations of NCDENR. The Contractor shall submit the proposed method of disinfection in the

disinfection plan provided to the Owner and Engineer prior to performing the work. In addition OSHA requirements for confined space shall be addressed in the disinfection plan and these measures shall be in place before personnel enter the pipelines, manholes, chambers, or storage tanks.

2. The Contractor shall clean the vault interior surfaces to remove all dirt and loose materials prior to disinfection. Potable water shall be used to clean the tank. All equipment, including brooms, brushes, spray equipment and workmen's boots shall be disinfected with a 200 mg/L chlorine solution before they are used to clean the tank. Prior to both testing and disinfecting, tanks shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt and foreign material accumulated during this cleaning operation shall be properly de-chlorinated and discharged from the structure.

3. Disinfection shall be accomplished after the mixing vault facilities have been leak tested and cleaned. Disinfection shall be repeated as often as necessary until the bacteriological testing has passed, and as directed by the Engineer or Owner in compliance with NCDENR regulations. The Owner will establish the minimum and maximum chlorine concentration allowed prior to bacteriologic sampling in the storage areas and mixing vaults. The Contractor shall be responsible for the discharge of any water from the vault after completion of the hydrostatic leak testing and disinfection is complete. Disposal of the water shall be approved by the Owner and Engineer prior to discharge, and shall be in accordance with Federal, State of North Carolina, and local requirements.

4. The mixing vault shall be disinfected by spray/ surface application disinfection (with high chlorine concentration (> 200 mg/L)) in order to minimize wasting and de-chlorination of large volumes of water during the disinfection process of the tanks and wet wells in accordance with the latest editions of AWWA C652 and AWWA C651. Disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 minutes, after which potable water shall be applied to the filter storage areas or mixing vaults.

5. In order to prevent damage to the walls of the mixing vault, the heavily chlorinated solution on surfaces shall be diluted with potable water after the required contact time is complete.

6. The filling and bacteriologic testing of the facilities and the associated chlorine residual minimum and maximum levels shall be coordinated with the Owner and Engineer. The spray method shall be performed inside pipelines where proper ventilation is ensured and full-face respirators are utilized.

7. The Contractor shall furnish and install all means and apparatus necessary for performing disinfection and or disposal of water generated from testing or disinfection activities.

D. Large Diameter Pipe

1. The Contractor shall clean the large diameter pipe interior surfaces to remove all dirt and loose materials prior to disinfection. Potable water shall be used to clean the pipe. All equipment, including brooms, brushes, spray equipment and workmen's boots shall be disinfected with a 200 mg/L chlorine solution before they are used to clean the pipe. Prior to both testing and disinfecting, pipelines shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt and foreign material accumulated during this cleaning operation shall be properly de-chlorinated and discharged from the pipe.

2. Disinfection shall be accomplished on all new large diameter pipelines in the project downstream from the filters - after the pipelines have been leak tested and cleaned. Disinfection shall be repeated as often as necessary, and as directed by the Engineer or Owner in compliance with NCDENR regulations. The Owner will establish the minimum and maximum chlorine concentration allowed prior to bacteriologic sampling in the large diameter pipe. The Contractor shall be responsible for the discharge of any water from the pipes after completion of the hydrostatic leak testing and disinfection is complete. Disposal of the water shall be approved by the Owner and Engineer prior to discharge, and shall be in accordance with Federal, State of North Carolina, and local requirements.

3. The large diameter pipes shall be disinfected by spray/ surface application disinfection (with high chlorine concentration (> 200 mg/L)) in order to minimize wasting and de-chlorination of large volumes of water during the disinfection process of the large diameter pipes in accordance with the latest editions of AWWA C652 and AWWA C651. Disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 minutes, after which potable water shall be applied to the pipeline segment.

4. In order to prevent damage to the pipe itself, or to the cement lining, the heavily chlorinated solution on surfaces shall be diluted with potable water and properly flushed and discharged as specified herein, after required contact time is complete.

5. The filling and bacteriologic testing of the facilities and associated chlorine residual minimum and maximum levels shall be coordinated with the Owner and Engineer. The spray method shall be performed inside pipelines where proper ventilation is ensured and full-face, OSHA approved respirators are utilized.

E. General

1. The sequential disinfection of the filter storage area, collection flume, mixing vaults and piping components shall be coordinated with the overall project sequence of construction activities. Project components shall be placed into service as soon as possible after successful bacteriologic testing. Bacteria samples shall be collected and performed at a minimum for every 1,000 ft. of new water main.

2. The Contractor shall be responsible for the maintenance of acceptable drinking water chlorine residuals, sanitary conditions, and any subsequent bacteriologic testing needed to verify water is suitable for distribution to the public - should a component of the project (i.e. pipe segment or chamber) stand idle for an extended

period and re-disinfection is required. The means of maintaining water quality through circulation or supplementation of treated drinking water shall be approved by the Owner and Engineer.

3. The Contractor may propose alternative means of disinfection of the storage tanks, mixing vault and large diameter pipeline project components. Alternative means must be in accordance with AWWA C651 and AWWA C652 and approved by the regulations of the NCDENR and the City of Fayetteville regulations. Any alternative disinfection means must be approved by the Owner and Engineer.

3.04 DISINFECTION AT PIPING TIE-IN POINTS OF NEW FLW/FW PIPING TO EXISTING FLW/FW WATER PIPING SYSTEM

A. The Contractor shall maintain disinfected conditions at all times in the general working areas, at the tie-in points of new FLW/FW piping to existing FLW/FW piping system as shown on the Contract Drawings.

B. All equipment in this work area, including personnel, hardware, tools, ladders, piping, and bulkhead shall be disinfected in accordance with the procedures described in AWWA C651 and C652, and as specified herein.

C. All equipment and personnel in the area of piping tie-ins shown in the Contract Drawings shall be disinfected immediately prior to entry into the work area.

D. Equipment shall be cleaned thoroughly using a high-pressure water jet, sweeping, scrubbing, or equally effective means. All equipment, including brooms, brushes, tools, hardware, temporary bulkhead, spray equipment, sponges, and workmen’s boots shall be disinfected before they are used for disinfection purposes.

E. The method of equipment disinfection can be submersion in, spraying with, or sponging with disinfectant solution of 200 mg/L concentration of available chlorine. Any accessible upstream and downstream interior of the existing and new pipe, and the manholes or concrete boxes that allow access to piping, shall be disinfected by swabbing or spraying with a minimum 200 mg/L chlorine solution.

F. Care must be taken when applying disinfectant solution, so that any excess runoff, or spillage is controlled and does not discharge untreated at grade. This excess runoff shall be de-chlorinated, treated and disposed as specified herein and in AWWA C651 and AWWA C652 Standards.

G. Appropriate personal protective equipment and proper safety procedures shall be used when handling chemicals. Safety of all workers in the disinfection work area shall be ensured by the Contractor at all times. Contractor’s safety plan shall be submitted to the Owner and Engineer for approval.

3.05 DISINFECTION OF SMALL DIAMETER PIPING AND RELATED APPURTANCES

A. All pipelines and related appurtenances shall be filled slowly either through an existing or new valve or gate, through pumping, or through pipeline taps with proper backflow protection.

B. Special care shall be exercised in filling lines to prevent damage to the new facilities.

C. The Contractor shall coordinate with the Owner the operation of all existing valves and pumps for filling operations. The Owner will operate all existing valves.

D. The Contractor shall perform all disinfection procedures, pipeline inspection, leak testing and evaluation, and final testing in accordance with Section 15000 and as specified herein.

E. Disinfection of small diameter pipe shall be accomplished after all piping has been leak tested and cleaned through flushing. Disinfection shall be repeated as often as necessary, and as directed by the Engineer or Owner. The Owner will establish the minimum and maximum chlorine concentration allowed prior to bacteriologic sampling. The Contractor shall be responsible for the discharge of any water from the pipes after completion of the leak testing and disinfection is complete. Disposal of the water shall be approved by the Owner and Engineer prior to discharge, and shall be in accordance with Federal, State of North Carolina, and local requirements.

F. The Contractor shall furnish and install all means and apparatus necessary for performing disinfection and for disposal of water generated from testing along with all required disinfection activities.

G. The sequential disinfection of the piping components shall be coordinated with the Contractor's sequence of construction activities. Project components shall be placed into service as soon as possible after safe bacteriologic testing.

H. The Contractor shall be responsible for the maintenance of acceptable drinking water chlorine residuals, sanitary conditions, and any subsequent bacteriologic testing, as described in AWWA Standard C651, needed to verify that water is suitable at all times for distribution to the public. The means of maintaining water quality through circulation or supplementation of treated drinking water shall be approved by the Owner and Engineer.

3.06 DISINFECTION OF FILTERED WATER, FINISHED WATER, POTABLE WATER, AND SAMPLE PIPING

A. Disinfection of the new large diameter filtered and finished water piping as well as smaller diameter potable water piping shall be performed by the Contractor as specified under Section 15000 – Basic Mechanical Requirements and in accordance with AWWA C651 – Disinfecting Water Mains.

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SECTION 15000

BASIC MECHANICAL REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.

B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.

C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.

D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.

E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.

F. The work shall include, but not be limited to, the following:

1. Connections to existing pipelines.

2. Test excavations necessary to locate or verify existing pipe and appurtenances.

3. Installation of all new pipe and materials required for a complete installation.

4. Cleaning, testing and disinfecting as required.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1, General Requirements

B. Division 2, Sitework

C. Division 5, Metals

D. Division 9, Finishes

E. Division 11, Equipment

F. Division 16, Electrical

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

A. The Contractor shall furnish to the Owner (through the Engineer) a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.

B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01300 – Submittals. In addition to the requirements of Section 01300 – Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.

C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified in Section 3.09.

C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules.

D. ALL BURIED EXTERIOR PIPING SHALL HAVE RESTRAINED JOINTS FOR THRUST PROTECTION UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS. ALL EXPOSED EXTERIOR PIPING SHALL HAVE FLANGED JOINTS, UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.

E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

F. Fiberglass duct shall be as specified in Section 15599, HVAC FRP Ductwork and Duct Accessories.

2.02 WALL PIPES

A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

Pipe Size	Waterstop Flange Diameter	Waterstop Flange Thickness
4" - 12"	OD + 3.10"	0.50"
14" - 24"	OD + 4.15"	0.75"
30" - 36"	OD + 4.50"	1.00"
42" - 48"	OD + 5.00"	1.25"
54"	OD + 5.90"	1.50"

2.03 SLEEVES

A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.

B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer's approval is obtained. Steel sleeves shall be

fabricated of structural steel plate in accordance with the standards and procedures of AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900 – Painting.

C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by Garlock Pipeline Technologies (GPT) or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 304 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.

D. Cast iron mechanical joint adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to affect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

2.04 SOLID SLEEVE COUPLINGS (FOR DUCTILE IRON BURIED SERVICE THROUGH 54-INCH)

A. Solid sleeve couplings shall be used to connect buried ductile iron service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal. Solid sleeve couplings shall be restrained with wedge-type restraining glands to meet the pressures specified in 15390.

2.05 RESTRAINED SLEEVE TYPE COUPLINGS (FOR STEEL AND DUCTILE IRON, EXPOSED SERVICE AND BURIED SERVICE ABOVE 54-INCH)

A. Sleeve type, flexible couplings shall be furnished and installed where shown on the Drawings or otherwise required to resist internal operating pressures. In addition to that specified herein, harnessed, sleeve type flexible couplings shall be provided on all exposed pipe 3 inches and larger in diameter that spans any expansion joint in a building or structure.

B. Materials shall be of high strength steel and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

D. For exposed applications

1. Harnessing for exposed applications shall be by rodding across the sleeve type coupling to the nearest pipe joint on either side of the coupling using threaded rods and rod tabs unless otherwise approved by the Engineer.

2. Couplings shall be as manufactured by Smith-Blair Model 411, Romac Industries Model 400, Dresser Industries Style 38, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.

E. For buried applications

1. Restraining and couplings for buried applications shall be one of the following alternatives.

a. Alternative 1

i. Couplings shall be as manufactured by Smith-Blair Model 411, Romac Industries Model 400, Dresser Industries Style 38, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.

ii. Restraining shall be with anchor pins, designed and installed to meet pipe specifications in Sections 15012 and 15390.

b. Alternative 2

i. Couplings shall be as manufactured by Victaulic Style 232, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.

ii. Restraining shall be with a restraint ring, designed and installed to meet pipe specifications in Sections 15012 and 15390.

F. Couplings shall be provided with manufacturer's fusion bonded epoxy painting system.

2.06 FLANGED COUPLING ADAPTERS

A. Flanged coupling adapters shall be furnished as required and as shown on the Drawings.

B. Flanged coupling adapters shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping.

C. All flanged coupling adapters shall be harnessed by tying the adapter to the nearest pipe joint flange using threaded rods and rod tabs unless otherwise approved by the Engineer.

D. Flanged coupling adapters shall be manufactured by Smith-Blair Model 912 or 913, Romac Industries Model FCG or FC 400, Dresser Industries Model 128-W, or equal.

E. Flanged coupling adapters shall be provided with manufacturer's fusion bonded epoxy painting system.

2.07 DISMANTLING JOINTS

A. Dismantling joints shall be furnished at locations shown on the Drawings.

B. Dismantling joints for sizes less than 12-inch shall be of ductile iron or carbon steel construction and shall be rated for the same pressure as the connected piping. Dismantling joints for sizes greater than 12-inches shall be of carbon steel construction and shall be rated for the same pressure as the connected piping.

C. Flanges for dismantling joints shall match the bolt pattern and pressure rating of the flanges for the connected piping.

D. All dismantling joints shall be restrained utilizing restraining rods provided by the manufacturer. Restraining rods shall be constructed from ASTM A193 Grade B7 steel. Restraining rods and restraint system shall be installed in strict accordance with manufacturer's recommendations.

E. Dismantling joints shall be provided with manufacturer's fusion bonded epoxy painting system.

F. Dismantling joints shall be manufactured by Smith Blair Model 975, Romac Industries Model DJ400, or equal.

2.08 GROOVED COUPLINGS

A. Grooved end pipe couplings shall be furnished as specified or shown on the Drawings.

B. Materials shall be of malleable iron and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated.

D. After installation, buried couplings shall receive two heavy coats of an approved coal tar which is compatible with the finish of the coupling. Exposed couplings shall be painted in accordance with Section 09900 - Painting.

E. Couplings shall be manufactured by Victaulic Company of America Style 31 or equal.

2.09 TAPPING SLEEVES AND TAPPING SADDLES

A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.

B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

2.10 UNIONS

A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.

B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.

C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.11 THERMOPLASTIC TUBING AND FITTINGS

A. Thermoplastic tubing shall be manufactured from polyallomor tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or equal. Brass sleeves shall be used.

B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the manufacturer's recommendations. Thermoplastic tubing shall be the Impolene (polyallomor) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or equal.

2.12 HEAT TRACED PIPING

A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 15390 – Schedules.

2.13 FLEXIBLE RESTRAINED EXPANSION JOINTS

A. Restrained expansion joints shall be manufactured of 60-42-10 ductile iron conforming to material and other applicable requirements of ANSI/AWWA C153/A21.53.

B. Each pressure containing component shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the materials requirements of, and tested in accordance with, ANSI/AWWA C213 and shall meet or exceed the requirements of ANSI/AWWA C550.

C. Seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11.

D. All bolts used in the assemblies shall be stainless steel and shall be coated with a premium quality epoxy.

E. Flanged ends shall comply with ANSI/AWWA C110/A21.10, with the addition of O-ring groove and O-ring.

F. Mechanical joint ends shall comply with ANSI/AWWA C153/A21.53.

G. Restrained expansion joints shall have a minimum pressure rating of 350 psi with a minimum safety factor of 3:1 assembly shall be tested at 350 psi before shipment.

H. Restrained expansion joints shall provide for self restraint without tie rods and shall provide for expansion and contraction capabilities cast as an integral part of the end connection.

I. Flexible restrained expansion joints shall allow for 8-inches (+6"-2") minimum expansion.

J. Flexible restrained expansion joints shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15° deflection per ball.

K. Restrained expansion joints shall be the Single Ball or Double Ball FLEX-TEND Expansion Joint as manufactured by EBAA Iron Inc., or equal.

2.14 CAM AND GROOVE COUPLINGS

A. Cam and groove couplings shall be manufactured fully in accordance with the dimensions and tolerances of MIL-C-27487/A-A-59326 and shall be pressure-tested. Coupling shall be supplied with locking feature as standard. Working pressure shall meet or exceed the values listed below:

Material	½”	¾”- 2”	2½”	3”	4”	5”- 6”
Brass	150	250	150	125	100	75
Aluminum	150	250	150	125	100	75
Stainless Steel	150	250	225	200	100	100
Polypropylene	75	100	-	50	-	-

B. Standard gasket materials for metallic couplings shall be Buna N. Standard gasket materials for polypropylene couplings shall be EPDM.

2.15 QUICK CONNECT COUPLINGS AND FLUSHING CONNECTIONS

A. Quick connect type coupling for NPW, chemical, and sump discharge service shall be furnished, delivered, installed, tested and placed in satisfactory operation complete with all necessary accessories at the locations shown on the Drawings and as specified herein. For 1.5-inch piping and larger, dry quick disconnect couplings shall be polypropylene provided with female coupler and male NPT threads, quick lock coupling, and dust cap and chain as manufactured by Camlock. For 1-inch piping and smaller, dry quick disconnect couplings shall be 5/8-inch threaded male garden hose connection with a 1-inch swivel.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.

B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.

C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in

strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

D. ALL EXCAVATION REQUIRED BY THIS CONTRACT SHALL BE UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION REQUIRED FOR THE INSTALLATION OF PIPE OR STRUCTURES SHOWN ON THE DRAWINGS.

E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.

G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.

H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.

I. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURERS RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the requirements of Section 02200 - Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.

J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.

K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.

L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.

N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.

O. AT THE CLOSE OF EACH WORK DAY THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP OR PLUG SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.

P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.

Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used <u>exceptions</u>: closure pieces at manholes and areas where joint deflection is required.

R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.

S. ALL PIPING SHALL HAVE TYPE "A" BEDDING AS SHOWN ON THE DRAWINGS, UNLESS OTHERWISE SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS.

T. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water piping. The tape shall be blue and silver and shall be clearly and permanently labeled "Water". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.

U. AT THE CLOSE OF WORK EACH DAY PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED AS SPECIFIED IN SECTION 02510, PAVING AND SURFACING, TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.

3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

3.03 PRESTRESSED CONCRETE PIPE

A. The laying of prestressed concrete pipe shall be in accordance with the manufacturer's recommendations and shall conform to the applicable sections of AWWA Manual M-9. Prior to assembling the spigot end into the bell end, both ends shall be thoroughly cleaned, and the rubber gasket and the bell end of the previously laid pipe shall be coated with vegetable soap furnished by the manufacturer.

B. For each crew that is inexperienced in laying this type of pipe, one reliable man shall be furnished by the manufacturer's representative with and instructed in the use of a set of steel inserts and feeler gauge to be used in determining if the rubber gasket is in proper position prior to the joint being pushed or pulled home. An experienced crew may omit the use of a feeler gauge. In either method of operation, the Contractor shall be responsible for a good, proper and sound joint. Any joint found in later tests to be faulty shall be repaired to the satisfaction of the Engineer.

C. After the pipe is "home" a cloth diaper (minimum 7-inches wide) supplied by the pipe manufacturer shall be placed and wired around the outside of the pipe at the joint. This diaper shall serve as a form for pouring a 1:2 cement-sand grout in the external recess.

D. Great care shall be taken to prevent the concrete core or jacket or the steel bell and spigot rings from being damaged, and any core, jacket or ring damaged in any way shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.

3.04 DUCTILE IRON PIPE

A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.

B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.

C. UNLESS OTHERWISE APPROVED BY THE ENGINEER, FIELD WELDING OF DUCTILE IRON WILL NOT BE PERMITTED.

3.05 PVC/CPVC AND HDPE PIPE

A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

B. Plastic piping shall not be installed when the temperature is less then 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.06 CARBON AND STAINLESS STEEL PIPE

A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.

B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.

C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.

1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.

2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.

3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.

4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle

shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

3.07 COPPER PIPE

A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.

B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.

C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.

D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections.

E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.

F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

3.08 POLYPROPYLENE AND POLYVINYLIDENE FLUORIDE PIPE

A. The pipe and fittings shall be of the same material for both inner and outer walls of the pipe.

B. Polypropylene pipe shall be black UV stabilized co-polymer conforming to the requirements of ASTM D-4101. Where used in exterior locations, material shall provide a weathering resistance absent of further coating, covering, or wrapping unless specified herein or shown on the Drawings.

C. Polyvinylidene flouride shall comply with ASTM D-3222. The material shall provide a translucence, thus enabling a visual inspection of liquid in the annular space between the inner and outer walls.

D. Where elastomers are selected by the manufacturer, such selection shall be with regard to the application of the chemical solution to be transported.

E. Pipe and associated fittings shall be rated for not less than 75 psi at 73°F.

F. Double-walled pipe and fittings shall be molded and used throughout. Molded ribs shall maintain permanent alignment of the inner and outer walls of the pipe and fittings.

G. Ends of fittings shall be flush, creating a single plane.

H. Wall thickness of the inner and outer walls of double-walled pipe shall be identical, providing identical pressure ratings.

I. Where shown on the Drawings, a leak detection system of the manufacturer's design shall be supplied, complete with vent pipes, manual drain outlet, and electric float switch. Switch shall be rated for 0.080 amps at 120 VAC.

J. Polypropylene and polyvinylidene flouride pipe shall be laid and joints assembled by skilled workers according to the respective manufacturer's recommendations. Joints shall be butt fusion welded.

K. Plastic piping shall not be installed when the ambient temperature is less than 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

L. Wall sleeves shall be provided where piping passes through exterior walls. All sleeves shall be provided with an acceptable waterstop.

M. Double walled pipe shall be Asahi/American or equal. Pipe shall be furnished complete with flanges or other appurtenant fittings by the same manufacturer and made especially for use with the double walled pipe.

3.09 JOINTS IN PIPING

A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed, and the condition corrected.

C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints.

Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.

D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution of mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.

F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated, and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.

G. Welded joints shall be made by competent operators in a first-class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A251. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.

H. Copper joints shall be thoroughly cleaned, and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions

of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.

I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

J. Dielectric isolation such as flange isolation kits, dielectric unions, or similar, shall be installed wherever dissimilar metals are connected according to the following table.

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Ductile Iron	Mild Steel/ Carbon Steel	Copper	Brass	Stainless Steel
Zinc			●	●	●	●	●	●	●
Galvanized Steel			●	●	●	●	●	●	●
Aluminum	●	●		●	●	●	●	●	●
Cast Iron	●	●	●				●	●	●
Ductile Iron	●	●	●				●	●	●
Mild Steel/ Carbon Steel	●	●	●				●	●	●
Copper	●	●	●	●	●	●			●
Brass	●	●	●	●	●	●			●
Stainless Steel	●	●	●	●	●	●	●	●	

1. "●" signifies dielectric isolation is required between the two materials noted.
2. Consult Engineer for items not listed in table.
3. Provide flange isolation kits for all flanged connections of dissimilar metals and hardware including connections to equipment.
4. Contractor shall include all isolation descriptions with piping submittals.

K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

L. Joints in polypropylene and polyvinylidelene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

3.10 FLUSHING AND TESTING

A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested as specified in Section 02604 - Utility Structures. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing of any section or portion of a pipeline.

B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.

C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.

D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.

E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.

F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.

G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.

H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped, and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one-hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected, and the test repeated until a successful test of the entire system is obtained.

J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.

K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.

L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

3.11 DISINFECTION

A. All pipe and fitting connected to and forming a part of a potable water supply shall be disinfected in accordance with the procedures described in AWWA C 651. Disinfection shall also be in accordance with the requirements of the North Carolina Division of Environmental Health and the Owner.

B. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or NCDEH and/or the Owner until the minimum residual chlorine content of 10 ppm has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to

placing the new sections of pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

3.12 PAINTING AND COLOR CODING SYSTEM

A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 15030 – Piping and Equipment Identification Systems. In the absence of a standard color designation system, the Engineer will establish a standard color designation for each piping service category from color charts submitted by the Contractor in compliance with Section 09900 – Painting.

B. All piping specified in this Section shall be painted in accordance with Section 09900 – Painting, except as follows:

1. Copper pipe

2. Stainless steel pipe. Flanges and supports or hangers shall be painted.

- END OF SECTION -

SECTION 15006

DUCTILE IRON PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. All ductile iron pipe and specials shall be marked with the manufacturer's name or trademark, size, weight, thickness class, the date of manufacture, and the word "Ductile".

B. Ductile iron pipe (DIP) of the sizes shown or specified shall conform to ANSI A21.51 (AWWA C151), Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds. All ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) for thickness design and shall be supplied in 18 or 20-foot nominal lengths or as required to meet the requirements of the Drawings. Fittings and specials shall be cast iron or ductile iron, conforming to the requirements of ANSI A21.10 (AWWA C110) or ANSI A21.53 (AWWA C153) and shall have a minimum rated working pressure of 250 psi.

C. Minimum Class 53 pipe shall be used for flanged spools.

D. Reference Section 15000, Basic Mechanical Requirements

PART 2 -- PRODUCT

2.01 DUCTILE IRON PIPE AND FITTINGS

A. All pipe and fittings shall be cement mortar lined. Linings shall conform to American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Ductile Iron Pipe and Fittings, ANSI A21.4 (AWWA C104) and shall be standard thickness. The mortar lining shall be protected with the bituminous seal coat. All buried DIP and fittings shall have a bituminous coating on the exterior surfaces in accordance with ANSI A21.51 (AWWA C151). All exposed DIP and fittings shall have a shop applied prime coat in accordance with Section 09900 - Painting.

B. Requirements for various types of joints are described in the following paragraphs. UNLESS OTHERWISE NOTED HEREIN OR ON THE DRAWINGS, ALL EXPOSED DUCTILE IRON PIPING SHALL HAVE FLANGED JOINTS.

C. Flanged joints and fittings shall have a minimum pressure rating of 250 psi with 125 lb. American Standard flanges. All flanges and fittings shall conform to the requirements of ANSI B16.1. Flanges shall be ductile iron and shall be of the threaded or screw on type. The face of the flanges shall be machined after installation of the flange to the pipe. No raised surface shall be allowed on flanges. Flanged pipe shall conform to the requirements of ANSI Specification A21.15, (AWWA C115). Pipe lengths shall be fabricated to meet the requirements of the Drawings.

D. Gaskets shall be the "Ring Gasket" type, 1/8-inch minimum thickness, cloth inserted rubber, red rubber or neoprene and shall be suitable for the service intended. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolts for flanged joints shall be a

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minimum ASTM A307; Grade B carbon steel and be in accordance with ANSI A21.10, (AWWA C110). The bolts shall have hexagonal heads and nuts, no washers shall be used.

E. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11 (AWWA C111). Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have cast-on lugs for adequately tying it together.

F. Restrained joint pipe shall consist of factory manufactured bolted retainer rings, ductile iron locking segments held in place by rubber retainers, or ductile iron retaining rings that lock over the bell of the joint and are secured to prevent rotation, and factory welded retainer beads or rings on the spigot of the pipe. All components of the bolted or snap ring assemblies shall be constructed of corrosion-resistant, high strength, low-alloy steel. Restrained joint pipe shall be Flex-Ring or Lok-Ring type joints as manufactured by American Cast Iron Pipe Company, HP LOK or TR FLEX as manufactured by US Pipe, BOLT-LOK or SNAP-LOK as manufactured by Griffin Pipe Products, TR FLEX or Super Lock as manufactured by McWane Ductile, or approved equal.

G. Restrained fittings for piping systems 16-inches in diameter and greater shall have factory restraint systems identical to the factory restrained joint pipe specified in Item F above. All fittings shall be minimum pressure Class 250 unless otherwise specified.

H. Restrained fittings for pipe systems 14-inches in diameter and smaller shall be Mechanical Joint fittings with restraint assemblies such as StarGrip by Star Pipe Systems, MEGALUG by EBAA Iron, ONE-LOK by Sigma, GripRing by Romac, or approved equal. Where threaded-rods are allowed, the rods and tabs shall be designed for the specified restraint system design pressure, shall have lengths less than 10 feet between fittings, and shall be painted with two heavy coats of coal tar epoxy after installation.

I. Solid sleeves used to connect buried ductile iron in finished water piping applications shall be restrained using EBAA Iron 1100TDM Megalug mechanical joint restraints where specifically indicated on the Drawings.

J. The manufactured systems for thrust restraint indicated above shall be used where restrained joint ductile iron pipe and fittings are specified or indicated on the drawings. Gripping gaskets are not an acceptable form of restraint. Thrust restraint and harnessing systems such as threaded-rods, friction clamps, retainer glands shall be used only where specifically specified herein, indicated on the drawings or if allowed by the Engineer in isolated applications where conditions warrant and necessitate their use. Concrete thrust blocks may be used in accordance with the schedule indicated on the drawings, if applicable.

K. Cast Iron Soil Pipe shall conform to the standards of the Cast Iron Soil Pipe Institute (CISPI) Specification CISPI 301, and also ANSI Specification A-112.5.2 for Hub & Spigot pipe or A.112.5.1 for Hub & Spigot pipe or A.112.5.1 for No-Hub Pipe. Pipe class shall be "Extra Heavy (XH)".

- END OF SECTION -

SECTION 15007

HIGH DENSITY POLYETHYLENE (HDPE) PIPE FOR CHEMICAL SERVICE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 HDPE PIPE FOR GENERAL CHEMICAL SERVICE

A. All material shall be manufactured from a PE 4710 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material shall meet the specifications of ASTM D 3350 with a minimum cell classification of 445574C. HDPE pipe and fittings shall contain no recycled compounds except those generated in the manufacturer's own plant from resin of the same specification from the same raw material. HDPE products shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, voids, or other injurious defects.

B. Pipe shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in 2.01.A. Pipe sizes 3” and larger shall have a manufacturing standard of ASTM F 714, while pipe smaller than 3” shall be manufactured to the dimensional requirements listed in ASTM D 3035. Pipe shall have a Dimension Ratio of SDR11. Pipe sizes 4” and larger shall meet AWWA C906, and pipe sized ½” to 3” shall meet AWWA C901. HDPE pipe shall be listed as meeting NSF-61.

C. HDPE pipe shall be marked either continuously or on intervals not to exceed five (5) feet by indirect printing with the following information:

1. Name and/or trademark of the manufacturer

2. Nominal pipe size

3. Dimension ratio

4. The letters PE followed by the polyethylene grade, followed by the Hydrostatic Design Basis

5. Manufacturing Standard Reference

6. Production Code from which time and date of manufacture can be determined

D. Fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted in 2.01.A. Fittings shall have a minimum pressure rating equal to or greater than the pipe to which they are joined unless

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otherwise specified. All fittings shall meet the requirements of AWWA C901 or C906.

1. Molded fittings shall comply with the requirements of ASTM D 3261.

2. All fabricated elbows, tees, reducing tees and end caps shall be produced and meet the requirements of ASTM F 2206. Each fitting shall be marked per ASTM F 2206 Section 10 including the nominal size and fitting EDR, which will meet or exceed the pipe DR identified for the project. The butt fusion outlets of fabricated fittings shall be machined to the same SDR as the system piping to which they are to be fused.

3. Socket fittings shall meet ASTM D 2683.

E. HDPE pipes and fittings shall be joined one to another by thermal butt fusion, saddle fusion, or socket fusion in accordance with procedures recommended by the pipe manufacturer and as outlined in ASTM F 2620. The manufacturer shall provide fusion training services to the Contractor upon request.

1. Butt fusion joining of unlike SDR's shall not be permitted. Transition from one SDR to another shall be accomplished by the use of mechanical couplings or a transition nipple, which is a short length of the heavier SDR pipe with one end machined to the lighter SDR.

F. Mechanical connections of polyethylene pipe to systems or fittings of other materials, or to unlike SDR, shall be by means of flanged connections or mechanical compression couplings designed for joining HDPE to HDPE or HDPE to another piping material.

1. Flanged connections shall consist of flange adapters and back-up rings and shall have a minimum pressure rating equal to or greater than the system piping. Flanged adapters shall be made to ASTM D 3261, or if machined, to ASTM F 2206. Flanges and MJ adapters shall be fused onto the pipe. Flange adapters shall meet the dimensional and material requirements of ASTM F 2880. Metallic back-up rings (Van-Stone style lap joint flanges) shall have a radius on the inside diameter of the bore so as to be compatible with HDPE flanges. Back up rings shall have bolt pattern that will mate with AWWA C207 Class D (or B or E), ASME/ANSI B 16.5 Class 150, ASME/ANSI B 16.1 Class 125, or ASME/ANSI B16.47 Series A.

   a. Gaskets of reinforced rubber or other elastomer that is completely compatible with the specified chemical in the pipe shall be required when joining to HDPE or non-HDPE materials. Flanged HDPE joints shall be gasketed at all service pressures.

   b. Flange assemblies shall be assembled and torqued according to PPI TN-38, “Bolt Torque for Polyethylene Flanged Joints.”

   c. HDPE pipe adjacent to flanged joints and the joints themselves shall be rigidly supported at a distance of one (1) foot or one pipe diameter, whichever is greater, beyond the flange assembly.

2. Mechanical compression couplings, or mechanical transition fittings, shall be designed for use and compatible with HDPE pipe. Mechanical couplings shall have

a pressure rating equal to or greater than the pipe.

a. Couplings without self-restraining capabilities (integrated serrated teeth or grippers) shall include a plan for external restraint or isolation from pipeline generated forces.

b. When mechanical compression couplings are used, HDPE pipes shall be reinforced by a stiffener in the pipe bore. Stiffeners shall be properly sized from the size and SDR of pipe being joined. The pipe stiffeners shall be formed of PVC, 304 stainless steel, or 316 stainless steel, and shall be completely compatible with the specified chemical.

c. Mechanical couplings shall be installed in accordance with the manufacturer's recommended procedure.

d. Mechanical transition fittings shall be POLY-CAM Series 735 or Engineer approved equal.

G. Tests for compliance with this Specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate of compliance and a report of each test shall be furnished by the manufacturer for all material furnished under this Specification. HDPE pipe and fittings shall be rejected for failure to meet the requirements of this Specification.

H. For HDPE pipe to be installed inside casing pipe for buried service, pipe shall be continuous from the source to the discharge unless shown otherwise on the Drawings. Joints shall occur only in handholes or manholes. Joints shall be fused if space allows for the fusion equipment in the handhole / manhole; otherwise, mechanical couplings shall be provided at the joints.

I. Wetted materials shall be completely resistant to corrosion by the specified chemicals. Pipe manufacturer shall guarantee that the material is suitable for the intended service.

J. All HDPE pipe, fittings (other than mechanical compression couplings), and fusion equipment shall be provided by ISCO Industries; Performance Pipe, a division of Chevron Phillips Chemical Company; Flying W Plastics; or Engineer-approved equal.

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SECTION 15008

PVC/CPVC PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pipe and fittings shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 15390 - Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:

Socket Type (Schedule 40); ASTM D 2466
Socket Type (Schedule 80); ASTM D 2467

D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment except at true (double) union valves. Flange gaskets shall be natural rubber or other material fully compatible with the fluid being conveyed. Where flanged piping is used with chemical systems, the gasket material shall conform to the requirements of the following table. Flange bolts shall be type 316 stainless steel minimum, with higher grade materials used where necessary for fluid (chemical) compatibility.

Chemical	**Acceptable Gasket Material**
Ammonium Hydroxide	EPDM
Powdered Activated Carbon Slurry	EPDM, Viton
Sodium Hydroxide (Caustic)	EPDM
Sodium Hypochlorite	Viton

E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

F. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform

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to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.

G. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2677. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.

H. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a

minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (1± inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.

I. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

J. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D 2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D 2235.

K. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D 3034 with a maximum SDR of 35. Pipe and fittings shall have bell and spigot ends with O-ring rubber gasketed, compression type joints. Joints shall conform to the requirements of ASTM Specification D 3212. Reruns of reclaimed materials shall not be accepted. Unless indicated otherwise, PVC wall pipes shall be provided for all piping passing through exterior walls. Wall pipes shall have a water stop solvent-welded to the pipe. Each wall pipe shall be of the same class and type as the piping to which it is joined.

L. Perforated and closed drainage pipe and fittings shall be rigid PVC pipe, Schedule 40 unless otherwise shown or specified with solvent welded type joints, or approved equal. Pipe shall be slotted or have two rows of 1/4-inch diameter holes spaced 4-inches apart along the circumference of the pipe. Longitudinal spacing of holes shall be 5-inches maximum.

2.02 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

A. CPVC shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. CPVC pipe shall be Type 4, Grade 1, Schedule 80, conforming to ASTM D 1784 and ASTM F 441. CPVC fittings shall be socket type conforming to ASTM F 439.

D. Solvent cement for socket type joints shall conform to ASTM F 493 for CPVC pipe and fittings. Solvent cement for chemical service shall be Weld-On 724 as manufactured by IPS Corporation, or equal.

2.03 REINFORCED THERMOPLASTIC HOSE AND FITTINGS

A. Reinforced thermoplastic hose shall be clear type, reinforced with polyester yarn. Hose material shall be PVC, EVA (Ethyl Vinyl Acetate), or Low-Density Polyethylene, depending on the application, as indicated in Section 15390 – Schedules. Hose shall be rated for the following working pressures:

Internal Diameter	Minimum Working Pressure (at 68°F)
½”	200 psi (75 psi at 150°F)
1”	125 psi (50 psi at 150°F)
1-½”	100 psi
2”	75 psi

B. Hoses shall be continuous from the source to the discharge unless shown otherwise on the drawings. Splices shall not be allowed unless approved in writing by the Engineer. If allowed, splices shall occur only in handholes or manholes. Connections and splices, if allowed, shall be barb and clamp type using materials that are compatible with the chemical being conveyed.

C. Reinforced thermoplastic hose shall be a manufactured product of Parker Nexgen or equal.

D. Wetted materials shall be completely resistant to corrosion by the specified chemicals. Hose manufacturer shall guarantee that the hose is suitable for the intended service.

- END OF SECTION -

SECTION 15009

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. The pipe shall be manufactured from Type III, Category 5, Class C, Grade P34 polyethylene resin in accordance with ASTM D-1248 and shall be SDR11, minimum. The pipe shall be manufactured in accordance with ASTM F-714 and shall conform to cell classification PE 345434C for PE 3408 under ASTM D-3350. The pipe material shall conform to the following cell classification requirements:

Property	Value	ASTM Test Procedure Designation
Density	0.955 gm/cm^3	D-1505
Melt Flow	0.1 gm/10 mil	D-1238
Flexural Modular	133,000 psi	D-790
Tensile Strength	3500 psi	D-638
ESCR	F_o>5000	D-1693
Hydraulic Design Basis	1600 psi	D-2837
UV Stabilizer	2-3% carbon black	D-160

B. The HDPE pipe shall have an elastic modulus of 100,000 psi as tested under ASTM D-638. The brittleness temperature shall be not greater than –180°F nor the Vicat Softening Temperature greater than 255°F as tested under ASTM D-746 and D-1525, respectively. The coefficient of thermal expansion shall be 8 x 10^{-5} inch/°F as tested under ASTM D-606. The Shore Hardness D shall be greater than 61 as tested under ASTM D-2240. The Hydrostatic Design Stress Basis (HDB) shall be 1,600 psi at 23°C and 800 psi at 60°C as tested under ASTM D-2837. The pipe shall contain no recycled materials or compounds.

C. HDPE pipe shall be marked either continuously or on intervals not to exceed five (5) feet by indirect printing with the following information:

1. Name and/or trademark of the manufacturer.

2. Nominal pipe size.

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3. Dimension ratio.

4. The letters PE followed by the polyethylene grade per ASTM D-1248, followed by the Hydrostatic Design basis in 100's of psi.

5. Manufacturing Standard Reference.

6. Production Code from which time and date of manufacture can be determined.

D. HDPE fittings shall be manufactured to the requirements of ASTM D-3261 and this Specification. Fabricated fittings shall be manufactured from pipe of at least one SDR heavier pipe than the system piping and shall be pressure rated to match the system piping. The butt fusion outlets of fabricated fittings shall be machined to the same SDR as the system piping to which they are to be fused. The manufacturer shall subject samples of each production lot of molded fittings to x-ray inspection for voids. Voids shall not be permitted, should voids be found in the samples, the entire production lot shall be x-ray inspected. If additional voids are found, the production lot shall be rejected. The x-ray testing shall be conducted by an independent laboratory and certified test reports made available to the Engineer upon request. Initial sampling shall be limited to not less than 5% of the production lot.

E. HDPE pipes and fittings shall be joined one to another by thermal butt fusion, saddle fusion, or socket fusion in accordance with procedures recommended by the pipe manufacturer and as outlined in ASTM D-2657. The manufacturer shall provide fusion training services to the Contractor upon request.

F. Butt fusion joining of unlike SDR's shall not be permitted. Transition from one SDR to another shall be accomplished by the use of mechanical couplings or a transition nipple, which is a short length of the heavier SDR pipe with one end machined to the lighter SDR.

G. Mechanical connections of polyethylene pipe to systems or fittings of other materials, or to unlike SDR, shall be by means of flanged connections (flange adapters and back-up rings rated for the same pressure service as the system piping), or mechanical compression couplings designed for jointing HDPE to HDPE or HDPE to another piping material. Mechanical compression fittings shall be the POLY-CAM Series 735 or Engineer approved equal.

H. Flanged joints shall use compatible bolts in accordance with the American Standard Gaskets of reinforced rubber or asbestos-rubber shall be required when joining to non-HDPE materials. Flanged HDPE joints shall be gasketed at all service pressures.

I. Bolts in flanged joints shall be evenly torqued in a crossing pattern. Bolts shall be re-torqued after one hour or more has passed. HDPE pipe adjacent to flanged joints and the joints themselves shall be rigidly supported for a distance of one (1) foot or one pipe diameter, whichever is greater, beyond the flange assembly.

J. When mechanical compression couplings are used HDPE pipes shall be reinforced by a stiffener in the pipe bore. Stiffeners shall be properly sized from the size and SDR of pipe being joined. Mechanical couplings shall be installed in accordance with the manufacturer's recommended procedure.

K. Tests for compliance with this Specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate of compliance and a report of each test shall be furnished by the manufacturer for all material furnished under this Specification. HDPE pipe and fittings shall be rejected for failure to meet the requirements of this Specification.

- END OF SECTION -

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SECTION 15012

STEEL PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall submit certification that the steel pipe has been designed to resist all loads implied and reasonably anticipated for the means and methods of installation applied by the Contractor.

B. Design pipe layout in accordance with AWWA M11

1. Use base stationing and elevation convention as shown on Drawings.

2. Include at minimum:

a. Specific number, location, and direction of each pipe, joint, and fitting. Number each pipe in installation sequence.

b. Station and centerline elevation at changes in grade or horizontal alignment.

c. Location of mitered pipe sections, beveled ends for alignment conformance, butt straps, and temperature stress control joints.

C. Welding Procedure Specification (WPS)

1. Qualified by testing in accordance with ASME Boiler Pressure Vessel Code (BPVC) SEC IX for shop welds and AWS D1.1/D1.1M for field welds.

2. Procedure Qualifications Records conducted on unlisted base metal to be production welded as required in the referenced welding Code shall be traceable to heat lots.

3. Written WPS required for welds, both shop and field.

D. Stulling: Design for pipe and fittings such that over-deflection and damage is avoided during handling, storage, and installation, including backfill and compaction.

E. The AWWA Specifications referenced in this section are supplemented as follows:

1. An affidavit of compliance is required from the pipe manufacturer stating the pipe material is manufactured to the requirements of the Specifications and referenced standards.

2. The pipe manufacturer shall include mill specifications on coil steel used in the production of the pipe. The steel manufacturer's certification that the material meets the ASTM Specification will be accepted in lieu of tests on specimens taken from the fabricated pipe. The manufacturer may purchase steel plates on the chemical basis and shall submit certified test reports.

1.02 DESIGN REQUIREMENTS

A. Contractor shall be responsible for all aspects of installation and testing of welded steel pipe.

B. Design Criteria for Service Conditions (provided for informational purposes only):

Condition	Requirement
Working Pressure (psi)	30
Transient Pressure (psi)	35
Field Test Pressure (psi)	15
Earth (dead) Load (lb/ft^2)	2,750
Live Load (lb/ft^2)	250

1.03 SUBMITTALS

A. Shop Drawings showing pipe layout including all fittings and straight sections in one complete package from the main pipe supplier.

B. Material list and steel reinforcement schedules for materials specified.

C. Fabrication Information

1. Pipe and fitting details for temporary and permanent facilities indicating:

a. Cylinder thickness

b. Manufacturing tolerances

2. Welded joint details including:

a. Butt Joints

b. Miter-cut ends for alignment conformance

c. Fittings

D. Welding Data (Shop and Field Welding)

1. Show on a weld map, complete information regarding base metal specification designation location, type, size, and extent of welds with reference called out for WPS and nondestructive examination numbers in tail of welding symbol.

2. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for all welds.

3. Submit welding data together with Shop Drawings as a complete package.

4. Fittings: Provide a joint weld beveling diagram. Refer to AWS D1.1/D1.1M, Annex P Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.

E. Product data for the following:

1. Material data

2. Chemical and physical test reports showing data consistent with specified requirements for each heat of steel proposed for use.

3. Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with NSF 61 and satisfies current applicable governmental health and safety requirements for use in potable water.

F. Pipe Manufacturer’s written Quality Assurance/Control Plan

G. Statements of Qualification

1. Pipe Manufacturer

2. Fittings and specials fabricator

3. Welder Logs

a. Name of welder

b. Welding procedure/positions for which welder is qualified to weld

c. Assigned certification stamp number

d. Certification Date

e. Current certification status

4. Contractor’s Shop Inspector

5. Contractor’s Field Inspection Firm and Personnel

6. Nondestructive Testing Quality Control Firm and Personnel

H. Procedures

1. Shop and field welding information; at a minimum include complete welding code paper trail with linkage to Shop Drawings.

a. Written WPS and Procedure Qualification Record.

b. Written Nondestructive Testing procedures.

c. Current Welder Performance Qualifications.

d. Written weld repair procedures for Work.

I. Reports

1. Source Quality Control Test Reports: Nondestructive weld testing (shop and field)

J. Design calculations prepared by a licensed professional engineer in the State for which the construction of the project is occurring for fittings, including opening reinforcement details of collars, wrappers, crotch plates; and harnessed joint assemblies.

1.04 QUALIFICATIONS

A. Pipe Manufacturer

1. Steel Plate Fabricators Association (SPFA) Certification of ISO 9000 Certification.

2. Experienced in fabricating pipe of similar diameters, lengths, and wall thickness required for the Work.

3. Demonstrate current production capability for volume of work required for this project.

4. Experience shall be applicable to fabrication plant facilities and personnel; not company or corporation that currently owns fabrication facility or employs personnel.

B. Pipe and Fittings Fabricator

1. Pipe: Successful fabrication of at least 100,000 lineal feet of the same diameter (or larger) and same wall thickness (or greater) within the past five years with the type of joint specified.

2. Fittings: Successful fabrication to AWWA C200 and AWWA C208 standards of at least 25 fittings of the same diameter or larger pipe, with wall thickness 3/16-inch or greater, within the past five years.

C. Welders and Welding Operators

1. Shop Welders: In accordance with ASME BPVC SEC IX

2. Field Welders: In accordance with AWS D1.1/D1.1M

D. Contractor's Shop Inspector

1. In accordance with AWWA C200

2. Responsibilities

a. Monitor conformance to approved WPS

b. Monitor conformance to approved Nondestructive Testing procedure specifications.

c. Monitor conformance of Welder Performance Qualifications.

d. Provide 100 percent visual inspection before, during, and after shop welding.

e. Coordinate Nondestructive Testing work and review test results.

f. Maintain records and prepare report confirming results of inspection and testing.

E. Pipe Manufacturer Field Representative: The field service representative shall have a minimum of 5 years' experience installing pipe with joints, linings, and coatings of the pipe to be furnished.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Fittings shall be marked at each end with "TOP FIELD CENTERLINE".

B. Securely bulkhead or otherwise seal ends of pipe and fittings prior to loading at manufacturing site.

C. Pipe ends shall remain sealed until installation.

D. The Contractor shall ensure the proper protection of piping materials during shipment, handling, storage, and installation as directed by the pipe manufacturer.

E. Damage to pipe and fittings, including linings and coatings shall be repaired to Engineer's satisfaction or removed from Site and replaced.

F. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

G. Support on sand or earth berms free of rock exceeding 3-inches in diameter.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. Steel pipe and fittings shall be under direction of the main pipe supplier. All straight pipe sections and fittings shall be manufactured by the same manufacturer.

B. All steel pipe and fittings shall be supplied by American Spiralweld Pipe Company or Northwest Pipe Company.

2.02 STEEL PIPE

A. Steel pipe and fittings shall be manufactured, tested, inspected, and marked to comply with AWWA C200 and additional requirements of these Contract Documents.

B. Materials in contact with internal conveyed liquid shall be NSF 61 approved for use with potable water.

C. Pipe shall be furnished principally in 40-feet net laying lengths with shorter lengths, field trim pieces and closure pieces as required by the Drawings for locations of fittings, or as required for construction.

D. Pipe Barrel

1. The steel pipe shall be mill type, smooth wall, spiral welded, or steel plate for straight seam welded steel pipe per AWWA for nominal pipe sizes 6-inches and larger. Steel pipe shall be new and shall meet or exceed the manufacturer and material requirements of ASTM A139, Grade C, or D, or ASTM A1011/ASTM A1018 Grade 40 or 45. Plates used for reinforcement collars, anchor rings, and crotch plates shall meet or exceed the requirements of ASTM A36 or A572 Grade 50. Steel pipe shall be designed for embankment (wide-trench) conditions and in accordance with AWWA M11 Steel Pipe – A Guide for Design and Installation, latest edition, as supplemented by this Section. and as follows:

a. Minimum Yield Strength of 42,000 psi

b. Minimum Tensile Strength of 58,000 psi

2. The inside diameter, including the lining, shall be a minimum of the nominal diameter of the pipe specified.

E. Buried steel pipe shall be manufactured to the nominal pipe sizes as shown on the drawings and shall have the following minimum wall thicknesses:

Buried Steel Pipe Schedule

Nominal Inside Diameter (inches)	Interior Lining Type	Cement Mortar Lining Thickness (inches)	Minimum Sheet or Plate Thickness (inches)
18	Cement Mortar Lined	0.500	0.250
54	Cement Mortar Lined	0.500	0.375

2.03 FITTINGS

A. Fittings shall be fabricated in accordance with AWWA C208. Pipe material used in fittings shall be of the same material and pressure class as the adjoining pipe. The minimum radius of elbows shall be 2 ½ times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11 ¼-degrees (one cut elbow up to 22 ½-degrees). If elbow radius is less than 2 ½ times the pipe diameter, per the approval of the Engineer, stresses shall be checked per AWWA M11 and the pressure class increased if necessary.

B. Specials and fittings: unless otherwise shown on the Drawings, shall be made of segmental welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe.

C. Laterals and outlets shall be reinforced in accordance with ASME Pressure Vessel Code, Section VIII, Paragraph G-37 or the latest version of AWWA M11.

D. Fabricate collar or wrapper reinforcement using same steel as specified for main pipe barrel.

2.04 INTERIOR LINING

A. Cement Mortar Lining

1. All steel pipe shall be manufactured to include cement mortar lining. Cement mortar lining conforming to AWWA C205 shall be provided. The minimum thickness of the mortar lining shall be as indicated in the pipe schedule. Shop

lining of welded joint pipe shall be held back as shown on the Drawings to facilitate welding.

2. Holdbacks shall receive a prime coat and be provided as shown on the approved shop drawings. Holdbacks shall be filled with cement mortar after joint completion per AWWA C205.

3. Defective linings as identified in AWWA C205 shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints.

4. Fittings shall be cement-mortar lined per AWWA C205. Pipe and fittings too small to cement-mortar line may be lined with AWWA C210 epoxy or AWWA C222 Polyurethane.

5. Cement mortar lining shall be provided for the 18-inch MW and 54-inch FLW piping.

B. Polyurethane Lining

1. Polyurethane coating shall be per AWWA C222 to a minimum dry film thickness of 25 mils, measured in accordance with SSPC-PA 2. Coating shall be continuous to the ends of the pipe except where field welding is indicated. Holdbacks of lining shall be of sufficient width as to not damage the lining when completing field welds. A heat resistant material of sufficient width to prevent damage to the lining shall be paced on each side of the coating holdback during welding to avoid damage to the lining. Any damage to the epoxy lining shall be repaired per AWWA C222.

C. Epoxy Lining

1. Epoxy Lining shall be per AWWA C210 to a minimum dry film thickness of 16 mills, measured in accordance with SSPC-PA 1. Coating shall be continuous to the ends of the pipe except where field welding is indicated. Holdbacks of lining shall be of sufficient width as to not damage the lining when completing field welds. A heat resistant material of sufficient width to prevent damage to the lining shall be paced on each side of the coating holdback during welding to avoid damage to the lining. Any damage to the epoxy lining shall be repaired per AWWA C210.

2.05 EXTERIOR COATING

A. Tape Wrap for Buried Steel Pipe and Fittings

1. The outside of all buried steel pipe and fittings shall receive a prime coat per the exterior tape system manufacturer's recommendations, except for areas of pipe to be field welded.

2. The outside of buried steel pipe shall receive, over the prime coat, a multi-layered, cold-applied tape wrap system which shall be shop applied and consist of a rubber and synthetic resin primer, one (20 mils) layer of inner wrapping and two (30 mils each) layer of outer wrap for a total system thickness of 80 mils. The cold applied tape wrap shall operate satisfactorily at a temperature of 150°F.

3. The wrap shall be applied in accordance with AWWA C214 and as specified herein.

4. Windings shall be spiral wrapped with at least 1" of overlap. All fittings shall be wrapped in accordance with AWWA C209 and C214. Successive layers shall be applied such that windings are staggered and overlay the midpoints of previous tape widths. The wrapping shall terminate 6" from outside field weld sites.

5. Polyethylene backed coatings shall be protected from sunlight at all times.

6. The tape wrap system shall be the YG III system as manufactured by the Polyken Division of Kendall Co., Boston MA, or equal.

7. Interior Welded Pipe: Finish wrap or heat shrink sleeves per AWWA C216 shall be applied to each joint of the pipe for continuous wrapping of all steel piping. Contractor shall complete internal welding prior to applying heat shrink sleeve and prior to backfilling.

8. Any tape wrap damaged during installation shall be repaired in accordance with AWWA C214 to the engineer’s satisfaction prior to backfilling operations.

9. Tape wrap system shall be used for 54-inch FLW piping associated with the filtered water mixing vault.

B. Polyurethane Coating

1. Polyurethane coating shall be per AWWA C222 to a minimum dry film thickness of 25 mils, measured in accordance with SSPC-PA 2. Coating shall be continuous to the ends of the pipe except where field welding is indicated. Holdbacks of coating shall be of sufficient width as to not damage the coating when completing field welds. A heat resistant material of sufficient width to prevent damage to the coating shall be placed on each side of the coating holdback during welding to avoid damage to the coating. Any damage to the polyurethane coating shall be repaired per AWWA C222.

2. Polyurethane coating shall be used for the 54-inch FLW piping associated with the filter tie-in.

C. Exterior Painting for Exposed Steel Pipe (Indoor and Outdoor)

1. Prepare surface to be coated in accordance with the coating manufacturers recommendations immediately prior to applying any coating.

2. Except for areas of pipe to be welded, the exterior of exposed steel pipe shall receive a prime coat of 5 to 10 mils (dry) of inorganic zinc primer rated for 300°F continuous service and shall be Carbozinc 11 as manufactured by Carboline, Tnemec-zinc Series 90-97, or equal.

3. Areas of pipe to be welded shall receive 1 mil (dry) of weldable primer as manufactured by Carboline, Tnemec, or equal. After welding and pressure and leakage testing are completed, welded joints shall be thoroughly cleaned of all foreign matter and any scale or rust and primed as previously specified.

4. Over the prime coat shall be a finish coat of 3 to 5 mils (dry) of a polyurethane coating and shall be Carbothane 133 HB, Tnemec Series 1075, or equal.

5. Field touch-ups shall be electrically inspected by the use of a holiday detector in accordance with AWWA C209.

2.06 JOINTS

A. All unwelded pipe joints shall be bonded for electrical continuity in accordance with the Pipe Manufacturer's recommendations unless otherwise specified in the Drawings.

B. Flanges, Flange Gaskets, and Bolting Materials

1. Flanged joints shall be used as shown on the Drawings. Flanges shall be AWWA C207, standard ring type, slip-on welding flanges.

2. Bolts and nuts shall be per the requirements of AWWA C207. The bolts shall have hexagonal heads and nuts. No washers shall be used.

3. All gaskets shall be the "Ring-Gasket" type, 1/8-inch minimum thickness. Segmented gaskets will not be acceptable. Gaskets for flanged joints must follow AWWA C207.

4. Where isolation is required between dissimilar metals or for cathodic protection, insulating joints shall be provided using isolation gasket kits. Isolating sleeves for bolt holes shall be mylar, and isolating washer material shall be GRE-G10.

5. Shop lining and coating shall be continuous to the end of the pipe or back of the flange. Flange faces shall be shop coated with a soluble rust preventive compound.

C. Lap and Butt-strap Welds

1. Lap welds or butt-strap welds shall be in accordance with AWWA C200, AWWA C206 (for field welding) and AWWA M11.

2. Lap and butt-strap field welded joints shall be used where restrained joints are required or indicated on the Drawings. The minimum lap shall be 1-inch.

3. Lap welded joints shall be welded as shown on the drawings. Holdbacks for coating and linings shall be provided as shown on the approved shop drawings.

4. If pipe restraint is not required, lap or butt-strap or butt welding may be used at the Contractors option.

D. Butt Weld Joints

1. Butt welded joints shall conform to AWWA C200, AWWA C206 (for field welding), and AWWA M11.

2. Butt welded joints shall be used where indicated on the Drawings, or at the Contractor's choice in lieu of lap and butt-strap welds. Butt welds shall be complete joint penetration welds (applies to single and double welded joint), and the ends of the pipe shall be appropriately beveled for an acceptable butt weld.

3. Butt welds shall be accurately aligned and retained in position during the welding operation so that in the finished joint the abutting pipe sections shall not be misaligned by more than 20 percent of the pipe wall thickness or a maximum of 1/8", whichever is less.

4. Holdbacks for coating and linings shall be provided as shown on the approved shop drawings.

E. Mechanical Couplings

1. Restrained mechanical couplings where indicated on the Drawings shall be as specified in Section 15000 Basic Mechanical Requirements.

2. Where two different pipe materials are joined, insulating mechanical couplings shall be provided and shall be double insulated Smith Blair Style 416, Baker Style 216, Romac Industries Inc. Style IC400, or equal for working pressures up to 150 psi only.

3. Couplings for buried service shall have all metal parts fusion epoxy coated in accordance with AWWA C213.

4. Pipe ends for mechanical couplings shall conform to AWWA C200 and AWWA M11. The shop applied outside coating shall be held back as required for field assembly of the mechanical coupling or to the harness lugs or rings. Harness lugs

or rings shall be fusion epoxy coated in accordance with AWWA C213 and pipe ends shall be painted with one shop coat of polyurethane conforming to AWWA C222.

5. Pipe for use with sleeve-type couplings shall have plain ends at right angles to the axis.

F. The piping layout shown on the Drawings is based upon standard fittings available in ductile iron pipe. Welded joints will not be acceptable where such joints would interfere with the removal of valves or equipment or create sections of piping too large for removal from structures as determined by the Engineer.

G. Harnessed flexible couplings may also be used in lieu of flanges at locations approved by the Engineer. Lugs or retainer rings shall be welded to the pipe in accordance with the requirements of AWWA Manual M11 for Steel pipe where required for harnessing of flexible couplings.

2.07 WELD TESTING AND INSPECTION

A. All welding procedures used to fabricate pipe shall be qualified under the provision of AWS B2.1 or ASME Section IX.

B. All welds made after hydrostatic testing of the straight sections and fittings of pipe shall be tested per the following paragraphs.

C. Shop Non-Destructive Testing

a. 100 percent visually examined by Contractor’s Shop Inspector

b. Hydrostatic testing 100 percent of straight pipe sections per AWWA C200

D. Field Non-Destructive Testing

a. All field welds shall be performed by AWS certified welders in conformance with standard procedures and shall be visually inspected and tested by an approved quality assurance testing firm in accordance with AWS D1.1 and AISC Design Guide 21 Welded Connections, Section 9.0 and other applicable referenced sections of AWS and AISC.

b. The Contractor shall be responsible for contracting with an approved testing firm. Nondestructive testing methods shall be used unless otherwise approved by the Engineer.

c. At minimum, all field welds shall be inspected in accordance with the following:

d. Visual: 100 percent of all welds.

1) Magnetic particle or Ultrasonic: 100 percent of all butt welds.

2) Magnetic particle: 100 percent of all lap and butt-strap welds.

3) Hydrostatic testing 100 percent of pipeline per AWWA C200.

2.08 MISCELLANEOUS STEEL PIPE AND FITTINGS

A. Other steel pipe and fittings not specified elsewhere shall conform to ASTM A120, black or galvanized, as directed by the Engineer, seamless, Schedule 40 or 80 as indicated in the appropriate Piping System Schedule in Section 15390, Schedules.

B. Unless otherwise shown or required, all piping and fitting shall be threaded. Fittings shall conform to ANSI B16.3, 300 pound class and shall be of the black malleable iron screw type. All threaded joints shall be made tight with an oil and graphite paste or Teflon thread tape applied to the male threads only. All pipe 1-1/2 inches and smaller shall be reamed to removed scale and dirt. Pipe to be galvanized shall have a deep galvanized coating applied in full accordance with ASTM A123.

PART 3 -- EXECUTION

3.01 GENERAL

A. Furnish feeler gauges of proper size, type, and shape for use during installation.

B. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer’s instructions and these specifications.

3.02 INSTALLATION

A. General

a. Install pipe in accordance with the requirements included in AWWA M11.

b. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.

3.03 MANUFACTURER’S FIELD SERVICES

A. The services of an experienced, competent and authorized field service representative acceptable to the Owner shall be provided for a period of not less than the following number of days for each process piping to perform all field services specified herein.

1. 18-inch MW: 2 days

2. 54-inch FLW associated with filtered water mixing vault: 2 days

3. 54-inch FLW associated with filter tie-in: 2 days

B. The field service representative shall visit the site to advise and consult with the Contractor and to review and instruct the Contractor in procedures for pipe handling, laying, and jointing at the start of pipe installation for each crew and shall coordinate his services with the Contractor. The field services representative shall not directly supervise the Contractor's personnel. The Contractor shall remain responsible for the piping installation work.

- END OF SECTION -

SECTION 15020

PIPE SUPPORTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and design calculations required to provide pipe supports in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Reference Section 05050, Metal Fastening.

B. Reference Section 15000, Basic Mechanical Requirements.

1.03 SUBMITTALS

A. Pipe support submittals will not be reviewed prior to review and acceptance of pipe layout submittal. Pipe support submittal shall be fully coordinated with approved pipe layout submittal. Contractor shall use approved piping layout submittal drawings to show proposed pipe support type and location with accurate dimensions to demonstrate that supports meet all specified requirements.

B. Applicable and associated cut sheets and drawings for materials and support components shall be submitted with the Shop Drawings in accordance with or in addition to the submittal requirements specified in Section 01 33 00 – Submittals, Section 40 05 00 – Basic Mechanical Requirements and other referenced Sections above.

1. Catalog cut information on all system components such as pipe supports, hangers, guides, anchors, and channel-type supports.

2. Drawings of the piping support systems, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide and anchor type by catalog number and Shop Drawing detail number.

3. With each piping support system Shop Drawing, the Contractor shall attach calculations prepared and sealed by a Professional Engineer licensed in the State where the project is located showing that the piping support system complies with the specified requirements, including all building code and seismic code requirements pertaining to support of piping and other non-structural components. See Section 01 73 23 – Seismic Anchorage and Bracing.

4. Table showing the manufacturer's recommended hanger support spacing for PVC, CPVC and FRP pipe for the services listed in Section 40 06 20 – Schedules.

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PART 2 -- PRODUCTS

2.01 GENERAL

A. The Contractor shall be responsible for the design of all piping support systems unless noted otherwise herein. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of the responsibility of providing a pipe support design sealed by a Professional Engineer. Standard details for pipe supports have been included on the Drawings to define minimum requirements as to the types of Contractor designed pipe supports that will be acceptable.

B. Where a specific location or type of support is shown on the Drawings, the location and type shall be incorporated in the Contractor's pipe support design.

C. Where special pipe support fabrications are required, products and execution shall be as specified in Section 05 50 00 – Metal Fabrications and other related and referenced Sections of the Specifications.

D. Existing piping support systems to support new piping shall only be used if the Contractor can show and demonstrate by submitting supporting calculations that they are adequate for the additional load imposed by the new piping, or if they are strengthened to support the additional load.

E. Contractor's pipe support design should include, but not be limited to, the following criteria and loads imposed on the piping system:

1. Thrust Loads based on the design pressures as specified in Piping Schedules in Section 40 06 20. Pipe support design shall not utilize process equipment for thrust restraint or support of piping loads.

2. Dead loads and live loads per the latest version of ASCE/SEI 7 or the local building code if more stringent. Loads shall include, but not be limited to, the following:

a. Weight of pipe

b. Weight of pipe contents

c. Weight of insulation

d. Ice loads (If applicable by location, ice loads per code shall be applied as indicated in the governing building code)

e. Seismic loading requirements and conditions as specified in the governing building code and referenced seismic design codes. Refer to Section 01 73

23 – Seismic Anchorage and Bracing and the structural code drawing for project specific seismic design criteria. Seismic and sway bracing shall be provided at maximum 10-foot centers.

f. Wind loads

3. Loads associated with thermal expansion and contraction of the piping system over the full range of potential temperatures the piping system could experience that should include, but not be limited to, the following:

a. Ambient temperature range per local historical weather data (historic high and low obtained from NOAA)

b. Process operating temperature range

c. Exposure to sunlight where applicable

4. Additional pipe support design considerations shall include the following:

a. A minimum safety factor of 2 or as approved by the Engineer, based upon the yield strength of the support material, shall be used for pipe supports, braces, hangers, and guides as well as for beam and column members used in channel-type support systems.

b. The horizontal pipe hanger and/or floor support spacing shall be as recommended by the pipe and/or hanger manufacturer but shall not exceed 10 feet on center unless indicated otherwise herein or on the Drawings.

c. The design, sizing and spacing of anchor bolts, including concrete anchors, shall be based on withstanding shear and pullout loads imposed by loading at each particular support. The minimum anchor bolt size shall be ½ inches in diameter. Refer to Section 05 59 00 – Bearing Devices and Anchoring.

2.02 HANGERS AND SUPPORTS

A. All piping shall be adequately supported and braced by means of steel hangers and/or supports, concrete piers, supplemental lateral bracing components, pre-fabricated brackets, or otherwise as may be required by the location and forces applied per governing code, including gravity and lateral forces from earthquake and/or wind (if outdoors). Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure. Refer to Standard Detail Drawings.

1. Metal pipe support materials, where carbon steel, ductile or other ferrous pipe is supported, shall be galvanized carbon steel meeting Section 05120 – Structural Steel and Section 05035 – Galvanizing unless indicated otherwise on the Drawings or in the specifications or by the Engineer.

2. Metal pipe supports indicated as standard type pipe hangers are designed and detailed for gravity loading only. Resulting lateral loads from wind, earthquake, or other lateral loads per code, or special loading conditions during construction, shall be applied to the pipe in accordance with the governing building code. Supplemental lateral stiffening members (when necessary) shall be provided along pipe or at gravity supports using appropriate supplemental members and connections when required by calculations. The Contractor shall include design calculations and details with all pipe hangar and support submissions for review by the Engineer. The main structure and structural components that will support the pipe hangers and other appurtenant components of the facility have been designed to resist all resulting secondary lateral loading from pipe hangers and other non-structural members for gravity and resulting lateral loads.

B. Hangers and supports shall conform to the following requirements:

1. All fabricated metal hangers and supports shall be capable of adjustment after installation. Different types of hangers and supports along a pipe length, including bends, shall be kept to a minimum.

2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.

3. Vertical piping shall be properly supported at each floor and between floors by stays or braces to prevent rattling and vibration.

4. Supports and hangers for plastic and FRP piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.

5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless-steel hangers.

6. Ferrous pipes to be painted shall be painted in accordance with Section 09 90 00 – Painting. Ferrous pipes that require painting or galvanizing shall be supported by galvanized hangers and supports. Stainless steel piping shall be supported by stainless steel saddles and straps (if required).

7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.

8. Plastic piping shall be supported by plastic coated steel hangers and supports.

9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.

10. Expansion and adhesive type anchors used for pipe hangers and supports shall be Type 316 stainless steel.

C. Metallic hangers and supports may be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction. All gravity type hangers and supports shall be restrained laterally to resist seismic loading and other loading as required by the governing code.

D. Non-metallic support system shall be a heavy-duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Contractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Contractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

PART 3 -- EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Support piping connections to equipment by pipe support and not by the equipment.

B. Support large or heavy valves, fittings, flow meters and appurtenances independently of the connected piping.

C. Support no pipe from the pipe above it.

D. Support piping at changes in direction or in elevation, adjacent to flexible joints, expansion joints, and couplings, and where shown.

E. The Contractor shall not install piping supports and hangers in equipment access areas or bridge crane runs.

F. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

G. Install pipe anchors (fixed supports and/or guides) where shown and/or as may otherwise be required to withstand expansion thrust loads and to direct and control thermal expansion. The Contractor may install additional pipe anchors and flexible couplings to facilitate piping installation, provided that complete details describing location, pipe supports and hydraulic thrust protection are submitted.

- END OF SECTION -

SECTION 15030

PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09900, Painting.

B. In addition to the legends specified herein the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.

C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01300, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.

D. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 PIPING BAND

A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefinished metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

2.02 PIPING IDENTIFICATION LEGEND

A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

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Diameter of Pipe or Pipe Covering	Height of Lettering
3/4 to 1-1/4 inches	1/2-inches
1-1/2 to 2-inches	3/4-inches
2-1/2 to 6-inches	1-1/4-inches
8 to 10-inches	2-1/2-inches
Over 10-inches	3-1/2-inches

B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4-inch in diameter, the Contractor shall furnish and attach approved color coded tags where instructed.

C. The colors referenced in the legend are as manufactured by KOP-COAT. They are used for convenience only.

D. Piping and Equipment Identification

1. Pipe color and lettering shall match that of the existing process piping. The paint color and lettering of any new piping applications shall be coordinated with the Owner.

SERVICE	LEGEND	ID
BASE BID		
Air	AIR	Match Existing
Ammonium Hydroxide	AH	Match Existing
Caustic Solution	CAS	Match Existing
Drain	D	Match Existing
Filtered Water	FLW	Match Existing
Finished Water	FW	Match Existing
Non-Potable Water	NPW	Match Existing
Potable Water	PW	Match Existing
Sample	SA	Match Existing
Sodium Hypochlorite	SH	Match Existing
Vent	V	Match Existing
ALTERNATE BID		
Powdered Activated Carbon	PAC	Coordinate with Owner

- END OF SECTION -

SECTION 15095

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.

B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM A126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings".

C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.

D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

A. The Contractor shall furnish to the Owner, through the Engineer, a Performance Affidavit where required in individual valve specifications, utilizing the format specified in Section 11000, Equipment General Provisions. Performance tests shall be conducted in accordance with the latest revision of AWWA C500 and affidavits shall conform to the requirements of the Specifications

B. Shop Drawings conforming to the requirements of Section 01300, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in

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accordance with JIC standards. Shop Drawings for pneumatically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

C. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the equipment named below to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures in accordance with the following schedule:

Item	Valve/Operator Type	Minimum On-Site Time Requirements
1.	Motor Operated Modulating Valves	One (1) 8-hour day
2.	Motor Operated Open-Close Valves (required only if manufacturer is other than for Item 1 above)	One (1) 8-hour day

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.

D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 -- PRODUCTS

2.01 CORPORATION STOPS

A. Corporation stops shall be of bronze with tapered male iron pipe threads on inlets and outlets. Terminal outlets shall have screwed bronze hex head dust plugs or caps. Unions shall be used on all corporation stop outlets with connecting piping. Corporation stops shall have a minimum working pressure rating of 250 psi and shall be as manufactured by Mueller Co., Hays Mfg. Div. of Zurn Industries, or equal.

2.02 FLOOR BOXES

A. Floor boxes shall be provided for all nut operated or floor accessed valves. Floor boxes shall be of the adjustable, sliding type, cast iron, suitable to withstand heavy traffic, as

manufactured by Clow Valve, Kennedy Valve Mfg. Co., or equal. The covers shall be marked with appropriate designations of piping contents (i.e.: water, sewer) and bases shall be the round type. All nut operated valves in this Section shall be clearly identified by stainless steel or laminated plastic identification tags. The tags shall be permanently affixed to the inside of the floor boxes, under grating, etc. and shall bear the embossed letters which clearly identify each valve by its appropriate designation.

B. Two (2) valve operating wrenches shall be supplied in 4 foot lengths with tee handles for each size nut supplied. Valve wrenches shall be Model No. F-2520 as manufactured by Clow Valve, Kennedy Valve Mfg. Co., Figure No. 122, or equal.

2.03 VALVE BOXES

A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.

B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.

C. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: WATER). Boxes shall be as manufactured by Clow Valve, Kennedy Valve Mfg. Co., Charlotte Pipe and Foundry Company, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.

B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated valves shall be tested for control operation as directed by the Engineer.

C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.

D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

E. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

3.02 SHOP AND FIELD TESTING

A. Shop and field testing of valves shall be as follows:

1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.

2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.

3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.

4. Preliminary and final field tests shall be conducted at a time approved by the Engineer. The Engineer shall witness all field testing.

5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer.

7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the process equipment. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal operating conditions, and under all specified conditions of opening and closing.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

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SECTION 15100

VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions and Section 15000 – Basic Mechanical Requirements.

B. Reference Section 15390 – Schedules for additional information on valves and operators/actuators.

C. The electric valve actuators shall meet the signal requirements described in Section 17060 – Signal Coordination Requirements, Section 17920 – Control System Input/Output Schedule, and Section 17950 – Functional Control Descriptions.

D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.

E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.

F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer (where new valves and actuators are furnished) in order to ensure complete coordination of the components and to provide unit responsibility.

1.02 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

1. Certification that the force required to operate all valves is as specified herein.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Electric actuators shall be provided where specified in the Valve Schedule in Section 15390 – Schedules.

B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.

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C. Quarter turn valves 8” and greater in size shall have geared operators.

D. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

2.02 MANUAL OPERATORS

A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:

1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes.

2. Exposed valves up to 6-inch shall be lever operated.

3. Exposed valves 8-inches and larger shall be handwheel operated.

4. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator. unless otherwise indicated on the Drawings.

B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.

C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.

D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel, lever, or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the valve is to be installed as shown in the Piping Schedule in Section 15390 – Schedules.

E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24”.

F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504.

G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.

H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

2.03 ELECTRIC VALVE ACTUATORS

A. Electric Actuators shall be open/close service or modulating service as specified in the Valve Schedule in Section 15390 – Schedules.

1. Open/Close (non-modulating) valve actuators shall be Series 2000 as manufactured by EIM Controls.

2. Modulating valve actuators shall be Series 2000 as manufactured by EIM Controls.

B. Performance Requirements

1. The actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.

2. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule in Section 15390, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuator's maximum rated breakaway of torque.

3. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves 24 inches and larger. Operating time shall not be less than 60 seconds for all modulating valves.

4. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F – 160 degrees F.

5. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of 60 starts per hour without overheating.

6. For modulating actuators, the gearing, motor and contactor shall be capable of 1200 starts per hour without overheating.

C. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes.

D. All gearing shall be hardened alloy steel or bronze and shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor

without failure. Output drive gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. The worm gear pinion shall be alloy bronze. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Motor reduction gearing shall be spur or planetary gearing and shall allow for field repair and change in gear ratio. For quarter turn applications, overtravel of the operator shall be prevented by internal mechanical stops cast into the actuator.

E. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.

F. A handwheel shall be permanently attached for manual operation. A gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 80 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for handwheel operation, it shall return automatically to electric operation when actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.

G. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia. Motors shall be 120V, single phase, 60 Hz AC or 480V 3-phase, reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule in Section 15390. Motor voltage shall be as indicated in the Valve Schedule in Section 15390. Motors shall be totally enclosed, non-ventilated, with NEMA Class F insulation minimum (Class H for modulating actuators) and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor housing. The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have plug and socket electrical connection to facilitate easy removal and replacement. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. The motor shall be capable of starting against the rated load in either the open or close direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.

1. Open/Close actuators shall be furnished with electro-mechanical reversing starters.

2. Modulating actuators shall be furnished with solid state reversing starters utilizing thyristors.

H. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting in from condensation. The following items shall be located in the control circuit compartment.

1. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.

2. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step'" with the actuator output drive at all times in either the electrical or manual mode of operation. A minimum of six (6) contacts, three (3) normally open and three (3) normally closed, shall be supplied at each end of valve travel. Four (4) additional contacts shall be provided to report end of travel or any desired position between ends of travel.

I. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20mADC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Division 17.

1. Modulating valve actuators designed to respond to a 4-20mADC signal shall be provided with a valve positioner which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the "open," "closed," or "last" position on loss of 4-20 mADC command signal.

2. Modulating valve actuators designed to respond to "pulse" open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to "pulse" open/close signals shall have the latching circuitry described above for open/close actuators disabled.

J. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. The actuators shall be designed to operate from a single point electrical source. The actuators shall be furnished with fuses inside of the terminal compartment. A quantity of two – ¾ inch NPT conduit entries shall be furnished.

K. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.

1. Open, Close, and Stop commands from external dry contacts (utilizing internal 24VDC power supply) and/or from an external signal of 12V to 120V. The inputs for the open, close, stop signals shall be field selectable to be respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.

2. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.

3. Four (4) unpowered contacts shall be provided which can be selected to indicate valve “Opened” and “Closed” position, “Remote” status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.

4. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

L. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote (LOR) selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. LOR switch shall be padlockable in any of the three positions.

   a. When the LOR is in the “Local” position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.

   b. When the LOR is in the “Off” position, the actuator shall not operate.

   c. When the LOR is in the “Remote” position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.

2. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

2.04 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following:

1. One (1) seal kit.

2. One (1) torque switch.

3. One (1) limit switch.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for the respective electric actuator applications:

Filtered Water Mixing Vault Bypass:

Service	Number of Trips	Number of Days/Trip
Installation, Testing, and Start-up	1	1
Services after Startup	1	1

B. At least one trip of one (1) day shall be provided for training providing instruction to the Owner's personnel in proper operation and maintenance of all equipment.

3.02 INSTALLATION

A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable specification sections for valves, and motor controls.

B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

3.03 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:

1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.

2. Submit written certification that:

a. Shop tests for the electrical system and all controls were successfully conducted;

b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.

3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:

   a. Current at maximum torque setting

   b. Torque at maximum torque setting

   c. Flash Test Voltage

   d. Actuator Output Speed or Operating Time

   e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

   f. Verification of actuator torque rating with valve.

3.04 FIELD TESTS

A. Field testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:

   1. Valve actuators shall be field-tested together with the associated valves.

   2. Test all valves at the operating pressures at which the particular line will be used.

   3. Test all valves for control operation as directed.

   4. Field testing shall include optimization of opening and closing times of the valves. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

B. Preliminary Field Tests

   1. General: Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components.

   2. Scope: Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly.

   3. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation, as specified or otherwise directed.

C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.

2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.

3. Final field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing.

4. Certification of Equipment Compliance: After the final field tests are completed and passed, submit affidavit according to Section 11000.

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SECTION 15101

BUTTERFLY VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. For Glenville Lake the existing electric actuators shall be mounted on the new valves and shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility. Operator mounting arrangements shall be as directed on the Drawings or as directed by the electric actuator Manufacturer and/or Engineer.

PART 2 -- PRODUCTS

2.01 BUTTERFLY VALVES

A. Butterfly valves shall be of the rubber-seated, tight-closing type conforming to the latest revision of AWWA C504 Specifications. The manufacturer shall have a minimum of 5 years experience in manufacturing butterfly valves of the sizes required in accordance with AWWA C504 Specifications. All butterfly valves shall be the product of one manufacturer. Butterfly valves shall be as manufactured by Pratt, Mueller Co., DeZurik, or Val-Matic. Each valve shall be performance and leak tested as specified in AWWA C504 revised as follows: In addition to the testing requirements of AWWA C504, each butterfly valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.

B. Butterfly valves shall be Class 150B, except in the finished water low pressure zone (LPZ) and high pressure zone (HPZ) or otherwise indicated in the valve schedules, and of the short body design with mechanical joint or flanged ends, as shown on the Drawings. Valves designated for the LPZ and HPZ piping systems (as indicated in 15390 piping schedule) shall be Class 250B with 250 lb ANSI drilled flanges.

C. Valve bodies shall be epoxy coated cast iron conforming to ASTM A126, Grade B, ASTM A48, Class 40 or Ductile Iron ASTM A536, Grade 65-45-12. Where required to meet design operating conditions, valve bodies shall be manufactured of higher strength materials. Valve bodies shall have integral hubs for housing shaft bearings and seals.

D. Butterfly valves shall be of the concentric or eccentric shaft types. Valve discs shall be constructed of epoxy coated ductile iron, ASTM A536, Grade 65-45-12. Disks shall be of the "offset" design to provide a full 360 degree seating surface with no external ribs transverse to flow, and shall comply with the latest revision of AWWA C504 Specifications. The valve manufacturer shall furnish Shop Drawings which include end clearance dimensions when the disc is in the full open position.

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E. The resilient valve seat shall be EPDM designed to seat against a pressure differential of 150 psi on either side of the valve, unless otherwise indicated. The resilient seat shall be mechanically attached to the valve disc or valve body. Any required seat attachment hardware shall be stainless steel. The resilient seat shall be capable of being adjusted or replaced in the field without moving the valve disc along the shaft axis, or removing the valve from the line. The mating seat surface shall be stainless steel or monel.

The seats shall be factory tested as per AWWA C504 at a test pressure of 150 psig, unless otherwise indicated, and post adjusted for differential pressures indicated herein.

F. Valve shafts shall be one-piece or two-piece units of stainless steel construction suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve disc by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material. Carbon steel extension bonnets shall be provided on buried service valves as indicated on the Contract Drawings. Otherwise, buried service valves shall be furnished with valve boxes as noted in Section 15095.

G. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of teflon or heavy-duty bronze. The valve assembly shall be furnished with a factory set two-way thrust bearing designed to center the valve disc in the valve seat at all times. End cover bolts shall be of stainless steel construction.

H. The shaft seal shall be either the bronze cartridge type with at least two O-rings, monolithic V-Type, or pull down packing type. If monolithic V-Type or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Butterfly valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator. For buried valves with pull down packing the packing gland cover assembly shall be heavy duty, soil and water resistant. Stuffing boxes for pull down packing shall have a depth sufficient to accept at least four rings of self-compensating type packing specifically selected for the operating pressures to be encountered. Stuffing box bolts, studs and nuts shall be stainless steel.

I. The "O" ring type shaft seal shall be contained in a removable bronze cartridge. The bronze cartridge shall be manufactured from ASTM B505 copper alloy UNS C93200 and shall meet the requirements of AWWA C504 for bronze, Grade E. The "O" ring material shall be nitrile, BUNA-N rubber, as intended for use with potable water or wastewater and per ASTM D-2000 with a hardness of 70 Shore A Durometer.

J. Manual operators for butterfly valves 18-inches in diameter or larger shall be the worm gear type conforming to AWWA C504. Manual operators for butterfly valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops, shall be sized according to Table IV for Class 150B, and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under

the differential pressure of 150 psi and maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule.

K. The manufacturer shall certify that the butterfly valves are capable of operating in continuous duty service under these pressures and flow conditions.

L. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

M. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

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SECTION 15104

BALL VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves required for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 BALL VALVES (WATER SERVICE)

A. Ball valves (water service) shall be of the full port, single seated, metal to metal seated, tight-closing type conforming to the latest revision of AWWA C507 Specifications. The manufacturer shall have a minimum of 5 years experience in manufacturing ball valves of the sizes required in accordance with AWWA C507 Specifications. All ball valves shall be the product of one manufacturer. Ball valves shall be as manufactured by Willamette Valve, Inc., or equal.

B. Each valve shall be performance and leak tested as specified in AWWA C507 revised as follows: In addition to the testing requirements of AWWA C507, each ball valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.

C. Ball valves shall be AWWA Class 150, unless otherwise indicated in the valve schedules, design with flanged ends, and installed as shown on the Drawings.

D. The valve body shall be constructed of epoxy coated cast iron conforming to ASTM A 48, Class 35, with a full, unrestricted circular inlet and outlet, with nominal opening diameter equal to the rated size of the valve. Each valve body shall be provided with flanged ends conforming in diameter and drilling to ANSI B16.1, Class 125. All flanges shall be flat faced and finished to true plan surfaces within a tolerance limit of 0.005 inch. Each flange face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Flange faces shall have concentric or spiral serrated finish. The body trunnions shall be fitted with ample sized bronze bearings of sufficient difference in hardness from the plug bearings to eliminate seizing and galling. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing teflon coated or other non-metallic material will not be acceptable. Bearings shall be machined in accurate alignment for reception of the plug trunnions.

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E. The body shall provide rigid means for supporting the valve operating mechanism without the necessity of additional supports and shall be of such design that it shall be capable of receiving the complete plug sub assembly. The valve body shall have integral hubs for housing shaft bearings and seals.

F. The body shall have a rigidly attached metal seat. The body seat shall be Monel (Alloy 400) and shall be machined, ground and polished for contact with the stainless steel seat mounted on the plug.

G. There shall be two (2) pipe connections, one for an air vent and the other for drain.

H. The plug shall be constructed of epoxy coated cast iron conforming to ASTM A48, Class 35, with a full unobstructed, circular waterway with a diameter equal to the rated size of the valve. It shall have trunnion supports cast integral on the axis of rotation. An extension of one trunnion, called the operating shaft, shall pass through a shaft seal chamber and connect to the valve operation mechanism.

I. The plug shall have a stainless steel seat conforming to ASTM A276, Type 304, mounted thereon which shall properly align with the body seat when the valve is in the closed position. The surfaces of the seat ring shall be spherically generated and shall be machined, ground and polished for contact with the body seat.

J. The plug trunnions shall be fitted with bronze bearings of sufficient difference in hardness from the body bushings to eliminate seizing and galling.

K. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing Teflon coated or other non-metallic bearing material will not be acceptable.

L. Valve shafts shall be integral with the plug and shall connect the plug to the torque unit. The shaft shall be of chrome Molybdenum Steel (ASTM A 322 Grade 4140) with hard chrome plate through the seal chamber suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve plug by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material.

M. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of heavy-duty bronze. The valve assembly shall be furnished with a factory set thrust bearing designed to center the valve plug in the valve seat at all times. End cover bolts shall be of stainless steel construction.

N. A shaft seal shall be provided of the type utilizing a plug shaft stuffing box, four (4) "O" ring seals, a bronze retainer and a corrosion resistant steel lock ring. The "O" ring material shall be BUNA-N rubber, as intended for use with potable water or wastewater.

O. Manual operators for ball valves 18-inches in diameter or larger shall be the worm gear or travelling nut type conforming to AWWA C507. Manual operators for ball valves mounted

above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under the differential pressure of 150 psi and maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule. Electric motor operators shall be as specified elsewhere in this Section.

P. The torque unit (valve operating mechanism) shall be of the traveling-nut type and shall be the product of the valve manufacturer. The assembly shall be mounted, and attached to the valve body. The torque unit shall be designed to accept a manual, cylinder or electric motor actuator. The torque unit housing shall employ the following:

1. A traveling crosshead to impart positive rotary movement to the plug which will move transversely to the valve shaft.

2. A cylinder piston rod or stainless steel Type 416 threaded leadscrew (reach rod or stem) with the crosshead directly attached thereto.

3. A rotator lever (of cast steel construction).

4. A matched set of interconnecting links (of cast steel construction) connecting the traveling crosshead to the rotator lever.

Q. The traveling crosshead shall be confined to permit linear motion only and to prevent it from any tendency to rotate due to linkage reaction. A plug shaft support bearing shall be supplied on the cover.

R. The torque unit shall be so designed that during the first 50 percent of stroke in closing the flow area is reduced by approximately 81 percent. The remaining 19 percent of flow area shall be gradually reduced to a complete shutoff throughout the last 50 percent of the closing stroke.

S. The torque unit shall be totally enclosed in a suitable housing with a removable cover and shall be capable of being inspected, lubricated, adjusted and repaired without interfering with or removing the valve from the line and shall be permanently lubricated. All parts shall be of first class workmanship, easily replaceable and manufactured of the best materials suited for the purpose. All parts subject to rubbing shall be of significantly different hardness to prevent galling and shall be sized to result in a maximum bearing stress at full load of 2,000 psi. The main shaft shall be replaceable without removing the torque unit housing and while the valve is in the line under pressure.

T. The manufacturer shall certify that the ball valves are capable of operating in continuous duty service under these pressures and flow conditions.

U. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

V. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats

(10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

2.02 BALL VALVES (SERVICE AIR)

A. Ball valves (service air) shall be manufactured by Apollo Ball Valve Division of Conbraco Industries, Inc., Pageland, SC., or equal. The body materials shall be cast bronze rated at 600 psi WOG, 150 psi saturated steam. Valves shall be tested by the manufacturer to MSS SP-72, 100 psi air under water, in the opened and closed position. The valve shall provide a port diameter equal to or exceeding the mating pipe size. Valves 2-1/2 inches in diameter and smaller shall have lever operators, unless otherwise specified herein or noted on the Drawings. Levers shall be cadmium plated steel covered with a vinyl grip and attached with a nut and have a hole for tagging purposes. The stem gland shall be adjustable and independent of the lever to compensate for wear. Bottom loaded stems shall be designed to be blow-out proof. The stuffing box seals and ball seats shall be composed of glass-reinforced TFE. The ball and stem shall be 316 stainless. Ball valves shall have NPT ends.

2.03 BALL VALVES (BALL CHECK FOR CAUSTIC SERVICE)

A. Ball check valves installed in carbon steel caustic solution piping shall be constructed of Type 304 or 316 stainless steel. Valves shall have a 200 psi minimum pressure rating and a maximum temperature rating not less than 300°F. Valves shall be flanged and equipped with unions as necessary to expedite removal and servicing.

- END OF SECTION -

SECTION 15107

FIRE, WALL AND YARD HYDRANTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 FIRE HYDRANTS

A. All fire hydrants shall be hub end, triple nozzle, approved AWWA type with two (2) 2-1/2-inch hose nozzles and one (1) 4-1/2-inch steamer nozzle with American National Standard hose threads and have a 6-inch bottom mechanical connection.

B. Hydrants shall have a 5-1/4-inch valve opening and shall be built in accordance with AWWA C502. Hydrants shall open left and have a National Standard Pentagon type operating nut (1-1/2-inch point to flat). Hydrants shall have a safety flange and a safety coupling on the valve stem. All hydrants shall be the Mueller Centurion #A-423, or American-Darling #B-62-B with 4'-0" bury depth.

2.02 WALL HYDRANTS

A. Wall hydrants shall be of the non-freeze type, cast-bronze construction with wrought stainless steel self-opening, vandal-proof locking cover box, 3/4-inch N.P.T. outlet, integral vacuum breaker backflow preventer, pressure relief valve, bronze casing, bronze operating parts convertible into service tool, "T" handle key. 3/4-inch female and 1-inch male N.P.T. inlet connection. The wall hydrant shall be Models 7.500 as manufactured by Josam, Z-1305 as manufactured by Zurn, 5509 as manufactured by Smith Company, or equal.

2.03 YARD HYDRANTS

A. Service water system hydrants shall be of the 2-inch non-freeze post-yard type with bronze casing, neoprene plunger. The barrel shall be self-draining; operating parts must be removable through the top of the hydrant.

B. The cold-rolled steel stem shall operate with a bronze operating nut. Stem threads shall be lubricated through the top of the operating nut tapped for grease fittings. Packing shall be double "O" rings to insure a positive shutoff with a minimum of packing friction when the hydrant is being operated. Each hydrant shall be equipped with suitable adapters to connect 2-inch and 3/4-inch hoses.

C. Each hydrant shall be supplied with 10-inch operating hand wheel.

D. Hydrants shall be Eclipse #2 as manufactured by Kupferle.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15114

MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 GLOBE VALVES (SERVICE/COMPRESSED AIR) (ALTERNATE BID)

A. Globe valves (service/compressed air) shall be bronze body and bonnet with brass stem and stainless steel regrindable disc plug. Valves shall be Jenkins Valve Fig. 546-P, Crane Co., or equal with minimum 300 psi non-shock cold water pressure rating and screwed ends.

2.02 SOLENOID VALVES

A. Three-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co., or equal, for 120V, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

B. Two-way solenoid valves shall be normally closed and shall open when the solenoid is energized, unless otherwise noted. The valve shall be of forged brass-body and bonnet with a BUNA "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi, and shall be as manufactured by ASCO Valves, Automatic Switch Co., or equal, for 120 volt, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

C. Four-way two-position solenoid valves shall be of the single coil type and shall be normally closed and shall open when the solenoid is energized (i.e. fail closed). The remainder of the four-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co. or equal, for 120V, 60 Hz, single phase operation. Solenoid

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enclosure shall be NEMA 4 watertight. The solenoid valve shall be provided with a manual override.

2.03 PRESSURE RELIEF, REDUCING AND REGULATING VALVES

A. Pressure relief valves 1 inch and under shall have bronze bodies and above 1 inch shall have cast iron bodies, bronze fitted with grey iron diaphragm base and straight chamber and phosphorus bronze diaphragm. The ratio of the diaphragm area to the seat area shall be adequate to overcome sticking. The seat disc shall be of non-corrodible, non-sticking material capable of withstanding extreme temperatures. Valves shall permit dismantling for repairs and cleaning without being removed from the line. Valves shall conform to the ASME Boiler Construction Code as approved by both the Underwriters Lab., and the National Board of Boiler Pressure Vessel Inspectors. All valves shall be designed for a minimum working pressure at least equal to the working pressure of the corresponding pipeline and shall have adjustment over a range of at least 20 percent above or below the required setting pressure of the installation.

B. Pressure relief valves (non-potable water service) shall be diaphragm activated, single seat, pilot operated and shall maintain a constant upstream pressure by relieving excess pressure. The valve shall be normally closed and shall open to maintain the required back pressure when the valve inlet pressure reaches the pilot control set point. The initial pilot control setting shall be 78 psi. The stem shall be stainless steel and shall be guided through the center for 100% of the stem travel. The main valve throttling plug shall be provided with V-port sections to insure precise control at low flow rates. All internal metal parts shall be bronze or stainless steel. The control pilot shall be direct acting, spring loaded, and adjustable with bronze body and stainless steel trim. The diaphragm and seat disc shall be BUNA-N. The valve shall be of the angle or globe pattern as shown on the Drawings and shall be fully repairable in the line. The pressure relief valve shall be the Model 428CP as manufactured by Bailey, Fresno, California, or equal.

C. Pressure reducing and regulating valves (water service) 1/2-inch and under shall be bronze and above 1/2-inch shall have cast iron bodies bronze fitted. Valves shall be constructed with full openings and capable of supplying a full flow of water at reduced pressure. Valves shall be so constructed that repairs can be made without removing the valves from the line. The valves shall be equipped with a sedimentation chamber and stainless steel or bronze strainer. Pressure reducing and regulating valves shall be the back pressure sustaining type and shall operate over a range at differential pressures from 5 to 120 psi. Reducing and regulating valves shall meet or exceed the requirements of ASSE 1003 (ANSI A112.26.2) and shall be Model 616R, as manufactured by Fisher Controls, WATTS Series 25 AUB, GA, or equal.

2.04 HOSE VALVES

A. Hose valves shall be 300 lbs. non-shock cold water angle or globe valves, Fig. 112/113 as manufactured by Jenkins Valve Co., or equal. Valves shall be bronze bodied with Buna-N or neoprene disc and bronze bonnet and packing nut. Valve stem, gland, and lock nut shall be brass. Valve shall be provided with 3 inch diameter malleable iron handwheel, cap and chain, and 3/4-inch or 1-inch (or 2 inch near flushing connections) hose connection outlet.

2.05 NEEDLE VALVES

A. Needle valves shall be bronze body and spindle with follower gland and shall be 400 psi, non-shock cold water needle valves, Figure 743-G as manufactured by Jenkins Bros., Corp., Crane Co. No. 88, or equal.

B. Needle valves (service air) shall be bronze body, with stainless steel stem. Valves shall be Jenkins Valve Fig. 741G, Crane Co. or equal and shall have minimum 400 psi non-shock cold water pressure rating and screwed ends.

2.06 PINCH VALVES

A. Pinch valves shall be of the full metal body mechanical pinch type with flanged joint ends on both body and rubber sleeve. Port areas shall be 100% of the full pipe area through the entire valve length. Flanges shall be of one size larger than pipeline size to allow extra thickness of rubber. Mating pipeline flanges shall be standard reducing flange with I.D. to exactly match valve I.D. All internal valve metal parts are to be completely protected by the rubber pinch tube. The rubber pinch tube shall be one piece construction with integral flanges drilled to ANSI 125# standard. The pinch tube shall also be Nylon reinforced with an exterior wrapping of 1/8" thick neoprene. Handwheel closing mechanism shall be double-acting and pinch the sleeve equally from two sides. The stem shall be non-rising and have a non-rising handwheel. There shall be no cast part in the operating mechanism. Each valve shall have flanges conforming to ANSI B16.1, Class 125 lb. Valves shall be Series "75 DW" as manufactured by Red Valve Co., Inc. or equal.

2.07 DUCKBILL CHECK VALVES (ALTERNATE BID)

A. The check valves shall be elastomeric duckbill type constructed of fabric reinforced elastomer. The valve shall be installed onto the carrier pipe by means of a flanged end connection to the pipe outlet. The valve shall allow forward flow through the carrier pipe and through the valve at the specified flowrate and not exceed the allowable headloss specified. When forward flow through the carrier pipe is discontinued the valve shall prevent backflow through the carrier pipe by sealing closed when hydrostatic pressure is applied to the exterior of the valve. The valve shall be capable of withstanding the specified backpressure capacity without any leakage through the valve.

B. The valve shall include a supplemental closure mechanism to maintain closure of the bill opening during zero flow and zero hydrostatic load. This mechanism shall be an integral part of the valve and be comprised of a permanently set curvature of the bill portion extending over the entire length of the bill opening.

C. The valve shall be configured as a concentric type where the bottom and the top of the valve is flared equally to provide the specified bill opening to diameter ratio dimension. The valve bill opening shall be aligned exactly vertical when installed to maintain symmetrically equal loads on each side of the valve under static and dynamic operation.

D. The operational conditions and valve performance requirements are listed in the following table for each specific valve required:

Valve Location	Nominal Pipe Diameter, in.	Maximum Flow Rate, gpm	Max. Allowable Headloss*, feet	Backpressure Capacity, psi	Elastomer Material
PAC Slurry Tank Overflow (2 valves)	4	150	2	Ambient	Pure Gum Rubber
Sanitary Manhole East of Carbon Facility	4	150	2	8	Pure Gum Rubber
Sanitary Manhole East of Carbon Facility	3	100	2	8	Pure Gum Rubber

* Maximum allowable headloss at the specified maximum flow rate.

E. The valve shall be a one-piece elastomer construction with internal fabric reinforcing all vulcanized into a composite material. The valve shall be equipped with an elastomeric flange as an integral part of the valve. The amount and configuration of the internal reinforcing shall be sufficient to maintain structural integrity of the valve under the specified operating conditions and allowable headloss value. The reinforcing shall extend into the flanged area to provide uniform strength across the entire valve exterior.

F. The flange drilling shall conform to ANSI B16.1 Class 125/ANSI B16.5 Class 150 standards. The valve shall be furnished with one set of galvanized/stainless steel/thermoplastic backing rings conforming to the same ANSI flange drilling standards.

G. The bill opening at the valve must be at least 1.57 times the nominal pipe diameter to maintain laminar flow through the valve. The bill portion of the valve shall be curved at a minimum of 90 degrees from the direction of flow. The curvature shall be permanently set through vulcanization and shall be an integral part of the valve body. This curvature shall provide closure of the bill opening under static conditions as well as dynamic backpressure conditions during periods of zero flow.

H. Valves 24” diameter and larger shall be equipped with a metallic support completely encapsulated within the top portion of the valve elastomer wall to provide additional structural support to the valve during static and dynamic operating conditions.

I. Duckbill check valves shall be manufactured by Tideflex Technologies / Red Valve Company, or approved equal.

- END OF SECTION -

SECTION 15115

PVC/CPVC VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. Valves provided for chemical service shall be constructed of materials suitable for the intended service. PVC valves shall be provided in PVC piping and CPVC valves shall be provided in CPVC piping.

B. PVC valve bodies shall be constructed of PVC which shall meet or exceed the requirements of cell classification 12454 according to ASTM D1784. CVPC valve bodies shall be constructed of CPVC which shall meet or exceed the requirements of cell classification 23447 according to ASTM D1784.

C. Materials of construction of other valve components shall be as specified below for the particular type of valve. Acceptable materials of construction of elastomers for chemical service shall be as follows:

Chemical	**Acceptable Gasket Material**
Ammonium Hydroxide	EPDM
Powdered Activated Carbon Slurry	EPDM, FKM
Sodium Hydroxide (Caustic)	EPDM
Sodium Hypochlorite	FKM

D. All flanged valves shall be flat face flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb. flanges.

2.02 PVC/CPVC BALL VALVES

A. Ball valves shall be true union design with flanged, socket, or threaded ends as required and as specified in Section 15390 – Schedules. All valves shall be full-port design and allow for bi-directional flow. Valve stems shall contain double o-ring seals. Valves shall have removable handles and integrally molded mounting features for actuator installation. Ball valves shall be rated for a minimum pressure of 150 psi at 70°F.

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B. Valve bodies, stems, balls, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. Ball seats shall be made of PTFE, and o-ring seals shall be as specified in 2.01 C.

C. Ball valves shall be manufactured by Asahi/America, Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.

D. Ball valves for sodium hypochlorite service shall be vented, with a single hole factory-drilled into the ball to vent in the upstream direction when the ball is in the closed position. Valves shall be color coded or marked to indicate vented ball design.

2.03 PVC/CPVC SWING CHECK VALVES

A. Swing check valves shall be single-disc design with pivoting swing arm/disc clapper assembly and flanged ends. Valves shall be full flow, gravity operated, and suitable for either horizontal or vertical applications. Valves shall be capable of top entry to facilitate cleaning and repair without removal from the line. Swing check valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies, bonnets, swing arms, and discs shall be constructed of PVC or CPVC as specified in 2.01 B. O-ring seals and shutters shall be as specified in 2.01 C.

C. Swing check valves shall be manufactured by Asahi/America, IPEX, Hayward Flow Control, or equal.

2.04 PVC/CPVC BALL AND DIAPHRAGM CHECK VALVES

A. Ball and diaphragm check valves shall be true union design with flanged, socket, or threaded ends as required and as specified in Section 15390 – Schedules. Primary seat shall be square-cut design to ensure proper seating. Valves shall be suitable for either horizontal or vertical applications. Ball and diaphragm check valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies, balls or diaphragms, end connectors, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. O-ring seals shall be as specified in 2.01 C.

C. Ball and diaphragm check valves shall be manufactured by Asahi/America, Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.05 PVC/CPVC DIAPHRAGM VALVES

A. Diaphragm valves shall be weir-type design with multi-turn handwheel for throttling applications. Diaphragm valves shall have flanged, socket, or threaded ends as specified in Section 15390 – Schedules. Valves shall have a position indicator and adjustable travel stop. Diaphragm valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies, bonnets, end connectors, and unions shall be constructed of PVC or CPVC as specified in 2.01 B. Valve diaphragms and o-rings shall be as specified in 2.01 C. PVDF vapor barrier shall be provided for PTFE diaphragms.

C. Diaphragm valves shall be manufactured by Asahi/America, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.06 PVC/CPVC BUTTERFLY VALVES

A. Butterfly valves shall be of flanged design. Valves 6” and smaller shall have lever handles, and larger valve shall have gear operators. Valves shall have the ability to mount actuators. Face seals shall completely isolate the valve body from process flow and function as a flange gasket on both sides of the valve. Butterfly valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies and discs shall be constructed of PVC or CPVC as specified in 2.01 B. Valve shafts shall be made of 316 stainless steel. Valve disc liners and o-ring seals shall be as specified in 2.01 C.

C. Butterfly valves shall be as manufactured by Asahi/America, Chemtrol, IPEX, Hayward Flow Control, Plastomatic, or equal.

2.07 PVC/CPVC NEEDLE VALVES

A. Needle valves shall be provided for accurate flow control applications. Valves shall have integrated stem/seat design and have fine pitch stem threads for precise adjustment. Valve ends shall be flanged, socket, or threaded as specified in Section 15390 – Schedules. Needle valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies shall be PVC as specified in 2.01 B, seats shall be PFTE, and o-ring seals shall be as specified in 2.01 C.

C. Needle valves shall be as manufactured by Chemtrol, Hayward Flow Control, or equal.

2.08 PVC/CPVC GLOBE VALVES

A. Globe valves shall be provided for flow regulation applications. Valves shall be of union bonnet or outside stem and yolk design. Valve ends shall be flanged, socket, or threaded as specified in Section 15390 –Schedules. Globe valves shall be pressure rated for 150 psi at 70°F.

B. Valve bodies and discs shall be PVC as specified in 2.01 B, and seals shall be as specified in 2.01 C.

C. Globe valves shall be as manufactured by Asahi/America, or equal.

- END OF SECTION -

SECTION 15170

LOW VOLTAGE ELECTRIC MOTORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all low voltage electric motors as shown on the Drawings and specified herein. All motors required for this Contract shall comply with this Section unless otherwise noted.

1.02 CODES AND STANDARDS

A. Motors and related accessories shall be designed, manufactured, and/or listed to the following standards as applicable:

1. Institute of Electrical and Electronics Engineers (IEEE)

a. IEEE 112 – Standard Test Procedure for Polyphase Induction Motors and Generators

2. National Electrical Manufacturer's Association (NEMA)

a. NEMA MG 1 – Motors and Generators

3. Underwriters Laboratories (UL)

a. UL 547 – Standard for Safety Thermal Protectors for Motors
b. UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations
c. UL 1004-1 – Standard for Rotating Electrical Machines
d. UL 1004-3 – Standard for Thermally Protected Motors
e. UL 1004-8 – Standard for Inverter Duty Motors

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

B. Each submittal shall be identified by the applicable specification section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Individual shop drawings for electric motors shall be submitted in accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, unless submitted as a part of the shop drawings for the driven equipment.

D. Shop drawings for electric motors shall include motor data sheets, dimensioned drawings, wiring diagrams for devices such as space heaters, temperature devices, and shaft grounding rings. Shop drawings shall identify electric characteristics and design, mechanical construction, manufacturer's name, type and pertinent specifications for the use intended, along with the name of the equipment to be driven. For motors rated 50 horsepower or greater, submittal of motor data for acceptance shall include, as a minimum, the following:

1. Manufacturer's type and frame designation

2. Horsepower rating

3. Time rating (per NEMA Standards)

4. Ambient temperature rating

5. Motor winding insulation system designation

6. RPM at rated load

7. Frequency

8. Number of phases

9. Rated-load amperes

10. Voltage

11. Code letter (starting KVA per horsepower)

12. Design letter for integral horsepower induction motors (per NEMA Standards)

13. Service factor

14. Temperature rise at full load and at service factor load

15. Efficiency at 1/4, 1/2, 3/4 and full load

16. Power factor at 1/4, 1/2, 3/4 and full load

17. Motor outline, dimensions and weight

18. Motor winding insulation system description

19. Horsepower required by connected machine at specified conditions (load curves) shall be supplied for all compressors, propeller and positive displacement pumps.

The foregoing data shall also be verified after manufacture and shall be included with the information to be furnished in the operation and maintenance manuals specified.

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Electric motors shall be manufactured by Baldor/Reliance Electric Company; Nidec Motors; Toshiba Industrial and Power Systems, Inc.; Siemens Energy & Automation, Inc.; General Electric Company; or equal.

2.02 MATERIALS AND CONSTRUCTION

A. Motors shall be built in accordance with the latest standards of NEMA, including, but not limited to MG-1 and MG-2, IEEE, ANSI and to the requirements specified herein.

B. Type

1. Unless otherwise noted, motors specified herein shall be polyphase squirrel cage, NEMA Design B, or single phase capacitor or repulsion start induction motors. Special equipment requiring a motor drive with unusual characteristics shall be equipped with a definite purpose motor to meet the necessary requirements.

2. Unless otherwise shown or specified, all motors 1/2 horsepower or larger shall be three- phase, 60 Hertz, NEMA Design B, squirrel cage induction motors designed for operation at 480 volts or greater as specified herein or shown on the Drawings.

3. Unless otherwise specified in the individual equipment specification for the driven equipment, or as required by the dynamic characteristics of the load as determined by the manufacturer of the machine to be driven, all polyphase squirrel cage motors shall be designed to withstand the starting voltage shown on the Drawings and shall have torque and locked rotor current characteristics as specified for NEMA Design B motors.

4. All motors 2 horsepower and smaller shall have windings encapsulated with a flexible epoxy compound, or insulated with a flexible epoxy compound, or insulated with the manufacturer's premium quality system which shall be subject to acceptance by the Engineer.

5. All motors above 250 horsepower shall have stator windings vacuum impregnated with a polyester insulation compound.

6. Unless otherwise noted, all motors smaller than 1/2 horsepower shall be standard single-phase capacitor start or repulsion start induction type designed for operation on 120 volts or 208 volts, 60 Hz alternating current. The motor shall deliver rated load without exceeding a 80 degrees C temperature rise while operating in a 40 degrees C ambient temperature. Small fan motors less than 1/4 HP may be split-phase or shaded pole type. Shaded pole motors rated more than 1/4 horsepower are not acceptable. Fractional horsepower motors shall be completely equipped with all necessary auxiliary components for starting and labeled as "Thermally Protected". Insulation shall be Class B, except that submersible motors shall have epoxy encapsulation. Unless otherwise noted, the motors shall be totally enclosed. Small fan motors may be of the open type where they are suitably protected from moisture dripping and lint accumulation. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

7. Where specified, vertical hollowshaft motors shall be designed to carry the motors', pumps', and associated equipment's full thrust. The motors shall be equipped with grease lubricated spherical roller thrust bearings and lower radial guide bearings. Vertical hollowshaft motors shall be fitted with nonreversing ratchet assemblies where required by equipment specifications. Vertical adjustment shall be provided by means of a lockable nut at the top of the shaft.

8. Vertical hollowshaft motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Horizontal motors shall not be installed where subjected to external thrust loads.

C. Rating

1. Each motor shall develop ample torque for its required service through its acceleration range and throughout its rated load range. The rating of the motors offered shall in no case be less than the horsepower shown on the Drawings or elsewhere specified. It should be noted that the motor sizes indicated on the

Drawings or as otherwise specified herein, are motor sizes required to operate the specific equipment which is specified. Higher rated motor sizes may be determined from the actual equipment submitted, approved, purchased, and installed. Protective devices, motor starters, disconnect switches, and other necessary equipment shall be furnished and installed for the actual motor sizes required at no additional cost.

2. Motor ratings shall be based on continuous operation. The maximum temperature rise for open and drip proof type motors shall not exceed 90 degrees C, and for totally enclosed type motors shall not exceed 80 degrees C.

D. Motor Winding Insulation

1. Insulation shall be as specified for each particular type or class of motor. The insulation system shall provide a high dielectric strength, long life covering for the windings which may be required to operate in a continually damp, corrosive, and/or chemically contaminated environment. The insulation shall be resistant to attack by moisture, acids, alkalies, abrasives, and mechanical and thermal shock. Leads shall be sealed with a non-wicking, non-hydroscopic insulation material.

2. Motor insulation resistance may be checked at any time after delivery to the job site or during the warranty period. Encapsulated motor stators may be subjected to insulation testing while completely submerged in water. Any motor not meeting the requirements specified herein will be rejected and shall be promptly replaced at no cost to the Owner.

3. Torque and locked rotor current characteristics for three phase motors shall be NEMA Design B. The locked rotor KVA/HP input at full voltage for 10 horsepower. motors and larger shall not exceed that permitted for Code Letter "J", except for specialized equipment requiring a motor drive with special definite characteristics.

4. Unless otherwise specified, non-inverter duty motors shall be furnished with a Class F insulation system. Unless otherwise specified, inverter duty motors shall be furnished with a Class H insulation system. In either case, temperature rise shall be limited to that for Class B insulation. Output torque and speed characteristics of each motor shall be suitable to operate the driven equipment through the full range of acceleration and operating load conditions without exceeding the nameplate current rating, and/or temperature rise.

E. Nameplates

1. The motor manufacturer's nameplate shall be engraved, embossed, or stamped on a stainless steel sheet and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Printed or laser-etched nameplates are not acceptable.

2. Nameplates shall include as a minimum, Items a through m as listed in Article 1.04 in addition to that required by NEMA standards. The nameplate shall be positioned so as to be readily visible for inspection as installed in the facility.

F. Design

1. Motors shall be designed to accelerate and drive the connected equipment under all normal operating conditions without exceeding nameplate ratings.

2. Motors specified for operation with variable frequency drives shall be inverter duty rated. Motors shall be considered inverter duty rated only if they meet all of the requirements for NEMA MG-1 Part 31.

3. Motors shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished. Inverter duty motors shall be designed to operate down to 10% of full load speed without the need for a line powered cooling fan.

4. Unless otherwise specified, electric motors shall be furnished with service factors in accordance with NEMA MG-1 as follows:

Type of Motor	Service Factor
Non-inverter Duty	1.15
Inverter Duty	1.0

5. Design selection with respect to the driven machine shall be such that the requirements do not exceed 85 percent of the motors' maximum rating modified by service factor, ambient temperature, enclosure, altitude and electrical service. The electrical service conditions shall be assumed to be 10 percent undervoltage, 5 percent underfrequency, and 3 percent voltage unbalance. Altitude shall be assumed to be the project site elevation plus 10 percent. Ambient temperature shall be assumed to be 95 degrees F in exterior locations, 104 degrees F (40 degrees C) in interior locations, and 122 degrees F (50 degrees C) within housings or enclosures; except where higher temperatures may be encountered within or on individual items of equipment. The applicable paragraphs of NEMA MG-1 shall be used in making the design selection.

6. Motors used with belt drives shall have sliding bases to provide for belt take up.

7. Terminal boxes shall be of sufficient size to accommodate the required quantity and size of conduits. Gasketed terminal boxes shall be furnished with all splash-proof and totally enclosed motors. NEMA ratings of the terminal boxes shall be suited for the application. Motors located in hazardous locations shall be furnished with terminal boxes suitable for the specific Class, Division, and Group suitable for the application. Terminal boxes shall be sized to accommodate accessory equipment such as motor differential current transformers, where required.

8. Terminal boxes for horizontal motors shall be located on the left-hand side when viewing the motor from the drive shaft end and shall be so designed that conduit entrance can be made from above, below, or either side of the terminal box.

9. Motors larger than 250hp shall be manufactured with the six stator coil leads wired to a suitably sized motor junction box for application in a differential relay scheme.

Current transformers shall be provided by the motor manufacturer and installed in the factory. All ground connections and current transformer connections shall be made in the factory.

G. Construction

1. Frames, mounting means, and shafts shall meet NEMA Standards for the horsepower, RPM, and enclosure selected. Enclosures shall be selected according to the degree of mechanical protection required and shall not be of aluminum construction. All motors shall have a manufacturer's standard shop machinery finish, consisting of a rust-resisting priming coat of zinc chromate and a finish coat of alkyd machinery enamel. Reference Section 09900, Painting.

2. Motors shall have cast iron frames and a heavy gauge steel terminal box, with neoprene gaskets between the frame and the box and between the box and its cover. A grounding lug(s) shall be provided inside the terminal box.

3. Motors weighing more than 50 pounds shall be equipped with at least one lifting eye. All lifting hardware shall be corrosion resistant.

4. Motors located in hazardous locations shall be totally enclosed and suitable for the specific Class, Division, and Group suitable for the application.

5. Motors located in Class I or II, Division 1 hazardous locations shall bear a U.L.-674 label and shall be provided with a breather/drain approved for the hazardous location. The U.L. listed breather/drain shall prevent the entrance of contaminants while allowing moisture to drain out of the motor.

6. When located outdoors, or elsewhere if specified, motors shall be totally enclosed, non-ventilated (TENV) or totally enclosed, fan-cooled (TEFC) machines, unless otherwise noted. Totally enclosed motors shall be provided with two (2) 1/4 inch drain holes drilled through the bottom of the frame, which allows complete drainage of the frame. Where specified, TEFC motors controlled by a variable frequency drive shall be provided with a separately powered cooling fan motor that runs at 60HZ to ensure proper cooling of the motor at low speeds. Cooling fan motor shall be suitable for 120VAC, single phase operation. Vertically oriented motors located outdoors shall be provided with a drip cover over the fan end to prevent accumulation of precipitation.

7. Unless otherwise specified, motors rated 100 horsepower or greater located outdoors, in unheated structures, in below grade areas, or as otherwise indicated, shall be furnished with space heaters and embedded motor winding high temperature switches with leads brought out of the motor terminal box. Space heaters shall be suitable for 120VAC operation and for a maximum surface temperature of less than 200 degrees C. Spare heaters shall be of sufficient wattage to maintain the internal temperature of the motor at approximately 10 degrees C above the ambient temperature when the motor is not running.

   Embedded motor winding temperature switches shall operate at temperatures well below the temperature rating of the motor winding insulation system. Motor

winding temperature switches are not required where other temperature monitoring devices (e.g. RTD's) are required.

8. Unless otherwise specified in the equipment specifications, motors rated 200HP or greater that are controlled by a VFD shall be furnished with resistance thermal detectors (RTD's) embedded in the stator windings, two per phase. RTD's shall be pre-wired to terminal blocks located in a separate terminal box as specified herein.

9. Unless otherwise specified in the equipment specifications, motors rated less than 200HP that are controlled by a VFD shall be furnished with motor winding high temperature switches embedded in the stator windings with the leads brought out to the motor terminal box.

10. If so specified and when located in indoor areas which are heated and weatherproof, motors shall be open drip-proof machines. Ventilation openings shall be arranged to prevent the entrance of drops of liquid or solid particles at any angle from zero to 15 degrees downward from vertical.

11. Unless otherwise specified, or required, motors rated less than 200 horsepower shall be furnished with bearings of the grease lubricated, antifriction ball type with conveniently located grease fittings and drain plugs. A means of preventing bearings from becoming overgreased shall be provided. Bearings shall have a minimum B-10 life of 20,000 hours.

12. Rotors shall be statically and dynamically balanced. Rotor windings shall be one-piece cast aluminum. Where applicable, rotors shall be constructed with integral fins.

13. Externally mounted motor shaft grounding rings shall be provided to protect motors against motor shaft and bearing currents. Grounding rings shall be provided for all motors controlled by VFDs, with the following exceptions:

    a. Motors located in hazardous areas
    b. Motors rated less than 1 horsepower
    c. Submersible motors

14. All motors shall be provided with factory-installed one-hole terminations (ring terminals) on the ends of all motor leads. Terminations shall be identified for use with cables that have stranding other than Class B, and shall be the irreversible compression type.

H. Power Factor and Efficiency

1. All motors, including vertical hollowshaft motors, in the range of 1-500 horsepower, inclusive, shall be designed specifically for energy efficiency and high power factor. The motor efficiency and power factor shall meet or exceed the values listed in the table below when the motors are tested in accordance with the NEMA preferred test method IEEE 112A, Method B, Dynamometer. Each motor shall meet the minimum guaranteed efficiency value indicated in the table below. All tests shall

be performed in accordance with the procedures contained in NEMA Standard MG1-12.58.

TABLE 12-11
FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS
ENCLOSED MOTORS

	2 POLE		4 POLE		6 POLE		8 POLE	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	75.5	72	82.5	80	80	77	74	70
1.5	82.5	80	84	81.5	85.5	82.5	77	74
2	84	81.5	84	81.5	86.5	84	82.5	80
3	85.5	82.5	87.5	85.5	87.5	85.5	84	81.5
5	87.5	85.5	87.5	85.5	87.5	85.5	85.5	82.5
7.5	88.5	86.5	89.5	87.5	89.5	87.5	85.5	82.5
10	89.5	87.5	89.5	87.5	89.5	87.5	88.5	86.5
15	90.2	88.5	91	89.5	90.2	88.5	88.5	86.5
20	90.2	88.5	91	89.5	90.2	88.5	89.5	87.5
25	91	89.5	92.4	91	91.7	90.2	89.5	87.5
30	91	89.5	92.4	91	91.7	90.2	91	89.5
40	91.7	90.2	93	91.7	93	91.7	91	89.5
50	92.4	91	93	91.7	93	91.7	91.7	90.2
60	93	91.7	93.6	92.4	93.6	92.4	91.7	90.2
75	93	91.7	94.1	93	93.6	92.4	93	91.7
100	93.6	92.4	94.5	93.6	94.1	93	93	91.7
125	94.5	93.6	94.5	93.6	94.1	93	93.6	92.4
150	94.5	93.6	95	94.1	95	94.1	93.6	92.4
200	95	94.1	95	94.1	95	94.1	94.1	93
250	95.4	94.5	95	94.1	95	94.1	94.5	93.6
300	95.4	94.5	95.4	94s.5	95	94.1		
350	95.4	94.5	95.4	94.5	95	94.1		
400	95.4	94.5	95.4	94.5				
450	95.4	94.5	95.4	94.5				
500	95.4	94.5	95.8	95				

TABLE 12-12
FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS
RATED 600 VOLTS OR LESS (RANDOM WOUND)
OPEN MOTORS

	2 POLE		4 POLE		6 POLE	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77	74	85.5	82.5	82.5	80
1.5	84	81.5	86.5	84	86.5	81.5
2	85.5	82.5	86.5	84	87.5	81.5
3	85.5	82.5	89.5	84	88.5	86.5
5	86.5	84	89.5	84	89.5	87.5
7.5	88.5	86.5	91	89.5	90.2	88.5
10	89.5	87.5	91.7	90.2	91.7	90.2
15	90.2	88.5	93	91.7	91.7	90.2
20	91	89.5	93	91.7	92.4	91
25	91.7	90.2	93.6	92.4	93	91.7
30	91.7	90.2	94.1	93	93.6	92.4
40	92.4	91	94.1	93	94.1	93
50	93	91.7	94.5	93.6	94.1	93
60	93.6	92.4	95	94.1	94.5	93.6
75	93.6	92.4	95	94.1	94.5	93.6
100	93.6	92.4	95.4	94.5	95	94.1
125	94.1	93	95.4	94.5	95	94.1
150	94.1	93	95.8	95	95.4	94.5
200	95	94.1	95.8	95	95.4	94.5
250	95	94.1	95.8	95	95.4	94.5
300	95.4	94.5	95.8	95	95.4	94.5
350	95.4	94.5	95.8	95	95.4	94.5
400	95.8	95	95.8	95	95.8	95
450	95.8	95	96.2	95.4	96.2	95.4
500	95.8	95	96.2	95.4	96.2	95.4

NOTES:

(1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.

(2) TEFC efficiencies apply to both horizontal and vertical motors.

2. Motors rated 50 horsepower or greater shall be individually tested at the factory before shipment, with a copy of test results provided for the Engineer, to assure compliance with the efficiency and power factor specifications.

I. Power Factor Correction

1. The power factor shall be corrected as necessary to achieve 85% (minimum) with capacitors sized and installed per manufacturer's recommendations. Capacitors shall be installed such that the motor shall not be damaged by overvoltage or excessive transient electrical torque. The capacitor(s) shall be connected as close as possible or directly to the motor terminals. Any power factor corrections shall not decrease the motor efficiency below the stated minimum requirement of this Specification. All power factor corrections shall be noted on the Shop Drawings submitted to the Engineer for approval. POWER FACTOR CORRECTION, TO ACHIEVE 85%, SHALL BE PROVIDED ON ALL MOTORS ABOVE 15 HORSEPOWER EXCEPT FOR THOSE MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES (VFD'S).

2. When required, power factor correction capacitors shall be connected on the line side of any type of reduced voltage starting motor controller (e.g. RVAT, RVSS, Part-Winding, Wye-Delta, etc.).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Motors shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Motors shall be properly protected from weather hazards. Motors shall not be allowed to be wrapped tightly in plastic while outdoors. Motors delivered to the site which will not be put in service for a time in excess of 30 calendar days, whether in storage or installed, shall have the shafts rotated a minimum of five (5) rotations every 30 days.

B. Motors provided with space heaters shall have temporary power applied to the heaters no later than 30 calendar days after delivery to the site until permanent power can be applied to the heaters.

C. Motors that, in the opinion of the Engineer, have not been properly protected shall be inspected by the manufacturer's representative. Any required electrical corrections for testing shall be made at the Contractor's expense prior to acceptance and/or use.

D. All motors shall operate without any undue noise or vibration and shall show no signs of phase unbalance.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. All motors shall be shop tested and inspected in accordance with the equipment manufacturer's standard procedures. Shop tests for motors 100 horsepower and larger may be witnessed by the Engineer. The manufacturer's testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to tests and inspection dates.

b. In addition to the efficiency and power factor testing specified herein, each motor shall be tested to determine compliance with the applicable requirements of the IEEE, ANSI and NEMA. Tests shall be as follows:

(1) Motors less than 50 HP

(a) Each motor shall be subjected to a standard, short commercial test including the following:

i) Running current, no load
ii) Locked rotor current
iii) High potential
iv) Winding resistance
v) Bearing inspection

(2) Motors between 50 and 100 HP

(a) Each motor shall be subjected to the above tests and shall be furnished with certified test results.

(3) Motors larger than 100 HP

(a) Each motor shall be furnished with certified test results. Each motor shall be subjected to a complete test consisting of full load heat run, percent slip, running load current, locked rotor current, breakdown torque (calculated), starting torque, winding resistance, high potential, secondary current and voltage at collector rings (wound rotor), efficiencies at 100, 75 and 50 percent of full load, power factors at 100, 75 and 50 percent of full load and bearing inspection. Tests will be witnessed by the Engineer where specifically indicated.

(4) Test Reports

(a) All test results for motors over 100 horsepower shall be submitted to the Engineer for approval. Copies of witnessed test raw data shall be submitted to the Engineer immediately upon completion of such tests.

2. Field Tests

a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.

b. All electric motors furnished for this project one (1) horsepower or larger shall have the information required in the following tabulation completed. See Exhibit "A" on following page.

c. All field testing shall be witnessed by the Engineer.

(EXHIBIT A)

MOTOR TEST RECORD					
Motor Identification Remarks	Location	Specified Horsepower	Nameplate Horsepower	Nameplate Amperage (FLA)	Measured Amperage Under Normal Operating Conditions

- END OF SECTION -

SECTION 15290

INSULATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install insulation as shown on the Drawings or otherwise specified. Insulation shall not be installed until piping has been field tested and approved by the Owner. The Contractor shall protect the insulation from moisture at all times.

B. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 INSULATED PROCESS/CHEMICAL PIPING

A. Fiberglass insulation shall be Owens Corning Fiberglass Corp., Fiberglass 25ASJ/SSC; Certain Teed Products Corporation, Certain Teed snap-on ASJ/SSL; or equal. Insulation shall be heavy density sectional pipe insulation with vapor barrier and self-sealing lap. Minimum density insulation density shall be 6 pounds per cubic foot. Contractor shall use manufacturer's recommended adhesives and tape for jointing material. Fittings shall be molded fiberglass. Minimum insulation thickness shall be 1-1/2 inches for 4" diameter pipe and larger, and 1 inch for smaller pipe.

B. Weatherproof insulation jacket for process piping shall be Certain Teed Products Corporation; Childers Products Company, Lock On and Slip On; or equal. Jacket shall be smooth embossed aluminum metal jacket with minimum thickness 0.016 inches thick for interior installations and at least 0.031 inches thick for exterior installations. Fastening shall use preformed "2"-lock seam with 2 inch butt strap with sealant. Bonds shall be 1/2 inch aluminum with wing seals. Fittings shall be prefabricated 0.016/0.031 inches thickness aluminum.

1. Contractor shall install weather proofing for outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings.

C. Insulation fitting covers and jacket for chemical piping shall be Zeston 2000 PVC by Manville, or equal. Fitting covers shall fit snugly over fittings, including all elbows and valves, etc. Jacketing shall be high-impact UV-resistant covering for insulated piping and shall match fitting covers. Fitting covers and jackets shall be white and suitable for painting. PVC jacketing shall be 30 mil thick and shall be factory curled to fit snugly. Fitting covers and jacketing shall be secured with tacks.

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D. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 15390

SCHEDULES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basin Mechanical Requirements.

1.02 PIPING SCHEDULES

A. Piping requirements for this Section are outlined on the Drawings and in the Piping Schedules. In the absence of a specified test pressure, pipe shall be tested at the greater of: 1) 150 percent of working pressure as determined by the Engineer or 2) 10 psig, unless the Schedule indicates no test is required.

B. If the pipe material is not shown on the Piping Schedule or otherwise specified, the following materials shall be used.

Pipe Size	Material	Type of Joint	Class/Design	Test Pressure
4-in and larger	DIP	Flanged (Exposed)	Class 53	(1)
		Restrained (Buried)	Pressure Class 350	
Less than 4-in	PVC/CPVC (2)	Socket	Sch 80	(1)
(1) Test at 150 percent of working pressure or 10 psi, whichever is greater. (2) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.				

1.03 VALVE SCHEDULES

A. All valves shall be tagged by the manufacturer according to the control valve designations listed in the Schedule.

B. Valves not listed in the valve schedule(s) shall be manually operated, unless otherwise shown on the Drawings.

WATER TREATMENT PLANT PIPING SCHEDULE

PIPE DESIGNATIONS		MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI)[1]			
			TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE[2]	WORKING	SURGE	RESTRAINT	FIELD TEST
P.O. HOFFER WATER TREATMENT FACILITY (BASE BID)											
AIR[7]	AIR	CARBON STEEL	N/A	N/A	WELDED / FLANGED	SCH 40	NO	125	0	125	100
D[5]	DRAIN	< 4" PVC	N/A	N/A	SOCKET	SCH 80	NO	N/A	N/A	N/A	N/A
		>= 4" DIP	PUSH-ON	CLASS 51	FLANGED	CLASS 53	NO				
FLW	FILTERED WATER	CARBON STEEL	FLANGED / WELDED	SEE SECTION 15012	N/A	N/A	NO	30	0	30	15
FW[6]	FINISHED WATER (LPZ)	DIP	RESTRAINED	CLASS 53	N/A	N/A	NO	120	200	320	180
	FINISHED WATER (HPZ)			CLASS 53				210	240	450	315
NPW	NON-POTABLE WATER	< 4" PVC / CPVC[3]	SOCKET	SCH 80	SOCKET	SCH 80	YES	80	80	160	120
		>= 4" DIP	RESTRAINED	CLASS 51	N/A	N/A	NO				
PW	POTABLE WATER	COPPER	N/A	N/A	SOLDER	TYPE 'L'	YES	80	80	160	120
		< 4" PVC	SOCKET	SCH 80	SOCKET	SCH 80	NO	80	80	160	120
SA	SAMPLE	PVC / CPVC[3]	N/A	N/A	SOCKET	SCH 80	YES	100	0	100	50
		HDPE	FUSION (W/IN CASING)	SDR 11	N/A	N/A	NO				
V	VENT	PVC	N/A	N/A	SOCKET	SCH 80	NO	15	0	15	5
P.O. HOFFER WATER TREATMENT FACILITY (ALTERNATE BID)											
TW[7]	TEMPERED WATER	CPVC	SOCKET	SCH 80	SOCKET	SCH 80	NO	80	80	160	120
GLENVILLE LAKE WATER TREATMENT FACILITY (BASE BID)											
FLW	FILTERED WATER	DIP	N/A	N/A	FLANGED	CLASS 53	NO	5	3	8	7

WATER TREATMENT PLANT PIPING SCHEDULE

PIPE DESIGNATIONS		MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI)[1]			
			TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE[2]	WORKING	SURGE	RESTRAINT	FIELD TEST
SA	SAMPLE	HDPE	FUSION	SDR 11	N/A	N/A	NO	60	75	135	90
		PVC / CPVC[3]	N/A	N/A	SOCKET	SCH 80	NO				

1) Restraint system design pressure shall be equal to the sum of working pressure and surge pressure and shall be used to determine the size, number, material, and dimensions of tabs and threaded-rods for piping specified or shown to have threaded-rods for thrust restraint.
2) Provide heat tracing and insulation as specified in Section 15391 on all exposed outdoor piping indicated.
3) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.
4) Flanges shall be provided as shown on the drawings or as approved by the Engineer.
5) Drain piping shall be plugged at open end and filled completely to test for leaks.
6) Low Pressure Zone (LPZ) piping refers to finished water piping adjacent to the Finished Water Pump Station downstream of pumps #1-2. High Pressure Zone (HPZ piping refers to finsihed water piping adjacent to the Finished Water Pump Station downstream of pumps #3-8. 7) ALTERNATE BID

CHEMICAL PIPING SCHEDULE

PIPE DESIGNATIONS		MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI)[1]		
			TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE[2]	WORKING	RESTRAINT	FIELD TEST
P.O. HOFFER WATER TREATMENT FACILITY (BASE BID)										
AH	AMMONIUM HYDROXIDE	HDPE	FUSION (W/IN CASING)	SDR 11	N/A	N/A	NO	70	125	75
		PVC/CPVC[3]	SOCKET (DIRECT BURIED)	SCH 80	SOCKET[4]	SCH 80	YES			
					SOCKET[4] (W/IN TRENCH)	SCH 80	NO			
CAS, SH	SODIUM HYDROXIDE (CAUSTIC SOLUTION), SODIUM HYPOCHLORITE	HDPE	FUSION (W/IN CASING)	SDR 11	N/A	N/A	NO	70	125	75
		PVC/CPVC[3]	SOCKET (DIRECT BURIED)	SCH 80	SOCKET[4]	SCH 80	YES			
					SOCKET[4] (W/IN TRENCH)	SCH 80	NO			
CCP[5]	CHEMICAL CASING PIPE	PVC	SOCKET	SCH 40 (LONG RADIUS BENDS)	N/A	N/A	NO	N/A	N/A	N/A
P.O. HOFFER WATER TREATMENT FACILITY (ALTERNATE BID)										
PAC	POWDERED ACTIVATED CARBON	HDPE	FUSION (W/IN CASING)	SDR 11	N/A	N/A	NO	90	200	125
		PVC / CPVC[3]	N/A	N/A	SOCKET	SCH 80	YES			
GLENVILLE LAKE WATER TREATMENT FACILITY (BASE BID)										
AH	AMMONIUM HYDROXIDE	PVC / CPVC[3]	N/A	N/A	SOCKET[4]	SCH 80	NO	25	75	75
		HDPE	FUSION	SDR 11	N/A	N/A	NO			
CCP[5]	CHEMICAL CASING PIPE	PVC	SOCKET	SCH 40 (LONG RADIUS BENDS)	N/A	N/A	NO	N/A	N/A	N/A
SH	SODIUM HYPHOCHLORITE	PVC / CPVC[3]	N/A	N/A	SOCKET[4]	SCH 80	NO	25	75	75
		HDPE	FUSION	SDR 11	N/A	N/A	NO			

CHEMICAL PIPING SCHEDULE

PIPE DESIGNATIONS	MATERIAL	BURIED PIPING		EXPOSED PIPING			DESIGN PRESSURE (PSI)[1]		
		TYPE OF JOINT	CLASS/ DESIGN	TYPE OF JOINT	CLASS/ DESIGN	HEAT TRACE[2]	WORKING	RESTRAINT	FIELD TEST

1) Restraint system design pressure shall be equal to the sum of working pressure and surge pressure and shall be used to determine the size, number, material, and dimensions of tabs and threaded-rods for piping specified or shown to have threaded-rods for thrust restraint.
2) Provide heat tracing and insulation as specified in Section 15391 on all exposed outdoor piping indicated.
3) For all PVC / CPVC designations, if piping is exposed to direct sunlight or if heat tracing is required, CPVC shall be used. Otherwise, PVC shall be used.
4) Joints shall be socket except for connections to existing piping with socket or threaded joints.
5) Casing pipe shall be provided for buried chemical piping identified above and sample piping identified on WTP Piping Schedule.

ELECTRICALLY OPERATED VALVE SCHEDULE

TAG NO.	VALVE TYPE	OPERATOR TYPE	SIZE (in.)	FLOW (mgd)	MAX DIFFERENTIAL PRESSURE (psi)	CLASS	SERVICE	LOCATION
P.O. HOFFER WATER TREATMENT FACILITY (BASE BID)								
MOV-43201, MOV-43202, MOV-43203	BUTTERFLY	OPEN/CLOSE	54	48	10	150	FILTERED WATER MIXING VAULT BYPASS	YARD SOUTHWEST OF 12 MG CLEARWELL
P.O. HOFFER WATER TREATMENT FACILITY (ALTERNATE BID)								
SV-51200	SOLENOID	OPEN/CLOSE	3	200 GPM	75	150	ISOLATION OF DILUTION WATER FLOW TO TANKS	CARBON SLURRY FACILITY - PUMP ROOM
GLENVILLE LAKE WATER TREATMENT FACILITY (BASE BID)								
MOV-5301, MOV-5303, MOV-5304, MOV-5309, MOV-5310, MOV-5311, AND MOV-5312[1]	BUTTERFLY	MODULATING[2]	10	2	5	150	FILTER EFFLUENT	FILTER GALLERY

1) Contractor to furnish eight (8) valves total - seven (7) valves shall be installed and one (1) valve turned over to the Owner as a spare.

2) Reuse existing modulating Beck actuators. See Contract Drawings for details.

SECTION 15391

HEAT TRACING SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install heat tracing and insulation systems as shown and required by notes in the drawings or as required by the Section 15390 - Schedules. All heat tracing components shall be supplied by the same manufacturer. The heat tracing and insulation system shall include but shall not be limited to self regulating heater cables, grommet end termination kits, power connection kits, splice kits, NEMA 4X enclosed thermostats, piping insulation and jacket and installation tape. The intent of this specification is for the contractor to supply all appurtenances needed for a complete and fully operational system at each location that a heat tracing system is required. The heat tracing system supplier shall be completely responsible for the design of the system such that the entire system meets all aspects of this specification and the system functions in the environment where it will be installed. All parameters of the system shall be sized and as recommended by the supplier.

B. The heat tracing system(s) shall be provided in accordance with the requirements of Section 15000 - Basic Mechanical Requirements.

C. Piping insulation and jacket shall be supplied with all heat traced piping and shall be in conformance with Section 15290 - Insulation. The thickness of the insulation shall be as stipulated in this specification.

D. All air release valve piping that will remain constantly wet and that is installed outdoors shall be heat traced. All pressure gauge piping installed outdoors shall be heat traced and insulated.

E. The minimum design ambient temperature for the heat tracing system design shall be -10°F.

F. All the components of the heat tracing system shall be individually Underwriters Laboratory (UL) listed. The system as supplied shall conform to all applicable parts of the following:

1. National Fire Protection Association (NFPA)

2. National Electric Code (NEC)

3. Local and State Building Codes

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Heat tracing system conductors and insulation for METAL piping shall be supplied in conformance with the following table:

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Heat Tracing Conductors and Insulation for Metal Piping			
		Cable Heat Rating Watts per Foot	
Pipe Size (in)	Insulation Thickness (in)	Design Air Temperature -10°F	Design Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5
1-1/2	1	3	5
2	1	3	5
2-1/2	1	3	5
3	1-1/2	3	5
4	1-1/2	5	8
6	2	5	8
8	2	5	8
10	2	8	10(1)
12	2	8	10(1)

(1) Two conductors shall be provided and shall be placed on top of and under the pipe.

B. Heat tracing system conductors and insulation for NONMETALIC Piping shall be supplied in conformance with the following table:

Heat Tracing Conductors and Insulation for Nonmetallic Piping			
		Cable Heat Rating Watts per Foot	
Pipe Size (in)	Insulation Thickness (in)	Ambient Air Temperature -10°F	Ambient Air Temperature -40°F
≤3/4	1	3	3
1	1	3	5
1-1/4	1	3	5
1-1/2	1	3	5
2	1	3	5
2-1/2	1	5	8
3	1-1/2	3	8
4	1-1/2	5	8
6	2	5	8
8	2	8	10
10	2	8(2)	(1)
12	2	8(2)	(1)

(1) Consult the heat tracing system manufacturer for the cable rating and the number of passes for each pipe.
(2) Two conductors shall be provided and shall be placed on top of and under the pipe.

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals:

1. Submittal data on all components of the heat trace system and any other data recommended by the manufacturer

2. Installation and maintenance instructions

3. List of replacement parts for the entire system in table format

4. Bill of materials list of the system as supplied in table format

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Each heat trace system shall be supplied by Thermon Manufacturing Company, Raychem Corporation or Chromalox. All system components shall be supplied by a single manufacturer.

2.02 MATERIALS

A. The self-regulating heater cable assembly shall consist of two parallel copper bus wires, minimum size 16 AWG, connected through a semi-conductive heating matrix. This heating element shall be covered with a cross-linked polyolefin insulation jacket. This insulation shall be covered by a tinned copper braid and then covered with a fluoropolymer insulating jacket. All heat cables shall be rated for 120 240 volt supply voltage. The heating cable shall be suitable for installation on metallic and nonmetallic pipe. All heating cable shall be properly marked by the manufactures number or nomenclature for ease of future maintenance. Cable shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where cable is shown to be installed in hazardous locations.

B. Each heat tracing circuit shall be supplied with a power connection and end seal kit. Each end seal kit shall include a lighted end termination kit Chromalox model UESL or equal. It shall be the Contractor’s responsibility to make sure that no circuit in the system be longer than as recommended by the heat tracing system manufacturer. All terminations, splices, junctions and tee’s in the circuit shall be made using manufacturer recommended and supplied kits. Junction boxes shall be provided where required for access to all circuit appurtenances.

C. Flexible heater elements shall be provided where indicated on the Drawings to protect pumps & other equipment. The flexible heater shall be 3 inches wide by 40 inches long and shall consist of a heater element encapsulated in silicone rubber. The silicone rubber shall be rated for a temperature range of -80°F to 390°F. The flexible heater shall be designed with eyelets in the ends and edges as required for mounting on the pump using manufacturer supplied silicone straps. The flexible heater shall be rated for 120 Vac and 600 watts of heat output. The flexible heater shall be supplied with a preset thermostat

which will energize the flexible heater when the ambient temperature reaches 40°F and shut down the heater when the ambient temperature reaches 50°F. The flexible heater shall be model SL-N as manufactured by Chromalox or equal.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat for each circuit shall be an adjustable ambient sensing thermostat designed for controlling the heating cable to provide freeze protection of pipes. The thermostat shall have an adjustable range of 15°F to 140°F. The enclosure for the thermostat shall be NEMA 4X. The Thermostat shall be rated to match the voltage of the heating cable and shall have a switch rating of 20 amps (minimum). Thermostat shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where thermostat is shown to be installed in hazardous locations.

B. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat shall have LED indication of set point, process temperature, high temperature alarm, low temperature alarm and RTD failure. The thermostat shall be housed in a NEMA 4X enclosure and shall suitable for use in a Class 1 Division 2 Location. The thermostat shall be UL listed. The Thermostat shall be rated to match the voltage of the heating cable with a switch rating of 30 amps (minimum). A common alarm contact shall be provided for remote indication of alarm status. The thermostat shall be Chromalox model DTS or equal.

2.04 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following:

1. 100 ft. of self-regulating cable for each cable wattage provided for the system(s)

2. One (1) spare ambient thermostat controller for each heat tracing system

3. One (1) spare ambient temperature RTD

4. Two (2) each of the following: cable termination kits, cable splice kits and cable tee kits

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits:

Service	Number of Trips	Number of Days/Trip
Installation and Testing	1	1
Startup and Training	1	1

3.02 INSTALLATION

A. The installation of all heat tracing and insulation components shall conform to all instructions and requirements recommended by the heat tracing system manufacturer. All installation and terminations shall conform to the National Electric Code.

B. All piping shall be pressure tested prior to installation of any heat tracing or insulation components. Thermal insulation shall only be installed when all heat tracing components are in place and satisfactorily tested as indicated herein. Once tested, the insulation shall be installed immediately to prevent damage to the heat tracing system components.

C. No insulation shall be installed using staples. Insulation jackets shall be installed as recommended by the insulation system supplier such that no damage is done to the heat tracing system components.

D. The installation of heat tracing cable on nonmetallic pipe shall be done in strict conformance with the heat tracing manufacturer’s recommendations. Requirements shall include heat shielding tape or wrap as recommended by the heat tracing manufacturer

E. Contractor shall install weather proofing for all outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings

F. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used

G. A label shall be installed on the piping insulation jacket every 15 feet and readily visible from ground level: ELECTRIC HEAT TRACING: CAUTION

3.03 FIELD TESTING

A. All heating cable shall be tested using a megohmeter (megger) between the heating cable bus wires and the metallic ground braid. A 2,500 VDC megger test is required and the minimum acceptable resistance value shall be 20 megaohms regardless of the circuit length. Any cables found to be less than this value shall be replaced at no additional cost to the Owner. The megger tests shall be performed as follows:

1. After installation of the cable and all fabrication kits but prior to installing any of the insulation system components.

2. After installation of the insulation system components but prior to energizing the cables.

3. All test reading for each megger test shall be recorded by the installer and submitted with the maintenance instructions.

- END OF SECTION -

SECTION 15400

OVERALL PLUMBING

(ALTERNATE BID)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.02 SUMMARY

A. The Contractor shall furnish all labor, equipment and material for the complete installation of the plumbing system as indicated on the Drawings and specified herein.

B. Plumbing systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

C. Provide the following Plumbing Equipment.

1. Potable water piping systems.

2. Thermometers.

3. Pressure Gauges.

4. Pipe supports, hangers, escutcheon plates, and sleeves.

5. Plumbing pipe insulation.

6. Pipe ID markers and equipment identification tags.

7. Plumbing Fixtures

8. Water Heaters.

9. Expansion Tank.

10. Emergency Shower and Eye/Face Wash Combination.

11. Flow Alarm Switches.

12. Tempered Water Systems.

13. Reduced Pressure Zone Backflow Preventer (RPZ).

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14. Hose Bibs

15. Wall Hydrants (Non-Freeze).

16. Hose Reels

17. Shut-off valves

18. Sanitary sewer (DWV) piping systems, floor drains and cleanouts.

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Division 1, Submittals.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Spreadsheet or chart identifying piping systems type and pipe size, model numbers of hangers to be used, special coatings for pipe supports etc.

11. Sample data sheet of piping and valves including information contained thereon.

12. Spare parts list

13. Special tools list

C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.

E. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.05 SCHEDULES ON DRAWINGS

A. In general, all capacities of equipment and fixtures characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. Variations of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

1.06 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.

1.07 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.

B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Indiana Plumbing and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. American Society of Mechanical Engineers (ASME).
4. Factory Mutual (FM).
5. National Electric Code (NEC).
6. Occupational Safety and Health Standards (OSHA).
7. State and local codes, ordinances and statutes.
8. Underwriters Laboratories (UL).
9. Others as designated in the specifications.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience, who issues complete catalog data on total product.

B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

E. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

F. Plumbing fixtures shall be set and connected to soil, waste, and vent and cold and hot water supplies in a neat, finished and uniform manner. Fixtures of each class and the connection to same shall be of equal height, level and at right angles to the wall unless otherwise directed by the Architect/Engineer.

G. Each plumbing fixture shall be provided with an approved P-trap, which shall be set as close to the outlet as practicable, all water supply connections shall be provided with loose key stops.

H. Vitreous china fixtures shall be carefully selected, free from spots, grazing or chips.

I. Fixture trim, traps, faucets, escutcheons, and waste pipes that are exposed to view shall be brass with polished chromium plating over nickel finish. Exposed supplies shall be brass pipe plated in the same manner.

J. All fixtures designated for use by the disabled shall fully conform and shall be installed per the requirements of the American Disabilities Act.

K. All iron and steel piping, and pipe fittings shall be manufactured domestically within the United States of America.

L. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

M. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, piping, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

D. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

2.02 MATERIALS

A. Underground cold water piping shall be Schedule 80 PVC meeting ASTM D 1785, 2241, or 2672 and having solvent welded joints.

B. Aboveground tempered and hot water piping shall be Schedule 80 CPVC Plastic Pipe meeting ASTM D 2846, ASTM F 441, 442 with solvent welded joints. Aboveground cold water piping shall be Schedule 80 PVC Plastic Pipe meeting ASTM D 1785, 2241, or 2672, with solvent welded joints. Exterior piping shall be insulated with aluminum jacket. Piping requiring heat tracing shall be copper tubing, Type “L”, with wrought copper solder joint fittings. Provide material transition fittings as necessary.

C. Underground soil, waste, and drainage pipe inside building and to a point 5’-0” (five feet) outside the building shall be Schedule 80 PVC pipe with PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311 drain, waste, and vent patterns and solvent welded joints.

D. Aboveground soil, waste, and vent piping shall be Schedule 80 PVC pipe with PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311 drain, waste, and vent patterns and solvent welded joints.

2.03 PIPING

A. Contractor shall form all holes; furnish and install all concrete inserts, flashings and sleeves in existing floors, walls, equipment foundations, ceilings, and roofs as required for the erection, installation, and support of all pipe and tubing.

1. Provide sleeves and flashings for all pipes and tubing, etc., furnished which passes through existing walls, intermediate floors, partition walls and roofs. Caulk wall opening with fire retardant sealant.

2. Provide fire stopping materials which consist of commercially manufactured products capable of passing ASTM E-814 (UL 1479) Standard Method of Fire Test for Through Penetration Fire Stops wherever piping penetrates a fire rated roof, wall or floor assembly.

3. Install concrete inserts, sleeves and flashings required, as indicated, or in a manner acceptable to the Engineer.

4. All holes missed by the Contractor, but required for the installation of the piping systems, shall be made in the walls, floors, roof and by the Contractor at no additional expense to the Owner by core drilling or saw cutting methods only.

5. Provide escutcheons around pipes in all areas. Use chromium plated escutcheons on pipe penetrations exposed in finished rooms or areas. Use stainless steel escutcheons in all process areas.

6. Install water hammer arrestors on all hot and cold water branch lines to fixtures and equipment.

7. Piping installed in chemical rooms or outside buildings shall be painted with corrosion resistant epoxy coating, Heresite, or equal.

B. CPVC

1. CPVC pipe shall be manufactured in accordance with ASTM D 2846; ASTM F 441; or ASTM F 442.

2. CPVC Fittings shall be socket type and manufactured in accordance with ASSE 1061; ASTM D 2846; ASTM F 437, 437, 439.

3. CPVC Joints shall be solvent welded, and be in accordance with ASTM F 493 and ASTM D 2846.

C. PVC

1. PVC pipe shall be manufactured in accordance with ASTM D 1785; ASTM D 2241; or ASTM D 2672.

2. PVC Fittings shall be socket type and manufactured in accordance with ASTM D 2464; ASTM D 2466, 2467.

3. PVC Joints shall be solvent welded, and be in accordance with ASTM F 656 and ASTM D 2564

D. Copper Water Tube:

1. Tube:

a. Reference: ASTM B88.

b. Type: L.

c. Temper: Hard drawn or soft annealed.

2. Joints:

a. General: Connect pipe with solder joints except where threaded or flanged fittings are required at valves, equipment connections or otherwise shown or directed.

b. Solder Joints: ASTM B32, Sb5 (95 5 tin antimony).

c. Threaded Joints:

1) Taper Pipe Threads: ANSI B2.1.

2) Joint Preparation: Teflon Tape.

d. Flanged Joints:

e. Flanges: ANSI B16.24, 150 lb. class.

1) Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8 inch thick.

f. Bolts and Nuts:

1) Standard: ANSI B18.21 and ANSI B18.2.2, respectively.

2) Material: ASTM A307, Grade B.

3. Fittings:

a. Type: Wrought Copper.

b. Reference: ANSI B16.22.

4. Unions:

a. Reference: FS WW U 516.

b. Material: Bronze.

c. Rating: 250 pound W.O.G.

5. All copper piping 2 1/2 inches and smaller, run within the interior of a building, shall be hard drawn copper Type "L".

E. Drain, waste and vent piping and fittings shall be manufactured by Tyler Pipe, Charlotte Pipe and Foundry, A.B. and I. Foundry, or equal.

1. The piping shall be installed complete, of the size and arrangement shown on the drawings. All piping shall be installed to allow for expansion, and parallel or perpendicular to the building construction. When pipe is installed underground, the ground shall be excavated to a minimum depth to accomplish the grade shown or required by code. The pipe shall have bearing along its entire length and if installed on fill, shall be supported by concrete cradles to firm earth.

2. All pipe shall be supported from the building structure in a neat manner, in compliance with current trade practices and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze hangers. Single runs of horizontal piping shall be supported with clevis type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipe will not be permitted. In concrete construction, approved inserts will be carefully set to support the piping. Soil and waste pipe shall be supported at intervals of not more than five feet on horizontal runs and at the base of every stack.

3. All pipes extending through the roof shall be a minimum of 3-inch diameter and shall be flashed with black EPDM rubber flashing boots. Vents shall extend 12-inches above finished roof and in conformity with NRCA details.

F. Pipe sleeves and escutcheons:

1. Sleeves shall be provided for all piping passing through masonry or concrete walls and floors. Sleeves for walls and floors shall be indicated, made watertight and extend above floor lines. Sleeves shall conform to the requirements of Division 15.

2. Escutcheon plates shall be polished chrome. Provide for all wall penetrations in finished areas.

G. Hangers and Supports shall be epoxy-coated Dura-Green by Cooper B-Line, Inc., Perma-Green III by Unistrut, Inc. or Approved Equal.

2.04 THERMOMETERS

A. Thermometers shall be all 300 Series stainless steel welded construction, 5” anti-parallax dial with bold black on non-reflective satin or white background, hermetically sealed and weatherproof, vibration dampened bimetallic actuation, over range protection of 50 percent full scale up to 500°F and 10 percent above 500° F, external recalibrator, 1 percent full scale accuracy. Thermometers shall be of the variangle stem configuration to maintain perpendicular orientation of the dial face to the User’s vision. Temperature

ranges shall be: 0/20-140°F.

B. Acceptable products: Tel-Tru Manufacturing #AA575R, Marshall Town Figure 254, or A. A. Weiss & Sons #5VBM.

2.05 PRESSURE GAGES

A. Pressure gages shall be selected so that normal operating pressures fall at approximately midscale and so that continuous operation does not exceed 75 percent of full scale.

B. Pressure gages shall be 4-1/2" dial type with bold black markings on white background, aluminum or steel pressure relieving case, phosphor bronze brazed Bourdon tube, bronze and stainless steel movement, provision for zero shift calibration without removing or bending the pointer. Accuracy shall be ANSI Grade A per ANSI B40.1 1980. Acceptable products: AMETEK/U. S. Gage 5000 Series, Marshall Town Figures 42 and 224, or A. A. Weiss & Sons #PG-1 Series.

2.06 GAGE COCKS

A. Gage cocks shall be brass with 1/4 inch NPT female threads and lever or tee handles. They shall be rated for service at 600 pounds WOG and 150 pounds saturated steam pressure. All gage cocks shall be the same.

B. Acceptable products: AMETEK/U. S. Gage Figure 520, Dresser Industries Figure 1095, or Parker Hannifin #V500P-4.

2.07 PRESSURE REDUCING VALVES

A. Valve shall meet ASSE 1003

B. Shall reduce incoming water pressure down to 25-75 PSI (adj). Max working pressure 300 PSI.

C. Body shall be cast bronze, copper, or cast iron. Components shall be lead free and meet all NSF 60 requirements. Diaphram shall be Reinforced EPDM

D. System shall be serviceable inline with replaceable seats, strainers, and include a bypass.

E. Valve shall be manufactured by Watts (LFU5B), Apollo, Bell & Gossett, Zurn, or equal.

2.08 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventers (3/4 to 2-inch):

1. Provide reduced pressure zone backflow preventers in the size shown on the Drawings. Backflow preventers shall be rated for 175 psig and temperatures up to 140 degrees F. Backflow preventers shall be tested and certified in accordance with ASSE 1013 and AWWA C506.

2. Provide with bronze body construction, FDA epoxy coated bronze body check valve and relief valve assemblies, and bronze seats, stainless steel trim.

3. Provide isolation valves on the inlet and outlet of each backflow preventer. Valves shall be quarter-turn, full port, resilient seated, bronze ball valves.

4. Provide bronze body valve test cocks.

5. Backflow preventers shall be Watts Series 909, Wilkins, or approved equal.

B. Reduced Pressure Backflow Preventers (2-1/2 to 10-inch):

1. Provide reduced pressure backflow preventers in the size shown size shown on the Drawings. Backflow preventers shall be rated for 175 psig and water temperatures up to 110 degrees F. Backflow preventers shall be tested and certified in accordance with ASSE 1013 and AWWA C506.

2. Backflow preventers shall have two (2) independent operating spring loaded check valves and one (1) spring loaded, diaphragm actuated, differential pressure relief valve installed between the check valves. Provide with FDA approved epoxy coated cast iron check valves, removable bronze seats, stainless steel internal parts, and FDA approved epoxy coated cast iron relief valve with stainless steel trim.

3. Provide isolation valves on the inlet and outlet of each backflow preventer. Valves shall be OS&Y gate valves. Backflow preventers 3-inch and larger shall have flanged connections (to match rating of pipe), and less than 3-inch shall have screwed connections.

4. Provide bronze body valve test cocks.

5. Backflow preventers shall be Watts Series 909, Wilkins, or approved equal.

2.09 PACKAGED EMERGENCY TEMPERED WATER HEATER

A. All components in contact with water shall meet NSF 61 and NSF 372.

B. Tank insulation shall comply with ASHRAE 90.1 and ENERGY STAR requirements.

C. Water Heater package shall be UL listed and comply with all ANSI Z358.1 requirements.

D. Integral thermostatic mixing valve shall meet requirements in section 2.11 below.

E. Warranty of 1 year on all components and 5 year on vessel. Cathodic rod(s) shall be guaranteed for 12 years.

2.10 EXPANSION TANK

A. Steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as scheduled. The air precharge shall be set to minimum system operating pressure at tank.

B. Tank interior shall comply with NSF 61 and NSF 372.

2.11 THERMOSTATIC MIXING VALVE

A. Thermostatic mixing valve shall conform to ASSE Standard 1016 Type T or ASSE

Standard 1070. Valves at emergency eyewash and showers shall meet all ANSI Z358.1 requirements.

B. Thermostatic mixing valves shall be capable of suppling flow at the maximum and minimum system flows and across adjustable temperature range (75-120, adj). The mixing valve shall have fail safes to prevent or divert scalding water.

C. Body shall be bronze construction and all components shall be replaceable and corrosion resistant.

2.12 WATER SERVICE BALL VALVES

A. Products and Manufacturers: Provide ball valves as made by one of the following:

1. Watts, Series FBV-3C or FBVS-3C.

2. Nibco.

3. Or Approved Equal.

B. 2-piece full port brass ball valve.

C. NSF/ANSI Standard 61, for potable water use.

D. Sizes: 1/4" – 3".

2.13 PIPE HANGERS AND SUPPORTS

A. Hangers and supports shall conform to recommendation of Standard Practice No. 58 and 69 of Manufacturer's Standardization Society of the Valve and Fitting Industry.

B. Hangers for pipes shall be clevis and adjustable rod hangers for single pipes or trapeze hangers for supporting more than one pipe on the same hanger. Trapeze hangers shall be made of 2-inch by 2-inch by 1/4-inch thick structural steel channels with legs down, and steel blocking of varying thickness welded to the channel under each pipe shall be used to obtain proper pitch.

C. Pipe covering protection saddles shall be the weld on type, and protection shields shall be half round heavy gage galvanized sheet metal with heavy density weight bearing insulation where required.

D. Hanger rods shall be 3/8-inch for pipe 2-inch and smaller, 1/2-inch for pipe 2-1/2-inch and larger. Acceptable manufacturers: Crawford, B-Line, Elcen Metal Products Co., or Fee & Mason.

E. Nickel plated spring ceiling plates shall be provided for all hanger rods in all exposed areas. Acceptable manufacturers: Grinnell, Crawford, B-Line or Elcen.

F. Electrolysis: Prevent electrolysis to copper tubing with rubber or neoprene lined pipe ring isolators and copper plated hanger and supports or other recognized industry methods.

G. Corrosion protection: Hangers located in chemical storage room areas of the Treatment

Facility shall be epoxy coated or manufactured of FRP. Threaded rod shall be epoxy coated or be manufactured of 316 stainless steel.

2.14 PIPE INSULATION

A. Products and Manufacturers: Provide insulation as made by one of the following:

1. Armstrong: AP Armaflex

2. Schuller: Aerotube II

3. Rubatex Corp.: R-180-FS

4. IMCOA: Imcolock

B. Pipe Insulation:

1. Type: Elastomeric Closed Cell.

2. FM Approved.

3. Unit slit tubing and miter cut fittings.

4. Thickness and Application: 1/2” to 1-1/4” pipe – 3/4 inch insulation and 1-1/2” to 4” pipe – 1-inch of insulation on all water piping above slab/grade.

5. Average thermal conductivity not to exceed 0.27 (Btu-in)/(hr-FT2-°F) at mean temperature of 75° F, temperature range -40° to 220° F; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistant.

C. Pipe Insulation Jacket:

1. Encase all exterior piping insulation with aluminum jacket and aluminum fittings with weather-proof construction.

a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

b. Factory cut and rolled to size with finish and thickness as indicated in pipe insulation schedule below in Part 3 of this Section.

c. Moisture barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.

d. Provide factory fabricated fitting covers of same material and thickness as straight lengths of jacket. Elbows shall be pre-formed 2-piece or gore, 45- and 90-degree, short and long-radius elbows.

e. Provide factory tee covers, flange and union covers, end caps and beveled and valve collars.

2.15 PIPE IDENTIFICATION

A. Piping shall be identified by means of card mounted, self-bonding pipe markers. Markers shall be made of nonporous, color fast, nonabsorbent vinyl plastic. Letters shall be black or white for easy readability.

B. Markers for pipe having an outside diameter of 3-inches or more (including insulation) shall have 2-inch high letters. Markers for pipe having an outside diameter of less than 3-inches (including insulation) shall have 1-inch high letters.

C. Provide matching 3/4-inch wide banding tape.

D. Acceptable Manufacturers: Seton Name Plate Corporation, W. H. Brady Company, or Westline Products Company.

2.16 VALVE TAGS AND NUMBERING

A. All valves shall be tagged with 1-1/4-inch diameter, 0.040-inch thick brass or laminated plastic tags with numbers and letters. A complete directory of valves, pump motors, controls, devices, and other equipment, giving use, location, size, and manufacturer's number of each shall be prepared with permanent ink, framed under glass, and hung in the mechanical equipment room where directed by Using Agency/Owner.

B. All valves above ceilings or access panels shall be identified by color-coded, self-adhesive "dots" affixed to the ceiling grid or the access panel frame. Dots shall be visible from a standing position on the floor immediately below the marker.

2.17 PLUMBING FIXTURES

A. Provide and install plumbing fixtures and equipment specified and scheduled on Drawings. Fixtures shall bear the manufacturer's name and trademark and quality or class of fixture. All exposed piping, etc., shall be chromium plated brass. The Contractor shall check the Architectural and Plumbing Drawings for details and dimensions prior to roughing in for fixtures.

J. ESE-1: Emergency Shower and Eye Wash Station. Shower to have self-closing valve operated by pull chain or rod. Shower head is deluge type, corrosion resistant plastic, steady flow (unit shall be complete with automatic flow control devices as required to limit emergency shower flow to 20 gpm and eye wash flow to 3 gpm) under operating pressures between 30-90 psig, assured by integral flow control in spray head assembly. Eye wash station to have corrosion resistant plastic bowl and push lever independent to shower. Supply and waste to be 1-1/4" I.P.S. with floor flange and interconnecting piping. Piping is galvanized steel protected by safety yellow corrosion resistant coating. Provide 120 VAC flow switch.

1. Acceptable products:

a. Bradley

b. Haws

c. Speakman

K. ESE-2: Freeze-Proof Emergency Shower and Eye Wash Station. Combination freeze-proof shower/eyewash unit intended for use where temperatures fall below freezing.

Heat trace cable protects unit from freezing to minus 50°F. Unit is encased in highly visible yellow removable ABS plastic shell. Shower to have quick acting, self-closing valve operated by pull chain or rod. Eye wash station to have high impact plastic bowl and push lever independent to shower. Supply and waste to be 1-1/4 " I.P.S. with floor flange and interconnecting piping. Provide 120VAC flow switch for remote alarm and heat trace indicator light.

1. Acceptable products:

   a. Bradley

   b. Haws

   c. Speakman

L. Flow Alarm Switches for Emergency Shower and Eye Wash Stations.

1. Provide flow alarm switches in conjunction with emergency showers, eye-wash units and face/body sprays where shown on the Drawings. Switches shall be selected according to the flow rate of the specific unit specified. Switches shall be provided by the manufacturer of the emergency flushing equipment or shall be accompanied by a statement of the equipment flow to ensure that proper selection is made. A typical combination eyewash/shower requires a modified flow switch capable of actuation at 2.5 gpm. Each switch shall include a single pole double throw snap action switch rated for 5 Amps, 125/250 VAC. Unless otherwise specified, the local alarm units shall be furnished and installed under Division 16.

2. Acceptable products:

   a. Bradley

   b. Haws Model 9001

   c. Speakman

   d. W.E. Anderson, Model V-6

2.18 FLOOR DRAINS

A. Floor drains shall be located as shown on the drawings. They shall have seepage flanges and nickel brass tops.

B. Refer to plumbing fixture schedule for floor drain variations, basis of design manufacturer and type.

C. Verify floor finish and type of proper top configuration.

D. Acceptable manufacturers: Zurn, Wade, or J.R. Smith.

2.19 MECHANICAL TRAP SEALS

A. Mechanical seal shall meet ASSE 1072 and accepted by the ICC and NC state regulators as an alternative to a trap primer.

B. Mechanical seal be normally closed and sealed airtight to prevent sewer gasses from entering an occupied space in the event that the trap has dried out. The seal shall open and allow unrestricted flow when fluid fills the drain.

C. Trap seal shall be Provent Systems – Trap Guard, or equal.

2.20 ROOF DRAINS

A. Roof drains shall be combination main and overflow with low silhouette domes.

B. Drains shall have a deck plate with appurtenances for membrane flashing.

C. The body shall be constructed from cast iron and epoxy coated.

D. Roof drains shall be ZURN Z164, or equal.

2.21 CLEANOUTS

A. Cleanouts shall be flush with floor with adjustable round or square nickel brass top, and shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required.

B. Adjustable Top Assemblies: Top assemblies shall vary with the floor finish where it is applied. Verify floor finishes for proper top configuration with General Contractor.

C. Yard cleanouts shall be flush with grade with poured concrete anchoring/encasement, troweled smooth all around

D. Acceptable products:

1. Floor cleanout: Zurn #ZN-1400-K-BP, J.R. Smith 4020, or Wade.

2. Wall Cleanout: Zurn #Z-1446, J.R. Smith 4530, or Wade.

3. Yard cleanout: Zurn #Z-1449, J.R. Smith 4280, or Wade.

2.22 HOSE BIB

A. Brass or bronze body construction, wheel handle, and ¾" connections.

B. Non-removable vacuum breaker complying with ASSE Standard 1011

C. Provide freeze protected hose bibs where indicated on Plans.

2.23 WALL HYDRANTS

A. Exposed "anti-siphon" automatic draining wall hydrant. Complete with integral backflow preventer, copper casing, all bronze interior parts with 1/2 turn ceramic disk cartridge and combination ¾ female solder and ¾ male pipe thread inlet. Stainless steel face with operating key lock. All solder connections are lead free.

2.24 STAINLESS STEEL HOSE REEL

A. Manual crank rewind with cam-lock brake and spring actuated pin lock.

B. 90 degree inlet with stainless steel ball bearing swivel joint and 1-inch female NPT threads.

C. Heavy duty stainless steel angle mounting bracket for column or wall mounting.

D. Storage for up to 75 feet of 5/8” or 3/4” I.D. hose.

E. Pressure rated for up to 4000 psi.

F. Unit shall be Steel Eagle, Hannay Reels, Inc., Reelcraft, or approved equal

2.25 ACCESS COVERS (FINISHED AREAS)

A. Cleanouts in or behind walls shall have an access cover and frame embedded flush with the finished wall. The cover shall be polished brass or nickel brass of ample size to provide a clear access to the cleanout.

2.26 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 - EXECUTION

3.01 POTABLE WATER SYSTEMS

A. Provide cold and hot water supply systems in the buildings as indicated, making connections to all fixtures and equipment requiring hot and/or cold water.

B. The Contractor shall provide swing or swivel joints on connections from mains to risers and from risers to branches. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

C. Install gages and thermometers in straight runs of piping so they may be read from the floor or operating platform. Install all gages with gage cocks.

D. Underground Pipe

1. The piping shown on the drawings shall be installed complete and shall be of the size shown. All pipe shall be installed in such a manner that it does not bear directly on rocks or debris in ground. Where pipe passes close to or through walls or footings, it shall be protected from contact with concrete or cinder block. All pipe passing through building walls shall be protected by a cast iron sleeve large enough to permit free movement of pipe. All turns shall be made with a gradual curve so there is no chance of kinking or collapsing the pipe. Where

pipe passes through a building wall from underground to inside building, the sleeve shall be packed with oakum and made watertight.

2. Pipe Joints

   a. Solder Joints for copper pipe: All pipe shall be reamed to full diameter before joining. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2-inch and larger, flux shall be applied to pipe and fittings. Joints shall be made with silver solder and a torch using a mixture of oxygen and acetylene.

   b. Install underground ductile-iron piping according to AWWA C600, and AWWA M41. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets

3. Pipe Supports: Earth shall be excavated to a minimum depth with an even surface to insure solid bearing of pipe for its entire length. Where water lines cross deeper excavations, these shall be filled and tamped to the proper level before copper pipe is installed.

4. Pipe Depth

   a. Interior: Water pipe shall NOT be permitted inside concrete slabs.

   b. Exterior: the water pipe shall have a minimum of 4 feet of cover and shall comply with state and local codes.

5. Under floor water piping shall be insulated with closed cell elastomeric foam insulation (reference Section 15260).

E. Aboveground Pipe:

1. The piping shown on the drawings shall be installed complete and shall be of the size shown. All piping shall be installed to allow for expansion, either parallel or perpendicular to the building construction. On individual fixtures, water hammer arrestors shall be installed at each fixture sized per PDI recommended sizes. On groups of fixtures, one water hammer arrestor (shock absorber) shall be installed for each group.

2. Pipe Joints: All pipe shall be reamed to full diameter before joining. Ends of pipe and inside of fittings shall be cleaned and flux applied to entire area of pipe end to be soldered. On pipe 1-1/2-inch and larger, flux shall be applied to pipe and fittings.

3. Solder Joints: Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 “Solder Metal” Grade 95TA. Solder and flux used for piping material providing water for human consumption shall be lead free. Flux shall be non-acid, non-lead type. Remove composition discs from solder end valves during soldering. Wipe excess solder, leaving a uniform fillet around cup of fitting.

4. Copper pipe shall be supported not to exceed 8 feet on center. Plastic pipe shall be supported in accordance with manufacturer's instructions, but in no case shall exceed 3 feet on center.

5. Use bracket type hanger fastened to walls to support piping running adjacent to walls and not supported from ceilings. Valves 3 inches and over in horizontal lines shall be supported independent of the pipelines.

6. Perforated strap iron hangers or wire are prohibited.

7. Pipe hangers shall be cleaned and painted with rust resistant paint before installation.

8. Hanger supports shall be securely fastened to structural members by beam clamps and clips, concrete inserts, or anchors.

9. Where pipes pass through walls and suspended ceilings, provide pipe sleeves of No. 20 gage galvanized iron, 1/2 inch larger than insulated pipe or bare pipe outside diameter.

10. Pipe passing through floors and foundation shall be provided with sleeves of standard weight galvanized steel pipe. Sleeves shall be at least 1 inch larger than bare pipe and 1/2 inch larger than insulated pipe outside diameter. Ends shall be cut square and smooth and finish flush with surface of building construction. Where specifically noted, ends shall extend 1 inch above floor and edges chamfered.

11. Pipe sleeves shall be securely bedded in the building construction. Sleeves shall finish flush with finished wall and ceiling lines. Note that where covering is provided, it shall extend continuously through sleeves.

12. Sleeves installed in vertical positions shall be perfectly plumb and sleeves in horizontal positions shall be level. They shall be located, set, and maintained in position while surrounding construction work is being installed so that the center of each pipe shall be accurately installed in the center of the sleeve. The space between the pipe or the insulation and the sleeve shall be caulked to prevent light or air transfer. Where vertical sleeves occur, such as in floors or ceilings, special collars secured to the pipes or to the ceiling construction shall be provided to prevent the packing from falling out. The standard floor and ceiling plates herein specified for finished areas may be used for this purpose provided they are firmly secured to the pipes.

13. Pipe Insulation: Continuous through inside walls and at all hangers; pack insulation around pipes with fireproof self-supporting mineral wool insulation material, fully sealed.

14. Insulation for cold piping: Insulate all fittings, including flanges, all valve bodies and devices associated with cold surfaces. Maintain vapor barrier integrity.

15. Insulation for hot and tempered water piping: Insulate all fittings. Do not insulate unions, flanges, strainers, valves, flexible connections, or expansion joints.

16. Finish insulation neatly at hangers, supports and other protrusions or interruptions.

17. Ensure hangers and cradles are properly installed to avoid crushing insulation.

18. Install protective metal saddles and insulated inserts to prevent insulation compression.

19. Insulate all exposed piping below fixtures scheduled for use by the disabled in accordance with ADA with pre-formed insulation kits.

    a. Truebro Lavguard 2E-Z, or equal.

3.02 ROOF VENTS

A. Roof stack terminals shall be flashed using materials and flashing compatible with roof system. See manufacturer recommendations.

3.03 WASTE SYSTEMS

A. Horizontal piping shall be installed as high as possible without sags. Install 3 inches and larger horizontal drain and waste piping to 1/8 inch per foot slope. Piping 2-1/2 inches and smaller shall be installed at a slope of 1/4 inch per foot.

B. Concealed piping shall be installed in time so as not to delay work of other trades and to allow ample time for tests and inspection.

C. Before beginning installation work, check plumbing Drawings with architectural, structural, mechanical, civil, air conditioning and electrical Drawings and make accurate layouts of plumbing piping. Coordinate with other trades and report all interferences, discrepancies, or proposed changes to the Engineer for approval prior to beginning installation work.

D. Underground piping shall be firmly bedded on solid ground as specified in Division 2. Soil and vent stacks shall be supported at the base by means of piers or hangers close to the bottom of the riser and at the floor by means of riser clamps.

   1. Each horizontal length of cast or ductile iron pipe and PVC DWV pipe shall be firmly fastened to wall, or otherwise suitably supported.

   2. All water risers shall be properly anchored with allowance made for expansion.

   3. Hangers, support and anchors shall be installed as required to adequately support the lines without interfering with their inherent flexibility. Pipes, pipe installation, hangers, supports, and anchors shall conform to the requirements of Section 15020.

E. Should the Contractor fail to accurately locate and lay out all necessary openings in new construction in sufficient time to incorporate same in the structure, then the Contractor shall, at no extra cost to the Owner, cut such holes as may be required and replace at his own expense all completed work which may have been damaged or destroyed by the cutting of the holes. All such cutting shall be done under the direction and with the permission of the Engineer.

F. Provide sleeves as described under potable water systems of this specification section.

3.04 FLOOR DRAIN AND CLEANOUT INSTALLATION

A. Floor drains shall be installed perfectly plumb and level with elevation to provide for proper floor pitch.

B. Verify that the floor drains are not disturbed during floor or concrete installation.

C. Cleanouts installed in connection with cast iron soil pipe shall consist of a long sweep 1/4 bend or one or two 1/8 bends extended to place of access or as shown on the drawings. An extra heavy cast brass ferrule with countersunk head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor. Cleanouts in connection with other pipe shall be tee pattern, 90-degree branch drainage fittings with screw cast brass plugs of the same size as the pipe up to and including 4-inches.

D. Cleanout tee branches with screw plug shall be installed at the foot of soil and waste stacks and on each building drain outside the building. Cleanouts on pipe concealed in partitions and walls shall be provided with chromium plated cast brass covers secured to plugs.

E. The access covers shall be installed to provide easy and complete access to the cleanout plug. Due consideration of wall construction must be given to allow for proper installation of frame and the installation shall be coordinated with the GC.

F. Each cleanout, unless installed under an approved cover plate, shall be above grade, readily accessible, and so located as to serve the purpose for which it is intended. Cleanouts located under cover plates shall be so installed as to provide the clearances and accessibility required by the local plumbing code.

G. Each cleanout in piping 2- inches or less in size shall be so installed that there is a clearance of not less than 12-inches in front of the cleanout. Cleanouts in piping larger than 2-inches shall have a clearance of not less than 18-inches in front of the cleanout.

3.05 PLUMBING FIXTURES

A. After plumbing fixtures have been installed, fixtures and trim shall be thoroughly cleaned of all grease, oil, dirt, labels, stickers, and other foreign matter, and all packing materials shall be promptly removed from the premises. All valves and faucets shall be adjusted to suit the operating water pressure and all work maintained in clean and proper operating condition until accepted by the Engineer.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

F. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

H. Installation of the plumbing fixtures and accessories shall meet the applicable requirements of the Accommodations for the Physically Handicapped Federal Regulation (36 CFR 910.34) and shall be located as shown on the Architectural Drawings.

I. Install traps on fixture outlets.

J. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 7 for sealant and installation requirements.

3.06 TESTING

A. Notify Owner and Engineer one week in advance that the items are ready for testing.

1. Perform testing before work is concealed with construction or insulation, or before backfilling if piping is to be buried.

a. Concealed piping shall be installed in time so as not to delay work of other trades and to allow ample time for tests and inspection.

B. Test pressures shall be in accordance with ANSI B31.1 Code for Pressure Piping, Paragraphs 121(a), (b), and (c).

1. Test pressures shall be as follows:

a. Cold Water System - 100 psig hydrostatic.

b. Compressed Air Water System - 100 psig hydrostatic.

c. Drainage, Waste, and Vent - 15 psig hydrostatic.

d. Natural Gas:

1) Systems on which the normal operating pressure is less than 0.5 pounds per square inch gauge (psig), the test pressure shall be 5.0 psig and the time interval shall be 30 minutes.

2) Systems on which the normal operating pressure is between 0.5 psig and 5.0 psig, the test pressure shall be 1.5 times the normal operating pressure or 5.0 psig, whichever is greater, and the time interval shall be 30 minutes.

3) Systems on which the normal operating pressure is 5.0 psig or greater, the test pressure shall be 1.5 times the normal operating pressure, and the time interval shall be one (1) hour.

2. All tests other than natural gas shall be held for at least 4 hours and until each joint has been inspected.

3. At conclusion of testing remove special test fittings, caps, blanking plates, etc. and replace damaged gaskets and place systems in operation.

C. If inspection or tests show defects or failure, such defective work, materials or failure shall be replaced without delay and inspection and tests repeated. Repairs to piping and equipment shall be repaired or replaced with new material or equipment. Caulking of screw joints or plugging leaks shall not be permitted.

D. All water piping shall be hydraulically tested at 100 psig and proven tight for a period of not less than 4 hours with no loss of pressure. Tests for each section shall be repeated at no additional cost to the Owner until the piping is proven tight at the specified test pressure. Upon completion of work, inspection shall be made by the Engineer. All corrections, changes or removal of defective work shall be made by the Contractor at no cost to the Owner prior to approval of installation.

E. Water and DWV Pipe Testing: Shall be hydrostatic tested as follows, except where more stringent tests are required by the codes.

1. Slowly fill with water each valved section in pipe, and apply the specified test pressure by means of a portable positive displacement pump connected to the piping in an acceptable manner.

2. Make taps if necessary, at points of highest elevation, and plug tightly afterwards.

3. Carefully examine all exposed pipe, fittings, valves and joints during the tests.

4. Where joints show seepage or slight leaks repair as requested.

5. Remove and replace any cracked or damaged pipe, fittings, valves, or other defective materials discovered during the test.

6. After replacements and repairs have been made, repeat tests until work is satisfactory and approved.

F. All drainage and vent piping shall be tested before fixtures are installed, by capping or plugging the openings and filling the entire system with water and allowing it to stand thus filled for three hours.

G. All natural gas systems shall be inspected, tested, purged and placed into operation in accordance with NFPA 54 and as required herein.

H. All water supply piping shall be tested before fixtures or faucets are connected.

I. Each fixture shall be tested for soundness, stability of support and satisfactory operation of all its parts.

J. Disinfection of potable water systems shall be performed in accordance with the procedures described in AWWA C651 or AWWA C652.

3.07 PIPE IDENTIFICATION

A. Pipe markers shall be located as follows:

1. On straight runs of pipe at intervals not exceeding 100 feet.

2. At every sectionalizing or main shut off valve.

3. On each riser at a point 5 feet above floor or platform.

4. On both sides of a wall or partition through which pipe passes.

B. Markers shall be applied so they can be read from the floor.

C. Markers shall be applied only after all insulating and painting has been completed.

D. Surfaces shall be clean and free of dust, oil, or loose paint before applying markers.

E. Before applying markers on insulated surfaces, smooth the surface with sandpaper. Clean surface of all dust after sanding.

F. After applying each marker, wrap one turn of pipe banding tape completely around the circumference of the pipe at each end of the marker. Overlap ends of marker with the tape and overlap the tape upon itself a minimum of 1-inch. The pipe banding tape shall match the background color of the marker.

G. Where a service is indicated on the drawings as a circulating system, the pipe marker legend for the particular service shall be followed by either the word “supply” or “return” to clarify the line function. An arrow designating direction of flow shall follow the legend on each marker.

3.08 CLEANING

A. Clean dirt and marks and other debris from exterior of equipment weekly.

B. Remove debris and waste material resulting from installation weekly.

C. Properly protect all plumbing fixtures and trim at all times and temporarily close all openings to prevent obstruction and damage.

D. Maintain protective covers on all units until final clean-up time and, at that time, remove covers, clean and polish all fixture and trim surfaces.

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SECTION 15500

BASIC HVAC REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning, piping, etc. as indicated on the drawings and specified herein.

B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

1.02 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly, and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Spare parts list

052016BR

11. Special tools list

C. The Contractor shall obtain from the manufacturer and submit to the engineer copies of the results of all certified shop tests.

D. The Contractor shall obtain from the manufacturer and submit to the engineer copies of certified letters of compliance in accordance with the Specifications.

1.03 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

B. Operation and Maintenance Manuals shall be submitted for all equipment.

1.04 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Furnish Owner, indexed and bound in loose leaf binders, three (3) complete sets of Operating and Maintenance Instructions and pertinent manufacturers' literature and information on all of the apparatus and equipment under this Division of the Specifications.

G. Submit all instruction books and manuals in accordance with Division 1.

1.05 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.

B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Uniform Plumbing Code, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

Air Conditioning and Refrigeration Institute (ARI)
Air Diffusion Council (ADC)
Air Moving and Conditioning Association (AMCA)
American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
American National Standards Institute (ANSI)
American Society for Testing and Materials (ASTM)
American Society of Mechanical Engineers (ASME)
Factory Mutual (FM)
National Electric Code (NEC)
NFPA 90A - Air Conditioning and Ventilation Systems
Occupational Safety and Health Standards (OSHA)
Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
Standard Building Code - 1985 edition
Standard Mechanical Code - 1985 edition
Standard Plumbing Code - 1985 edition
State and local codes, ordinances and statutes
Underwriters Laboratories (UL)

Others as designated in the specifications.

1.06 QUALITY ASSURANCE

A. All material and equipment shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

B. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

C. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

D. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

1.07 IDENTIFICATION MARKERS

A. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:

Yellow/Green: Supply air

Blue: Exhaust, outside, return and mixed air

Nomenclature: Include the following:
Direction of air flow.
Duct service (supply, return, exhaust, etc.)

1.08 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make-up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial-commercial grade.

D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located, otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring-type vibration isolators.

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SECTION 15590

FANS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 GENERAL REQUIREMENTS

A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.

B. All anchor bolts, washers, clips, clamps and fasteners of any type shall be constructed of 316 stainless steel.

C. All fan motors shall be provided with high premium energy efficient totally enclosed fan cooled type, unless otherwise noted.

D. Provide exhaust fans which have been tested and rated in accordance with AMCA standard, and bear AMCA Certified Ratings Seal.

E. Provide motors and electrical accessories complying with NEMA standards.

F. Fans shall be standard prefabricated units of the type, size and arrangement indicated on the Drawings. All fans shall be rated and constructed in accordance with the Air Moving and Conditioning Association. Special construction materials, coatings and multi-speed fan motors shall be provided as indicated on the Drawings.

G. Impellers shall be rigidly constructed, accurately balanced dynamically and statically at the speed at which it is scheduled to operate and free from objectionable vibration or noise. Fans with corrosion resistant coatings shall be balanced after being coated.

H. Fans shall have no overloading characteristics for the horsepower indicated. All points on the fan brake horsepower curve shall not exceed the motor horsepower rating

I. V-belt drives shall be rated at least 50 percent greater than the rated motor horsepower, and shall have sheaves which can vary the fan speed by 10 percent above or below the rating point. The fan motor shall be mounted on an adjustable heavy mounting plate.

J. The operating fan speed shall be no greater than 85% of the maximum allowable fan speed for the selected model.

K. Unless otherwise noted on the Fan Schedule fans shall be manufactured to meet the balance quality and vibration limits of Fan Application Category BV-3 per AMCA Standard

204.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01350 - Seismic Anchorage and Bracing

B. Section 15500 - Basic HVAC Requirements

C. Section 15598 – Metallic Ductwork and Duct Accessories

D. Section 15990 – HVAC Testing, Adjustment, and Balancing

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals.

B. The Contractor shall submit shop drawings for fan supports, locating and identifying each support, brace, hanger, guide, component and anchor. Fan support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer of the State of North Carolina and shall comply with Section 01350 Seismic Anchorage and Bracing.

C. Required information shall include:

1. Horsepower, voltage, and rotating speed of motors.

2. Total weight of the equipment plus the approximate weight of the shipped materials.

3. Complete erection, installation, and adjustment instructions and recommendations.

4. Fan performance curve at the operating speed, minimum, and maximum speeds. Provide brake horsepower curve for the operating speed.

5. Details of corrosion resistance coating.

6. Detailed construction information and data sheets for all accessories such as roof curbs, dampers, damper operators disconnect switches, vibration isolators etc.

7. Example equipment nameplate data sheet.

8. Interconnecting wiring diagrams.

9. List of recommended lubricants.

10. Special Tools List

11. Reports of Certified Shop Tests

12. AMCA Approval for Fan Ratings

13. Sound data

14. Manufacturer’s Installation Certification

15. Manufacturer’s Field Test Results Certification

D. The Contractor shall submit to the Owner a color chart of available colors for the corrosion coating to be applied to fans as indicated in the Contract Documents. The Owner shall select the final color choice.

1.04 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300, Submittals.

1.05 MANUFACTURERS

A. The materials covered by these specifications are intended to be equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

1.06 CONTRACTOR'S RESPONSIBILITY AND MANUFACTURER’S FIELD SERVICES

A. The services of a qualified manufacturer's Technical Representative shall be provided. The manufacturer Technical Representative’s services shall include the following site visits:

Service	Total Days	No. of Trips	Remarks
Installation Checkout	1	1	In accordance with Section 15590
Startup and Testing	1	1	In accordance with Section 15990
Training	1	1	In accordance with Section 01700

B. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.

C. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

1.07 SPECIAL TOOLS

A. Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

PART 2 -- PRODUCT

2.01 ROOF MOUNTED UPBLAST CENTRIFUGAL EXHAUST FANS

A. Centrifugal fans shall be backwardly inclined, non-overloading blades of aluminum construction. Wheel inlets shall overlap an aerodynamic aluminum inlet cone.

B. Wheel shall be balanced in accordance with AMCA Standard 204-05.

C. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".

D. Fans shall be V-belt or direct driven as indicated on the drawings or as contained herein.

E. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners.

F. The two piece top cap shall have stainless steel quick release latches to provide access to the motor compartment without the use of tools.

G. Fans shall have internal terminal box mounted on the exterior for ready wiring.

H. The motor shall be separated from the exhaust air stream.

I. Bearings shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum catalogued operating speed.

J. Belts shall be oil and heat resistant, static conducting.

K. Drives shall be keyed and securely attached to the wheel and motor shafts.

L. All drives shall be variable pitched type and shall be sized for 150 percent of the installed motor horsepower.

M. Centrifugal fans shall be as manufactured by Loren Cook Co., Greenheck Fan Corp, or approved equal.

N. See Section 2.02 of this specification for additional requirements.

2.02 ADDITIONAL REQUIREMENTS FOR ALL FANS

A. The following additional requirements shall apply to all fans.

1. Backdraft or motor-operated dampers shall be provided and installed in the openings as indicated on the Contract Drawings.

2. All fans shall be provided with either integral or supplementary spring vibration or sound-absorbing mountings.

3. Where indicated, roof mounted exhaust fans shall be mounted on a prefabricated roof curb.

4. All motors unless indicated otherwise in this Specification or the Contract Drawings shall be TEFC. The break horsepower at any point on the fan curve for the design speed shall not exceed the motor nameplate horsepower. The break horse power shall include all applicable belt drive losses. Using the motor service factor shall be prohibited.

5. All equipment shall be seismically secured and restrained in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, latest edition, as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) and designed in accordance with the seismic provisions of ASCE-7 and the current North Carolina Building Code to the extent that the most stringent provisions are utilized in developing the design seismic forces. See section 01350 for additional details and requirements.

6. All non-fiberglass fans shall receive a corrosion resistant coating. The coating shall be an epoxy coating suitable for protecting the equipment from continuous exposure to air containing hydrogen sulfide 3ppm. The fans in the Supplemental Carbon Facility shall be suitable for exposure to methanol in addition to hydrogen sulfide. The coating shall be applied to all surfaces of the fans including but not limited to fan wheels, propellers, hubs, structural components, housings (interior and exterior), inlet boxes, dampers, screens, lube lines, curb boxes, and curb box adapters. A UV resistant top coat shall be applied to all coating systems that are not rated for UV exposure. The Contractor shall submit and coordinate the available color choices to the Owner for final color selection.

7. Where indicated in the design documents, fans shall exceed the uncertainty requirements of AMCA standard 203 and shall perform within +/- 3% of the flowrate with respect to the static pressure of the fan curve.

2.03 DAMPERS

A. See the respective sections in Sections 15598 for construction requirements.

B. Dampers shall be coordinated to operate and interface with the fan being furnished.

C. Dampers shall be sized to fit the specified openings.

2.04 PREFABRICATED ROOF AND WALL CURBS

A. Prefabricated roof and wall curbs shall be installed where indicated on the Drawings or as specified herein. The curbs shall be fabricated of .064 inch sheet aluminum with all joints heliarc welded. Cants and roof flanges shall be an integral part of the curb. The inside of the curb shall be insulated with rigid glass-fiber thermal and acoustical liner of approximately 3-lb. density and 1-1/2 inch minimum thickness with a neoprene or equal coating for protection from erosion. The lining shall conform to NFPA 90A Standards with a flame spread and fuel contributed rating not exceeding 50. Pressure-treated wood nailers shall be provided at the tops of the curbs. The curbs shall be sized to suit equipment. Roof curbs shall be a nominal of 12-inches above the height of the roof unless indicated otherwise on the Contract Drawings. The roof curbs shall receive an epoxy corrosion resistant coating on the interior and exterior surfaces that is suitable for the conditions indicated in the Additional Requirements for All Fans section above.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Contractor shall install fans in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.

B. Contractor shall coordinate fan work with work of walls, and ceilings, as necessary for proper interfacing.

C. Connect ducts to fans in accordance with manufacturer's installation instructions.

D. The Contractor shall have the Manufacturer’s Technical Representative provide in writing that the equipment is installed per the manufacturer’s requirements and operates as required by the Contract. The Contractor shall submit the written confirmation to the Engineer for information only.

3.02 FIELD QUALITY CONTROL

A. Testing: After installation of fans has been completed, test each fan to demonstrate proper operation of units at performance requirements as specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected. See Section 15990, HVAC Testing, Adjusting and Balancing for testing requirements.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched coatings with a coating specified by the equipment manufacturer for repairs.

- END OF SECTION -

SECTION 15598

METALLIC DUCTWORK & DUCT ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all ductwork, fittings, and accessories as shown on the Drawings and in accordance with the Specifications.

B. The equipment shall be furnished complete with all accessories, special tools, base attachments, mountings, anchor bolts and other appurtenances as specified or as may be required for a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15500 - Basic HVAC Requirements

B. Section 15990 – HVAC Testing, Adjustment, and Balancing

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all new and modified ductwork, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals.

B. The Contractor shall submit shop drawings for supports for new and modified ductwork. The shop drawings shall locate and identify each support, brace, hanger, guide, component and anchor. Ductwork support systems shall be designed and Shop Drawings prepared and seal by a Registered Professional Engineer of the State of North Carolina and shall comply with Section 01350, Seismic Anchorage and Bracing.

C. The Contractor shall submit shop drawings for support of multi-section dampers and louvers. The shop drawings shall identify all supports and reinforcement required to allow the multi-section dampers and louvers to be rated for the maximum pressure of the individual damper and louver sections. The support system shall be designed and calculations prepared and sealed by a Registered Professional Engineer of the State of North Carolina.

1.04 WARRANTY AND GUARANTEE

A. Warranty and Guarantee shall be as specified in Section 11000 with the exception that the warranty period shall be for two (2) years.

PART 2 -- PRODUCT

2.01 GENERAL REQUIREMENTS

A. All work shall be constructed and installed in a first class workmanlike manner in accordance with the recommendations given in the latest edition of the Sheet Metal & Air Conditioning Contractors National Association (SMACNA) HVAC Duct Construction Standards and Round Industrial Duct Construction Standards, unless otherwise specified.

B. All ductwork shall be constructed in accordance with the Schedule of Duct Construction Standards listed on the last page of this section. Transverse duct connections shall be bolted, gasketed connections.

C. All ducts shall conform accurately to the dimensions indicated on the Drawings, shall be straight and smooth on the inside with neatly finished joints, and shall not be decreased at any point to avoid obstructions. No piping, conduit or structural work shall be installed in or through any ductwork. All ductwork shall be run as close as possible to structural members, walls and ceilings. Duct work shall be as shown on the drawings, subject to such modifications as may be necessary to suit field conditions.

D. Where existing walls, floors or roofs must be penetrated, the Contractor shall neatly cut the required openings and patch the existing work to provide a neat and finished appearance.

E. All ducts shall be made reasonably tight throughout and shall have no openings other than those required for the proper operation and maintenance of the systems.

F. Minimum thickness for metal ducts shall be per SMACNA guidelines, but in no instance shall be less than 20 gauge for steel ducts and 14 gauge for aluminum ducts.

G. Supports for ducts shall be provided and securely fastened in place at every change in direction and as required to prevent deflection.

H. Changes in size of ducts shall be by means of a taper transformation piece, the included angle of the taper being not more than 20 degrees.

I. All duct work joints shall be sealed to achieve a SMACNA Seal Classification Rating as indicated in the ductwork schedule of this specification.

J. The weight of material used for ducts and stiffeners, the fabrication methods, cross breaking of flat duct surfaces, and assembling of the ductwork shall conform to the Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. Beaded duct construction shall not be used.

K. All duct panels shall be braced or reinforced as necessary, in addition to the minimum requirements in the ASHRAE Guide, to eliminate vibration and noise and to prevent deflection from the indicted shapes and dimensions.

2.02 GALVANIZED STEEL, STAINLESS STEEL AND ALUMINUM DUCT

A. Ductwork material shall be as indicated in the duct schedule in Part 3 of this specification.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 (Z275) coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A480/A480M, Type 316 having a number 2D finish for all applicable ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements, and shall be properly protected where subject to mechanical injury.

D. Aluminum: ASTM B209, alloy 1100, 3003, or 5052 for all applicable ducts and of adequate strength and rigidity to meet the conditions of the service and installation requirements, and shall be properly protected where subject to mechanical injury.

E. Transverse duct connections for rectangular ducts shall be bolted, gasketed connections made with standard Ductmate 35 System as manufactured by Duct Mate Industries, W.D.C.I. or approved equal. All longitudinal seems shall be Pittsburg Z, or better. Duct flange system material shall match the duct material. Gaskets shall be suitable for exposure to hydrogen sulfide 2ppm.

F. Transverse duct connections for round ducts shall be bolted, gasketed connections in accordance with chapter 12 of SMACNA Round Industrial Duct Construction Standards. Duct connections shall be the same material as the duct. Utilize longitudinal seam ductwork. Gaskets shall be suitable for exposure to hydrogen sulfide 2 ppm and outdoor use.

G. All ductwork shall be shop fabricated in sections with flanged ends. The Ductmate 35 flange system shall be factory spot welded to the ductwork. No field welding of ductwork shall be permitted. Welding equipment and electrodes shall be of a type specifically suited for welding light gauge 316 stainless steel or aluminum, as applicable, to provide consistently good quality welds.

H. All duct sections shall be constructed and installed without forming dips and traps.

I. All ducts shall have a minimum clearance of three (3) inches from all combustible material.

2.03 HANGERS AND SUPPORTS

A. All ductwork shall be securely hung and anchored to the building structure. Unless otherwise shown or specified, hangers and stiffeners for ducts shall conform with the recommendations given in the SMACNA HVAC Duct Construction standards and SMACNA seismic restraint manual. Ducts shall be supported on trapeze hangers consisting of angles and rods. Use of strap hangers and straps is prohibited.

B. All hangers, rods, supports, bolts, nuts, washers, inserts, and appurtenances shall be constructed of the same material as the ductwork that it supports.

C. All ductwork shall be supported from trapeze type hangers. Stainless/Glavanized steel hanger rods shall be minimum 3/8 inch for all ducts with half perimeter up to 72 inches, and ½ inch diameter for all ducts with half perimeter larger than 72 inches. Aluminum hanger rods shall be of sufficient diameter to achieve the equivalent strength of the stainless steel hanger rods for the sizes indicated. A pair of rods shall be provided at each duct support point. Maximum hanger spacing shall be 8 feet for ducts with half perimeter up to 72 inches and 6 feet for ducts with half perimeter larger than 72 inches.

D. Hanger Construction and installation shall conform to SMACNA Standards, except as specified. No sheet metal duct hangers or straps will be allowed.

E. Support shall be furnished at each fitting. Material of supports shall match duct material.

F. Seismic & Wind Requirements: All ductwork shall be provided with seismic and wind restraints in accordance with the Seismic Restraint Manual, Guidelines for Mechanical Systems, as published by SMACNA, in accordance with the North Carolina Building Code, the indicated design wind speed, and ASCE-7 to the extent that the most stringent provisions are utilized. Material of seismic and wind restraints shall be as specified herein. A calculation signed and sealed by a Professional Engineer of the State of North Carolina shall be provided verifying that the installed supports meet the seismic and wind requirements. See section 01350, Seismic Anchorage and Bracing and the Structural Design Drawings for additional details and requirements.

2.04 ACCESSORIES

A. Louver (ALTERNATE BID)

1. Manufacturer: Provide products of one of the following:
   a. Ruskin
   b. Greenheck
   c. Airolite
   d. Approved equal

2. Frame, blade, and jamb seal materials: 6063T5 Aluminum or 316 Stainless Steel

3. Inside and outside of all aluminum parts shall be coated with a corrosion resistant coating. The coating shall be Kynar 500 or approved equal. Final color selection shall be provided by the Owner. The Contractor shall submit a full color chart for selection and approval.

4. Frame shall be a minimum 0.125 inches thick for aluminum and 18 gauge for stainless steel

5. Blades:
   a. Drainable with minimum wall thickness of 0.081 inch for aluminum and 18

gauge for stainless steel

b. Blades shall be angled at 37 degrees

6. Drain gutters shall be in head frame and each blade

7. Downspouts in jambs shall drain water from louver

8. Mounting hardware shall be 316 stainless steel.

9. Provide bird screens in identical material to match louver. Screens shall be expanded and flattened type.

B. Manual Volume & Backdraft Dampers in Rectangular Stainless Steel or Aluminum Duct (ALTERNATE BID):

1. Manufacturer: Provide products of one of the following:

a. Greenheck

b. Ruskin

c. Nailor

d. or equal

2. Frame, blade, axle, bearings, jamb seal, and linkage materials: Match ductwork.

3. Blades:

a. Opposed blades for volume dampers and parallel blades for backdraft dampers;

b. Vinyl edge seals, thermoplastic elastomer seals for corrosive/chemical services.

4. Damper shafts shall be solid hexagonal or square shape.

5. Linkage shall be concealed in damper frame.

6. Provide outside handle, quadrant and approved position indicator and locking device on volume dampers.

7. Reference: SMACNA Standards.

C. Sheet Metal Safing: Provide sheet metal safing of the same material as the duct, to close off and seal airtight all unused areas behind louvers.

D. Screens (ALTERNATE BID):

1. ½-inch (13 mm) mesh, with screen material matched duct material, framed with bolt holes unless indicated otherwise.

E. Registers and Grilles:

1. Manufacturer: Provide product(s) of one of the following:

   a. Titus (Basis of Design, model numbers scheduled on drawings)

   b. Anemostat

   c. Price Industries

   d. Nailer Industries, Inc.

   e. Hart and Cooley.

2. Units shall be factory-fabricated of Type 316 stainless steel construction for stainless steel and FRP ductwork and aluminum for aluminum and galvanized steel ductwork. They shall distribute the specified air volume (cubic feet per minute).

3. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance.

4. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device will be acceptable. Volume dampers shall be opposed blade type for all diffusers and registers.

5. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling.

6. An additional volume damper shall be installed in duct stub to each air outlet for balancing of air volume.

7. Supply Registers:

   a. Supply registers shall be double deflection type, complete with adjustable vertical face bars and a key operated opposed blade damper.

8. Air extracting devices shall be installed at all collar take-offs to supply registers. The air extracting devices shall have two sets of individually adjustable blades to equalize flow and control volume at collar takeoffs and shall be gasketed around the perimeter.

9. Exhaust and Return Registers and Grilles:

   a. Exhaust and return registers shall be furnished with fixed vertical face bars, set straight, and a key operated opposed blade damper.

F. Duct-Mounted Access Doors and Panels:

1. Provide access doors at all duct connections dampers for access and maintenance of damper motor actuators and linkages.

2. Fabricate doors and panels airtight and suitable for duct pressure class.

3. Seal around frame attachment to duct and door to frame with neoprene.

4. Door and frame to be of same material as duct.

G. Flexible Connectors unless indicated otherwise shall meet the following requirements:

1. Self-extinguishing material shall meet NFPA 90A, NFPA 701 and UL-214 Standards.

2. Material:

a. Commercial grade neoprene coated woven fiberglass, Proflex by DUCTMATE, or approved equal.

b. Corrosion/chemical resistant applications shall be of Teflon coated woven fiberglass fabric. Minimum density 18 oz./sq. yd. and rated to 500 F.

3. Extra wide edge connectors factory fabricated with a strip of fabric. Material of connectors shall match duct material.

H. Instrument Test Holes: Material to suit duct material, including screw. Size holes to allow insertion of pitot and other testing instruments, and length to suit duct insulation thickness.

I. Turning Vanes:

1. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically.

2. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted.

3. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer’s instructions.

J. Drip Pans

1. Drip pans shall be welded 16 gauge, type 316 Stainless Steel.

2. Drip pans shall extend 2” beyond the dimensions of the equipment of ductwork above on all sides.

3. Drip pan shall have a minimum 1” lip.

4. Drip pan shall be sloped to a ¾” copper type L drain line such that pooling or standing water is prevented. The drain shall be continuously sloped a minimum of 1/8” per foot. The drain shall terminate 6” above the sink or nearest floor drain.

5. Provide a dielectric coupling between the stainless steel drip pan and copper drain line to prevent contact between dissimilar metals.

6. Contractor shall coordinate drip pan supports with the existing structural construction above. The Contractor shall provide all supplemental beams and channels needed. The support system shall be capable of supporting the weight of a full drip pan plus an additional 300 lb. load.

7. See Section 15990 - HVAC Testing, Adjusting, and Balancing for drip pan testing procedures.

2.05 DUCT INSULATION

A. Products and Manufacturers:

1. Provide insulation as made by one of the following:

a. Armacell – AP/Armaflex FS

b. Aeroflex – Aerocel

c. or equal

B. Insulation

1. Type: Elastomeric Closed Cell Foam

2. FM Approved

3. Application

a. 1.5-inch thick where insulation is required. See Part 3 for required insulation installation locations.

4. Average thermal conductivity not to exceed 0.28 (Btu-in)/(hr-FT2-°F) at mean temperature of 75°F, temperature range -40° to 220°F; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistant. The insulation shall have a flame spread rating of less than 25 and a smoke development of less than 50 per ASTM-E84.

5. Insulation shall be sealed vapor tight using an adhesive at all joints. The adhesive shall have a flame spread of less than 25 and a smoke development of less than 50 when tested per ASTM-E84.

6. All insulation shall receive a 316 stainless steel jacket for stainless steel ductwork and aluminum for all other duct materials. The jacket shall be meet ASTM C921and be a minimum of 0.016 nominal thickness. Exposed insulation ends such as duct discharge points or overlapping insulation shall receive caps made of the same material as the jacketing. Jacketing shall be secured with straps of the same material as the jacketing.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling.

B. Prevent end damage and prevent dirt and moisture from entering ducts and fittings. Where possible, store ductwork inside and protect from weather. If necessary to store outside, store above grade and enclose with waterproof wrapping.

3.02 INSTALLATION OF DUCTWORK

A. Examine areas and conditions under which ductwork is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

B. Assemble and install ductwork in accordance with recognized industry practices, Manufacturer's installation instructions, and SMACNA standards to achieve the seal and leakage classes indicated in the Duct Construction Table at the end of this specification.

C. Install each run with minimum number of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth.

D. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.

E. Field Fabrication: Complete fabrication of work at project as necessary to match shop-fabricated work and accommodate installation requirements.

F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment.

G. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 3" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where

possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings.

H. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

I. Turning vanes shall be installed in all miter elbows to permit air to make the abrupt turns with a minimum of turbulence. The turning vanes shall be quiet and free from vibration when the system is in operation. Vanes shall be installed in all short radius elbows in accordance with SMACNA Duct Construction standards.

J. The dial regulators for manual volume dampers shall be marked so that the "open" and "shut" positions are clearly identified. The dial regulators on insulated ductwork shall be mounted on an elevated platform which will finish flush with the surface of the insulation. Manual volume dampers shall be located at accessible points and wherever possible some distance from a duct transition or fitting. Care shall be taken during installation to make certain that sheet metal fasteners do not protrude into the duct and interfere with damper operation. Volume dampers shall be provided in each branch duct take off and in both ducts downstream of each trunk duct split.

K. Duct access doors shall be provided before and after duct mounted coils, within working distance of, and on the fusible link side of all fire dampers, adjacent to volume dampers, on the linkage side of automatic dampers, duct mounted sensors, and at all other apparatus requiring service or inspection in the duct system. Access doors shall be a minimum of 15 x 18 inches; where the size of the duct will not accommodate this size the doors shall be made as large as practical. The doors shall be rigid and airtight, and provided with neoprene gaskets, hinges and sash locks. Whenever space requirements are such that a hinged access door is impractical, a screw fastened lift-out door shall be provided instead.

L. Test openings shall be installed in the ductwork at the points listed below. The test openings shall be a minimum of 3/8" and shall be sealed by a screw cap and gasket, and shall be installed so that the insulation is not disturbed when the cap is removed. The test openings shall be located as follows in all heating, ventilating, air conditioning, and dehumidification systems:

1. Upstream and downstream of each coil, duct heater, filter bank, or other inline equipment that heats, cools, humidifies, dehumidifies, or filters air.

2. In the outside air, supply, and return ducts adjacent to the respective connections on all AHUs, HVs, DHUs, etc.

3. In the main supply duct on single zone units and in each zone supply duct on multizone units

4. As indicated on the Contract Drawings.

M. Air filter gauges for measuring the differential pressure through all filter banks shall be supplied and installed; one gauge shall be installed for each bank. The gauge shall be of

the inclined tube differential type complete with 1" thick acrylic plastic body, mirror-polished scale, built-in level vial, over pressure safety traps, signal flags, 2 vent valves for zeroing gauge, 2 static pressure tips, two 5-foot lengths of 1/4" stainless steel tubing, 2 compression fittings, mounting hardware, a bottle of red gauge oil and instructions. The gauges shall have a range of 0-1.0 inch water column with minor divisions of .02 inch water column.

N. The Contractor shall install prefabricated roof curbs before the installation of roofing.

O. All air outlets shall be with rigid connection to the ductwork.

P. After the installation is completed, the Contractor shall seal all joints air tight. Sealants and tape shall have a flame spread not greater than 25 and a smoke developed rating of not over 50 per ASTM E-84.

3.03 INSULATION INSTALLATION

A. Insulation shall be installed on all outdoor ductwork carrying conditioned air, all ductwork carrying conditioned air through unconditioned spaces, and all ductwork carrying unconditioned air through conditioned spaces. Conditioned air is any air that has received any heating, cooling, or dehumidification from HVAC equipment. Conditioned spaces are any spaces that receive conditioned air. Return and exhaust ductwork serving a conditioned space is considered conditioned air.

B. Ductwork carrying cooled conditioned air passing through spaces that only receive heated conditioned air shall be insulated. Ductwork carrying cooled air for spaces that require year round cooling such as electrical rooms, shall be insulated when passing through spaces that are provided heated conditioned air during the heating season.

C. Follow manufacturer’s installation instructions and recommended adhesives. The installation method shall provide a continuous vapor barrier.

D. The insulation vapor barrier shall be maintained through all supports, flanges, reinforcement, and penetrations. Where the duct weight would deform the insulation material at supports, the Contractor shall use fiberglass insulation blocks. The blocks shall be the same thickness as the insulation. The vapor barrier shall be maintained using a system approved by the insulation manufacturer for spanning the insulation block. Insulation jacket installation shall conform to manufacturer installation instructions.

3.04 DAMPER AND LOUVER INSTALLATION

A. The Contractor shall install dampers and louvers per the manufacturer’s installation instructions.

B. The Contractor shall install all reinforcement required for multi-section dampers and louvers to all the assembly to withstand the rated velocity and pressure of the individual damper and louver sections.

3.05 EQUIPMENT CONNECTIONS

A. Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicated in the Contract Drawings and Specifications.

3.06 ADJUSTING AND CLEANING

A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

B. At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.07 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's Technical Representative shall be provided. The manufacturer Technical Representative's services shall include the following site visits:

Service	Total Days	No. of Trips	Remarks
Installation Checkout	--	--	
Startup and Testing	--	--	
Training	--	--	

DUCT CONSTRUCTION SCHEDULE					
SERVICE	**PRESSURE CLASS**	**DUCT MATERIAL**	**SEAL CLASS**	**LEAKAGE CLASS**	**CONSTRUCTION STANDARDS**
P.O. Hoffer Water Treatment Facility (BASE BID)					
Electrical Rooms	+/- 2 inwg.	Galv Steel – G90	C	12	SMACNA HVAC Duct Construction Standards
P.O. Hoffer Water Treatment Facility (ALTERNATE BID)					
Carbon Slurry Tanks	+/- 2 inwg	Aluminum	C	12	SMACNA HVAC Duct Construction Standards

- END OF SECTION -

SECTION 15604

ELECTRIC RESISTANCE HEATING

(ALTERNATE BID)

PART 1 --GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all electric space heating units as required for a complete electric installation as specified herein and indicated on the Drawings.

B. The extent of the electric space heaters work is indicated on the Drawings and further defined by the requirements of this Section. The Contractor shall reference the Schedule included herein or indicated on the Drawings for quantities, electrical ratings, ventilation ratings, and other unit specific information.

C. All field mounted equipment, conduit, and wiring that is required to for the heating equipment shall conform the applicable requirements of Division 16.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 15000 – Basic Mechanical Requirements

B. Section 15500 – Basic HVAC Requirements

C. Section 15598 – Metallic Ductwork and Duct Accessories

D. Section 15990 – HVAC Testing, Adjusting, and Balancing

E. Division 16 – Electrical

1.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Certified Shop Tests. The electric space heating units shall be given routine factory tests in accordance with the requirements of the appropriate standards.

2. Field Tests. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1, and Section. The tests shall be made by the Contractor who shall also furnish the required testing equipment.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Special Tools List

3. Reports of Certified Shop Tests

4. Operation and Maintenance Manuals

5. Testing Procedure per Section 15990

6. Manufacturer’s Installation Certification

7. Manufacturer’s Field Test Results Certification

B. Each submittal shall be identified by the applicable Specification section.

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Equipment specifications and product data sheets identifying all materials used and methods of fabrication.

2. Example equipment nameplate data sheet.

3. Complete wiring diagrams showing all devices requiring electrical connection, wire numbers, terminal block numbers and other pertinent wiring information.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.07 SPECIAL TOOLS

A. The electric space heating units shall be furnished with all special tools necessary (one

set per like piece of equipment) to disassemble, service, repair and adjust the equipment.

1.08 IDENTIFICATION

A. Each electric space heating unit shall be identified with the identification number on the Drawings (e.g. UH-1, UH-2, etc.). A nameplate shall be securely affixed in a conspicuous place on each unit. Nameplates shall be as specified in Section 15500-Basic HVAC Requirements.

1.09 WARRANTY

A. Manufacturer shall provide a one year comprehensive warranty.

PART 2 --PRODUCTS

2.01 MANUFACTURER

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable firms regularly engaged in the manufacturing of electric space heating units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 ELECTRIC UNIT HEATERS

A. Product and Manufacturers: Provide completely factory assembled and wired units as made by one of the following:

1. QMARK MUH Unit Heater

2. Indeeco UHIR Unit Heater

3. Chromalox HVH Unit Heater

4. Approved Equal

B. Capacity and electrical supply characteristics shall be as shown on the Drawings.

C. Construction:

1. Unit shall be UL listed.

2. Finned tubular heating elements shall be brazed copper plated steel fins and epoxy sealed ends.

3. The motor shall be UL rated, permanently lubricated ball bearings, designed to resist moisture and corrosion.

4. Heating elements and motor shall be enclosed in a heavy gauge galvanized steel cabinet with a durable polyester powder coat finish.

5. The unit shall contain an adjustable outlet grille.
6. The unit shall be wired for single point power connection.

7. The enclosure shall house the element terminals and the following factory pre-wired controls:

    a. Automatic reset over temperature cutout
    b. Secondary manual reset/over temperature cutout
    c. 24V Control transformer
    d. Fan delay relay
    e. Terminal blocks for field wiring
    f. Three position selector switch (Auto, Off, Fan Only)
    g. Internal thermostat with external adjustable knob
    h. “Heater On” Pilot light to indicate when heating elements are energized

D. The Contractor shall furnish universal swivel mounting brackets. The mounting bracket shall be suitable for horizontal wall mounting or vertical ceiling or suspended mounting.

2.03 WASHDOWN ELECTRIC UNIT HEATERS

A. Product and Manufacturers: Provide completely factory assembled and wired units as made by one of the following:

1. QMARK QWD Washdown Unit Heater

2. Indeeco Triad Washdown Unit Heater

3. Chromalox HD3D Washdown Unit Heater

4. Approved Equal

B. Capacity and electrical supply characteristics shall be as shown on the Drawings.

C. Construction:

1. Unit shall be UL listed for corrosive areas and NEMA 4X hose down requirements.

2. Finned tubular heating elements shall be type 316 stainless steel sheath with mechanically wound stainless steel fins and mounting fittings.

3. The motor shall be UL rated, totally enclosed with permanently lubricated ball bearings, designed to resist moisture and corrosion. The motor shall be fitted with an epoxy-coated aluminum fan blade and factory wired to a NEMA 4X enclosure.

4. Heating elements and motor shall be enclosed in a round, stainless steel shroud.

The shroud shall be a minimum of 16 gauge.

5. The shroud shall contain a stainless steel louvered outlet grille and plated rear grille.

6. The unit shall be wired for single point power connection.

7. The NEMA 4X enclosure shall house the element terminals and the following factory pre-wired controls:

   a. Automatic reset over temperature cutout
   b. Secondary manual reset/over temperature cutout
   c. 24V Control transformer
   d. Fan delay relay
   e. Terminal blocks for field wiring
   f. For unit above 12kW, a separate motor contactor shall be supplied
   g. Three position selector switch (Auto, Off, Fan Only)
   h. Internal thermostat with external adjustable knob
   i. “Heater On” Pilot light to indicate when heating elements are energized

8. Each unit shall receive a corrosion resistant coating internally and externally including housing, fan blade, and grilles. The coating shall be Heresite or approved equal. The coating shall be rated for high temperature applications.

D. The Contractor shall furnish universal swivel mounting brackets. The mounting brackets shall be a minimum of 16 gauge 304 stainless steel. The mounting bracket shall be suitable for horizontal wall mounting or vertical ceiling or suspended mounting.

PART 3 --EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall handle the unit heaters and components carefully to prevent damage, breaking, denting, and scoring. Contractor shall not install damaged electric unit heaters or components.

B. The Contractor shall store the unit heaters and components in a clean dry place, which will adequately protect the units from weather, dirt, fumes, water, construction debris, and physical damage.

C. The Contractor shall comply with the manufacturer's rigging and installation instructions for unloading unit heaters, and moving them to final location.

3.02 INSTALLATION

A. The Contractor shall install unit heaters as indicated on the Contract Drawings, in accordance with the manufacturer's installation instructions, and shall verify that the manufacturer's nameplate data corresponds with the unit designation.

B. The Contractor shall hang/support the units from substantial structural components of the building (e.g. walls, floors, columns, beams, etc.). Supports for the units and associated ductwork supports for insertion type installations shall not be hung from piping, other ductwork, or other equipment supports. After installation, the unit shall be protected with a protective cover during the balance of construction.

C. The Contractor shall have the Manufacturer's Technical Representative provide in writing that the equipment is installed per the manufacturer's requirements and operates as required by the Contract. The Contractor shall submit the written confirmation to the Engineer for information only.

3.03 TESTING, ADJUSTING, AND CLEANING

A. After installation is completed, the Contractor shall clean all exposed unit surfaces, vacuum the heating coils and vacuum the inside of the cabinets.

B. See Section 15990 – Testing, Adjusting, and Balancing for testing and adjusting requirements.

3.04 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's Technical Representative shall be provided. The manufacturer Technical Representative's services shall include the following site visits:

Service	Total Days	No. of Trips	Remarks
Installation Checkout	1	1	In accordance with Section 15604
Startup and Testing	1	1	In accordance with Section 15990
Training	1	1	In accordance with Section 01700

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SECTION 15800

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1. Control Panels and Electrical wiring shall conform to the requirements of Division 16, Electrical and Division 17, Instrumentation. Provide a clear plastic NEMA rated, gasketed hinged door to encompass all non NEMA rated front of panel instruments.

1.02 SUMMARY

A. The Contractor shall furnish all labor, equipment and material for the complete installation of the heating, ventilation, air conditioning system as indicated on the Drawings and specified herein.

B. Air conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

C. Work Included Under Other Sections:

1. 480V, 3-phase power wiring and conduit under Division 16, Electrical.

2. Motor starters under Division 16, Electrical, unless factory mounted and wired by equipment manufacturer.

3. 120V, 1-phase wiring and conduit to Control Panels and remote field devices under Division 16, Electrical.

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.

B. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics, wiring, diagrams, etc.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Spare parts list.

11. Special tools list.

12. Control Panels:

    a. Panel layout drawings indicating dimensions and device layout for panel mounted devices, sub-panel mounted devices and internal components.

    b. Wiring schematics indicating factory installed wiring as well as field installed interconnection wiring between control panels, remote mounted starters, and remote mounted equipment.

    c. Catalog data for all control panel components including but not limited to enclosures, controllers, starters, pilot lights, selector switches, pushbuttons, etc.

C. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.

E. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.

1. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

2. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.05 EXTRA MATERIALS

A. Provide one additional set of specified fan belts, sheaves, and filters for each unit, packaged for storage. Tag products to identify associated unit.

1.06 SCHEDULES ON DRAWINGS

A. In general, all capacities of equipment and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

B. Motors and wheel diameters shown on the schedules are the minimum. If a larger wheel diameter or horsepower is required, it shall be so quoted and noted.

1.07 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.

1.08 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the Work.

B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Indiana Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Diffusion Council (ADC)
3. Air Moving and Conditioning Association (AMCA)
4. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)
5. American National Standards Institute (ANSI)
6. American Society for Testing and Materials (ASTM)
7. American Society of Mechanical Engineers (ASME)
8. Factory Mutual (FM)
9. National Electric Code (NEC)
10. NFPA 90A Air Conditioning and Ventilation Systems 2009 edition
11. Occupational Safety and Health Standards (OSHA)
12. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)
13. Indiana Building Code 2008 edition
14. Indiana Mechanical Code 2008 edition
15. Indiana Plumbing Code Uniform Plumbing Code 1997 edition
16. Indiana Energy Code 2008 edition
17. State and local codes, ordinances and statutes
18. Underwriters Laboratories (UL)
19. Others as designated in the specifications.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three (3) years documented experience, who issues complete catalog data on total product.

B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

E. Touch up and/or repaint to match original finishes all factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.

D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

2.02 AIR CONDITIONING UNITS (SPLIT SYSTEMS 6 TONS AND SMALLER)

A. Provide air conditioning unit(s) manufactured by one of the following:

1. Trane

2. Carrier

3. AAON

4. Or Approved Equal.

B. The system shall be a floor mounted supplemental air conditioner designed and built to the highest of industry standards. The system shall be complete and factory run-tested before shipment.

C. Cabinet Construction: The cabinet and access panels shall be fabricated from powder coated galvanized steel or aluminum. The panels shall be lined with 2 lb/ft3 high density sound and thermal insulation and sealed with self-extinguishing gasketing conforming to NFPA 90A and 90B.

D. Component Access: The air conditioner shall be fully accessible in-place through easily removable side access panels.

E. Electrical System: The system shall incorporate overcurrent and overload protection in accordance with UL requirements. Each blower motor, compressor, electric heater stage and humidifier (if applicable) shall be provided with a factory mounted and wired starter / contactor.

F. The control circuit shall be a 24 VAC Class 2 low voltage circuit including a circuit breaker for protection. Low voltage, high voltage and grounding wires shall be color coded and shall be individually numbered at each end for ease of service tracing. All wiring shall be in accordance with the National Electric Code (NEC).

G. Overflow Safety Float Switch: A condensate pan water level switch shall be incorporated to shut the system down if an overflow condition is sensed.

H. Remote Stop/Start: The system shall contain an electrical control circuit that shall be a 2-pin terminal connection for remote stop / start of the air conditioner by a remote source.

I. Blowers/Motors:

1. Direct Drive Systems:

a. The blower(s) shall be direct driven with double width, double inlet housing and forward curved blades. The blower(s) shall be dynamically and statically balanced to minimize vibration and operate in the Class I range. The blower(s) shall be corrosion protected with a painted housing and impeller wheel.

b. The three speed (208V) evaporator motor shall be factory wired for the correct speed to produce the specified air quantity. The motor(s) shall have internal overload protection. (277V & 460V direct-drive motors shall be two speeds.)

J. Belt Driven Systems:

1. The blower(s) shall be belt driven with double width, double inlet housing and forward curved blades and permanently lubricated ball bearings sized for an average 100,000 hours of service life. The blowers shall be dynamically and statically balanced to minimize vibration and operate in the Class 1 range.

2. The blower(s) shall have an adjustable base for belt tensioning and a locking system to prevent the motors from moving. The motors' drive sheaves shall have an adjustable pitch to change the speed of the blowers. The motor(s) shall be 1725 RPM and shall have overload protection and a minimum NEMA service factor of 1.15.

K. Temperature & Humidity Control:

1. The standard system shall be configured as a "cooling only" system. Heating, reheating and/or humidity control shall be optionally added to provide total space temperature and humidity control (as scheduled on Drawings).

L. Variable speed compressor systems shall be provided with wall mounted (5-2 day) programmable thermostat.

M. Two-Stage (dual compressors) systems shall be provided with wall mounted multi-stage 7 day programmable thermostat.

N. Filters:

1. The air conditioning unit shall have a drop out, 1" deep, class 2 (per U.L. Standard 900) filter easily accessed through the hinged return grille. The filter shall have a rating of at least 80% average arrestance as measured by ASHRAE Standard 52-76 test method.

O. DX Systems:

1. DX Coils:

a. Evaporator systems shall be configured for a draw-thru air pattern to provide uniform air distribution over the evaporator coil face. The coils shall be seamless drawn copper tubes, mechanically bonded to tempered aluminum fins with a raised-lanced fin design for maximum heat transfer. Coil end plates shall be hot dipped galvanized. The evaporator coil shall be mounted in an insulated stainless steel condensate drain pan.

2. Split / Remote systems shall have a liquid line solenoid for refrigerant isolation to prevent liquid slugging. All high-pressure joints shall be brazed, and the entire system shall be pressure tested at the factory with dry nitrogen, evacuated to at least 50 microns and fully charged with refrigerant.

3. Refrigeration Charge: All split / remote DX systems shall ship with a dry nitrogen holding charge. All self-contained DX systems shall ship with a full refrigerant (R-407C) operating charge.

4. DX - Scroll Compressors

   a. Each compressor shall be a high efficiency, high-reliability and low sound Scroll Compressor, unless specifically noted otherwise.

   b. The compressor shall be complete with charging and service schraeder ports, internal vibration isolation, internal thermal overloads, internal pressure relief valve, internal discharge gas vibration eliminator and external vibration mounting isolation.

5. DX – Air Cooled Outdoor Condenser:

   a. Provide Low Ambient Head Pressure Control, to allow operation down to a minimum ambient temperature of 0°F via Fan Cycling Head Pressure Control.

6. DX - Air Handling/Condensing Units:

   a. DX - Air Handling Unit:

      1) The system shall be a DX-Air Handling Evaporator. The air handling section shall house, at a minimum, the evaporator coil, expansion valve, evaporator blower/motor and associated electrical and refrigeration components.

      2) The system's compressor(s) shall be located with the Remote Condensing section.

      3) The air handling unit shall require only single point main power supply connection and the system shall ship from the factory with a dry nitrogen holding charge ready for field refrigerant charging.

   b. DX – Air Cooled Outdoor Remote Condensing Unit

      1) The system shall be an outdoor remote air cooled condensing unit with direct-driven, propeller fan(s). The system's compressor(s) shall be located with the remote condensing unit section. The condensing unit cabinet shall also house the condenser coil, blower and blower motor and outdoor rated electric box.

      2) The condensing unit shall be sized to provide the total heat of rejection of the system at a 95°F DB ambient temperature for the corresponding DX Air Handling Unit, per ANSI and ASHRAE standards.

P. Electric Heat:

1. A factory mounted and wired electric resistance heater shall be included to provide an automatic heating mode as required. Electric heaters shall be

provided with thermal / magnetic circuit breakers which shall protect each conductor. The heater elements shall be housed within a steel frame with mounted supports. Included shall be one automatic resetting over-temperature safety device (pilot duty), and a non-resettable over-temperature safety device (located in main power line).

2. Heaters shall use fast reacting nichrome wire heater elements, which cool quickly when turned off, eliminating residual heat problems.

Q. Sequence of Operation:

1. When the system Thermostat switch is set to the ON position and the zone temperature rises above the cooling setpoint, the controller energizes the compressor relay coil. When the compressor is called on, the compressor and the outdoor fan motor start to maintain the zone temperature to within ± 2° F of the sensor setpoint at the sensed location. On units with dual circuits, the second stage of cooling is initiated as a result of the Proportional/Integral control algorithms calling for additional cooling.

2. The evaporator fan(s) shall be controlled by an On/Auto switch. In the Auto position the fan(s) shall run when the compressor energizes on a call for cooling. In the On position the fan(s) shall run continuously.

3. The controls shall provide compressor anti-short cycle timing functions through minimum off and on timing to increase the reliability, performance and to maximize unit efficiency. Upon power initialization, the control shall perform self-diagnostic checks to ensure that all internal controls are functioning. It shall check the configuration parameters against the components connected to the system.

4. The float switch located in the auxiliary condensate drain pan shall stop unit operation if liquid is detected. The unit operation shall not be permitted until the float switch is manually reset.

5. When the system Thermostat switch is set to the ON position and heating is required, the controller energizes the Heat relay coil. When the Heat relay contacts close, the electric heat is energized to maintain the room temperature set point requirement.

6. Provide common remote alarm dry contacts for remote indication of system failure and/or high room temperature alarm (exceeds set point by 10º F).

2.03 PACKAGED AIR CONDITIONING UNITS

A. Provide air conditioning unit(s) manufactured by one of the following:

1. Trane.

2. Carrier.

3. AAON.

4. Or Approved Equal.

B. The units shall be convertible airflow. The operating range shall be between 115° F and 0° F in cooling as standard from the factory. Cooling performance shall be rated in accordance with ARI testing procedures. All units shall be factory assembled, internally wired, fully charged with refrigeration, and 100 percent run tested to check cooling operation, fan and blower rotation, and control sequence before leaving the factory. Wiring internal to the unit shall be colored and numbered for simplified identification. Units shall be UL listed and labeled, classified in accordance for Central Cooling Air Conditioners.

C. Unit casing shall be constructed of zinc coated, galvanized steel. Cabinet construction shall allow for all maintenance on one side of unit. Service panels shall have lifting handles and be removed and reinstalled by removing two fasteners while providing water and air tight seal. All exposed vertical panels and top covers in the indoor air section shall be insulated with cleanable foils-faced, fire-retardant permanent, odorless glass fiber material, or double walled construction with foam insulation fill. The base of the unit shall be insulated with 1/8 inch, foil-faced, closed cell insulation, or double walled construction with foam insulation fill. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1-1/8 inch high down flow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up. The base of the unit shall have provisions for forklift and crane lifting, with forklift capabilities on three sides of the unit.

D. All units shall have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage. Internal overloads shall be provided with the scroll compressors.

E. Unit shall be completely factory-wired with necessary controls and contactor pressure lugs or terminal block power wiring. Unit shall provide an external location for mounting a fused disconnect device. Microprocessor controls shall provide for all 24 volt control functions. The resident control algorithms shall make all heating, cooling, and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm shall maintain accurate temperature control, minimize drift from set point, and provide better control. A centralized microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection. 24-volt electromechanical control circuit shall include control transformer and contactor pressure lugs for power wiring. Units shall have single point power entry as standard.

F. Evaporator and condenser coils shall have internally finned, 5/16 inch copper tubes mechanically bonded to a configured aluminum plate fin. Coils shall be leak tested to 575 psig and pressure tested to 450 psig. A removable, reversible, double-sloped condensate drain pan with through the base condensate drain shall be standard.

G. Filter shall be throwaway 2-inch MERV 8.

H. All units shall include High Pressure Cutout as standard.

I. Indoor fan on 3-5 ton units shall have multispeed, direct drive motors. All 6-10 ton and higher units shall have belt drive motors with an adjustable idler-arm assembly for quick

adjustment to fan belts and motor sheaves. All motors shall be thermally protected. All indoor fan motors shall meet US Energy Policy Act of 1992.

J. Outdoor fan shall be direct-drive, statically and dynamically balanced, draw-through in the vertical discharge position. The fan motor shall be permanently lubrication and shall have built-in thermal overload protection.

K. Each refrigerant circuit shall have a thermal expansion valve as standard. Service pressure ports and refrigerant line filter driers shall be factory installed as standard. An area shall be provided for replacement of suction line driers.

L. The unit top shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed. The top shall be ribbed for extra strength and shall prevent water from pooling on unit top.

M. Options:

1. Provide CompletCoat, where in dictated on Plans and Schedules, (Trane proprietary coating, Basis of Design, or equal coating) coil coating system by factory, the cathodic epoxy type electro-disposition coating shall be formulated for high edge build to plate fin and tube heat exchangers. The coating shall be selected to provide excellent resistance and durability to corrosive effects of alkalies, acids, alcohols, petroleum, seawater, salt air and corrosive environments. The unit shall be equipped with crankcase heater(s), low pressure switches, Frostat, and thermostatic expansion valve as standard.

2. Hinged access doors shall be provided on the Filter/Evaporator, Supply Fan/Heat, and the Compressor/Control Access Doors.

3. Provide factory installed Return Smoke Detectors.

4. Provide factory installed through the base electrical with disconnect.

5. Provide factory roof curb designed to mate with the unit’s down flow supply and return and provide support and water tight installation.

6. Provide factory installed Air Side Economizer System. The assembly shall include fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, and spring return actuator. Provide solid state enthalpy control system. The powered exhaust of return air shall be provided to maintain building pressurization.

7. Provide remote NEMA 1 control panel with Air Conditioning System run and ready pilot lights, system malfunction alarm pilot light, space temperature sensor and adjustable set point controller, smoke detector audible and visual alarm with reset station, and fan On/Off/Auto switch.

    a. Push-to-test pilot light devices shall be IDEC TWTD Series, or equal.

N. Sequence of Operation:

1. When the room temperature rises above the cooling set point or falls below the heating set point, the microprocessor controller energizes the first step of cooling

or first step of heating. If the outdoor ambient conditions are suitable for the 0-100 percent air side economizer operation, the outside air and return air dampers shall be controlled to provide supply air conditions based upon the enthalpy reference point. If the economizer is disabled due to ambient conditions, the mechanical cooling or heating shall be activated and the outside air damper shall be in the minimum position to provide the scheduled minimum outside air.

2. When the system is in mechanical cooling, the microprocessor controller energizes the compressor relay coil. When the relay contacts close, the compressor contactor coil is energized provided the low and high pressure controls are closed. When the compressor contacts close, the compressor and outdoor fan motor start to maintain the room temperature to within ± 2° F. On units with multiple stages, additional stages of cooling shall be initiated as a result of the proportional/integral control algorithms calling for additional cooling.

3. The indoor air fan shall be controlled by an On/Off/Auto switch in the Remote Control Panel. In the Auto position the fan shall run when the compressor contactor energizes on a call for cooling or when the heating relay calls for heating. In the On position the fan shall run continuously.

4. The microelectronic control shall provide compressor anti-short cycle timing functions through minimum off and on timing to increase the reliability, performance and to maximize unit efficiency. Upon power initialization, the control shall perform self-diagnostic checks to ensure that all internal controls are functioning. It shall check the configuration parameters against the components connected to the system.

5. The smoke detectors located in the supply and return air stream shall stop the system operation and provide a visual and audible alarm upon smoke detection. The unit operation shall not be permitted until the smoke detector is manually reset. The float switch located in the auxiliary condensate drain pan shall stop unit operation if liquid is detected. The unit operation shall not be permitted until the float switch is manually reset.

6. When the zone temperature falls below the heating set point and the economizer is disabled, the controller energizes the Heat 1 relay coil. When the Heat 1 relay contacts close, the first stage electric heat contactor is energized if the proof of air flow switch makes. If two stages of electrical heat are scheduled on the Drawings and the first stage of electric heat cannot satisfy the heating requirement, the controller energizes the Heat 2 relay coil. When the Heat 2 relay contacts close, the second stage of electric heat contactor is energized. The first and second stages of electric heat are cycled on and off as required to maintain the zone temperature.

7. The exhaust air fan shall modulate by use of a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure. It shall provide 100% outside air tracking power exhaust to maintain a 0.10" positive pressure within the room by exhausting a proportional amount of the entering fresh air.

8. Provide high and low room temperature alarm indication if room temperature exceeds set point by 10° F or more.

9. Provide remote alarm dry contacts for remote indication of system failure and/or room temperature alarm.

2.04 REFRIGERANT PIPE INSULATION

A. Products and Manufacturers: Provide insulation as made by one of the following:

1. Armaflex.

2. Rubatex.

3. Or Approved Equal.

B. Pipe Insulation:

1. Type: Elastomeric Closed Cell.

2. FM Approved.

3. Unit slit tubing and miter cut fittings.

4. Thickness: 1/2- inch for refrigerant suction, water source heat pump and condensate piping and 1-inch for hot water piping.

5. Average thermal conductivity not to exceed 0.27 (Btu-in)/(hr-FT2-°F) at mean temperature of 75° F, temperature range -40° to 220° F; permeability not to exceed 0.20 by ASTM E96; water absorption 3 percent by ASTM D1056 and ozone resistant.

6. Field-Applied Jacket: Piping located outside the building shall have weatherproof 316 stainless steel smooth in 0.10 inch thickness field-applied jacket. All jacketing shall have an integrally bonded moisture retarder over the surface in contact with the insulation. The jacketing shall be fabricated with continuous modified Pittsburg Z-lock on the longitudinal seam. Each butted section of jacketing shall be sealed with a butt strap, and secured with a Fabstap (Childers) Pab-Band (PABCO). Provide 316 stainless steel elbow covers in 0.016 inch thickness and protected with PABCO's Sure-Fit or Childers Stainless Steel Ell-Jacs. Product shall be by PABCO, Childers Metals, or approved equal.

2.05 REFRIGERANT PIPING

A. Products and Manufacturers:

1. Refrigerant piping specialties:

a. Sporlan.

2. Expansion valves:

a. Sporlan.

b. Alcoa.

3. Silver solder - "Easy-Flow 45":

a. Harman.

4. Moisture indicator - "SEE-ALL":

a. Sporlan.

B. Refrigerant Piping:

1. Copper tubing conforming to ASTM B280 and/or FS WW-T-799, dehydrated for refrigerant use, with high-temperature soldered joints and wrought copper (400 psig) fittings.

a. For underground use: Type K.

b. For aboveground use: Type L.

C. Piping Joints:

1. Joints between copper tubing and fittings to be high temperature brazed joint (melting point not less than 1000° F, Harris Products Stay-Silv 15. Do not use flux. Purge the line with nitrogen to prevent scale build up.

2. Joints between copper and brass, steel, etc., shall be silver soldered only, Harris Products Safety-Silv 45 with Stay-Silv White Brazing Flux.

D. Pre-charged Line Sets: Size per manufacturer's recommendations.

E. Field Assembled Units:

1. Size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:

a. Suction lines: 2 DegF.

b. Liquid lines: 1 DegF or 2 psi.

c. Hot gas lines: 1 DegF or 3.6 psi.

d. Size discharge and hot gas risers for positive oil return to compressors.

F. Refrigerant Dryer:

1. Sporlan material "CATCH-ALL" filter-drier with aluminum molded core.

2. In each liquid line.

3. A three-valve bypass around filter-drier.

4. Install so core can be removed without cutting or breaking any refrigerant line.

G. Moisture Indicator:

1. Show presence of moisture in system by change of color.

2. Install full size in the main liquid line adjacent to the filter-drier.

3. Use Sporlan "SEE-ALL."

H. Strainers:

1. Design to permit removing screen without removing strainer from piping system.

2. Screens not larger than 80 mesh.

3. Strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.

I. Oil Traps: Provide in lines as required.

J. All Valves:

1. All bronze.

2. 2 IN and less: Solder ends.

3. 3 IN and over: Four (4) bolt union ends.

K. Shut-Off Valves:

1. Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.

2. Wheel, globe, angle or "T" handle.

L. Check Valves:

1. In liquid lines 5/8 IN and less: Lift check type.

2. In lines 3/4 to 2 IN: Swing check type.

3. In lines 3 IN and over: Wafer type swing check with bronze disc.

M. Expansion Valves:

1. Sized by manufacturer for refrigerant used.

2. Provide one (1) in each circuit with liquid distributor connection immediately after.

N. Vent and Test Valves: Angle cap type with seal and outlet caps.

O. Pre-charged Line Sets: Install per manufacturer's recommendations.

P. Field Assembled Lines:

1. Refrigerant piping:

a. Purge refrigerant piping of all air while connections of refrigerant piping are being made.

1) Shut-off valves.

2) Connect tank of dry nitrogen to line on back side of valve.

3) Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.

2. Testing:

a. Refrigerant piping systems: Follow general testing guidelines of ASHRAE 15, except as modified herein.

b. Pressurize the high and low pressure sides of the piping system after completion of the refrigerant piping.

c. Pressurize at the test pressures specified in ASHRAE 15 for the refrigerant type to be used in the system.

d. Repair any leaks and repeat tests until no further leaks are found and the system passes a static leak test at test pressure for a duration of 24 HRS.

3. Cleaning:

a. Disconnect suction and discharge lines from compressor for clean up after complete system is tested.

b. Valve or blank off system into three (3) separate systems for purpose of cleanup.

1) Suction side including cooling coils.

2) Discharge side including air cooled condenser.

3) Hot gas reheat side including heating DX coils.

c. Thoroughly clean each system using pumped refrigerant until system is proven clean to satisfaction of refrigeration compressor serviceman.

d. Notify Engineer for a visual inspection of both cleaning process and completely cleaned system.

4. Evacuation and Drying:

a. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to gas pressure as recommended by the equipment manufacturer.

b. Evacuate to 100 micron Hg and hold for 72 HRS.

1) Use laboratory type vacuum pump capable of holding absolute pressure of 50 micron Hg.

2) Check the vacuum with a suitable mercury column gage.

c. Admit another drying charge of refrigerant and allow 4 to 6 HRS to absorb moisture and install dryer cores.

d. Use second evacuation to remove all refrigerant and moisture.

e. After second evacuation, charge system with refrigerant.

f. Charge the system with refrigerant as required after final evacuation.

2.06 CONDENSATE DRAIN PIPE

A. Poly Vinyl Chloride Pipe and Fittings:

1. Pipe: ASTM D1785 and D2466.

2. Weight: Schedule 40.

3. Fittings: ASTM D1785 and D2466.

4. Joints: Chemical weld with manufacturers recommended solvent.

2.07 NAME PLATES

A. White laminated phenolic plastic with minimum 3/16 inch high black engravings if viewing distance is less than 24 inches, 1/2 inch high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances.

B. Nameplates shall be affixed with weatherproof adhesive.

C. Nameplates shall be provided at all thermostats, control switches, panels, or any other device providing information on equipment being controlled. Name plates shall be provided on all HVAC equipment matching equipment scheduled identification numbering.

D. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:

1. Yellow/Green: Supply air

2. Blue: Exhaust, outside, return and mixed air

3. Nomenclature: Include the following:

a. Direction of air flow.

b. Duct service (supply, return, exhaust, etc.)

2.08 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. All exterior equipment shall be properly secured and anchored to structure.

D. Install units on vibration isolators, where fans are not internally isolated.

E. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation of the Owner's representative(s).

F. Provide the minimum access space for maintenance of individual components such as fans, filters, coils, humidifiers, etc., as scheduled or shown on the Drawings. Arrange these components in a manner that allows for ease of replacement.

G. Arrange fans and surrounding components in such a way that poor fan performance does not result.

3.02 HVAC TESTING, ADJUSTING AND BALANCING

A. Contractor shall provide all necessary instrumentation, tools, ladders, and labor etc. to complete all air balancing, tests and adjustments.

B. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

C. All testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with NEBB, AABC, or SMACNA Organization. Testing, adjusting, and balancing technician shall hold current certification by one of these organizations. Submit certification to Engineer for approval.

D. Contractor shall be solely responsible for the protection and safeguarding of his work and shall provide every protection against accidents, injury, and damage to persons and property.

E. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

F. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

G. Inspection: Contractor to perform inspection for proper installation and operation of all equipment.

1. Pre Startup Inspection:

a. Verify proper equipment mounting and setting.

b. Verify that control, interlock and power wiring is complete.

c. Verify alignment of motors and drives.

d. Verify proper piping connections and accessories.

e. Verify that lubrication is completed.

2. First Run Observations:

a. Verify direction of rotation.

b. Verify setting of safety controls.

c. Monitor heat build up in bearings.

d. Check motor loads against nameplate data.

3. Equipment Check:

a. Verify proper overload heater sizes.

b. Verify function of safety and operating controls.

c. Verify proper operation of equipment.

H. Air Systems Testing:

1. Test, adjust and balance systems in accord with the AABC "National Standards for Field Measurements, Total System Balance, Air Distribution, Hydronics Systems, Volume One Number 81266", or SMACNA's "Air Handling

Specification".

2. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.

3. Test rpm for all equipment, including adjusting of each fan, air handling unit, air conditioning unit to design requirements within the limits of mechanical equipment provided.

4. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.

5. Make pitot tube traverse of main supply and exhaust ducts, determine cfm at all fans and units and adjust fans and units to within 5 percent of design requirements.

6. Test and record fan system static pressure.

7. Record all fan speeds.

8. Record air quantity delivered by each fan.

9. Distribution:

    a. Adjust volume dampers, control dampers, etc., to proper design CFM in ducts.

10. Air Terminals:

    a. Identify each air terminal as to location and determine required flow reading.

    b. Test and adjust each air terminal to within tolerance of design requirements as listed below.

        1) Diffusers and Supply Registers: 0% to +10%.

        2) Return Registers: 0% to -10%.

        3) Exhaust Registers: 0% to -10%.

    c. Test procedure on air terminals shall include recording comparison of required cfm and observed cfm, adjustment of terminal, and recording of final cfm.

11. Verification:

    a. Prepare summation of readings of observed cfm for each system, compare with required cfm, and verify that duct losses are within specified allowable range.

    b. Verify design cfm at fans as described above.

c. If the air systems are not properly balanced, the Contractor shall re-balance and recheck all data.

I. Automatic Control System:

1. In cooperation with the control supplier’s, set and adjust automatically operated devices to achieve required sequence of operations.

2. Testing organization technician shall verify all controls for proper calibration and list those controls requiring adjustment by Contractor or control system installer.

J. The test and balance activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Engineer. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for the Owner's operations personnel.

K. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

3.03 MANUFACTURER’S SERVICES

A. Air Handling Units:

1. Furnish services of qualified manufacturer's factory trained service personnel to assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct plant operators in the care, operation and maintenance of the equipment. A certificate from the manufacturer relative to these services is required.

2. Service personnel shall not make less than two visits to each site as necessary to assist in the installation of the equipment, to check the completed installation, to perform the tests, and to instruct plant operators in the proper care, operation and maintenance of the equipment.

3. Training: In addition to the above requirements, furnish services of qualified manufacturer's factory-trained operations and maintenance service personnel to instruct and train plant operators in accordance with the requirements of Division 1 at a time to be specified by the OWNER for a minimum of 8 hours, for heating, ventilating and air conditioning equipment and system operation.

3.04 CLEANING

A. Clean dirt and marks and other debris from exterior of equipment weekly.

B. Remove debris and waste material resulting from installation weekly.

3.05 GUARANTEE

A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of one (1) year. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

-END OF SECTION-

SECTION 15950

HVAC AUTOMATIC TEMPERATURE CONTROLS

PART 1 -- GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install all HVAC Automatic Temperature Control (ATC) systems and accessories, and in accordance with the Specifications.

B. Air conditioning equipment and controls shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the equipment and controls.

C. All labor, material, equipment and software not specifically referred to herein or on the plans, which are required to meet the functional intent of this specification, including the integration to existing applications and reporting, shall be provided without additional cost to the Owner.

D. Automatic temperature control systems indicated on the Drawings and control devices such as thermostats, etc., indicated to be 24 volts shall be supplied, mounted and wired by the ATC manufacturer. The ATC manufacturer shall size and provide low voltage transformers where required. The Automatic Temperature Control (ATC) Subcontractor shall be responsible to furnish and install the control wiring to each control device.

E. Wiring and Conduit: 120V, 1-phase wiring and conduit to Control Panels and motorized dampers shall be provided under Division 16, Electrical. All 480V 3-phase wiring and conduit shall be provided under Division 16, Electrical. Control wiring and conduit from Control Panels to field devices and equipment shall be provided by HVAC, Automatic Temperature Control Contractor. Wiring and conduit shall meet all requirements of Division 16.

1.02 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Division 1.

B. Submit documentation in the following phased delivery schedule:

1. Control equipment hardware and software.

2. System schematics, including:

a. Sequence of operation.

b. Point names.

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c. Point addresses.

d. Point to point wiring.

e. Interface wiring diagrams.

f. Panel layouts.

g. System riser diagrams.

h. Logic Diagrams

C. Upon completion of the work, provide a complete set of ‘as-built’ control drawings in AutoCAD 2014 or newer file format.

D. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment as follows.

1. Index sheet, listing contents in alphabetical order.

2. Manufacturer's equipment parts list of all functional components of the system, disk of system schematics, including wiring diagrams.

3. Description of sequence of operations.

4. As-Built interconnection wiring diagrams.

5. User’s documentation containing product, system architectural and programming information.

6. Trunk cable schematic showing remote electronic panel locations, and all trunk data.

7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.).

8. Conduit routing diagrams.

9. Copy of the warranty.

10. Operating and maintenance cautions and instructions.

11. Recommended spare parts list.

1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed

shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

E. Air Terminal Unit Actuator and Unitary Controllers: ATC supplier shall furnish actuators for all motorized dampers on VAV boxes requiring actuated dampers. Contractor shall coordinate and arrange for actuators and DDC unitary controller to be shipped to air terminal unit factory for factory mounting.

1.04 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.

1.05 CODE, PERMIT AND STANDARDS

A. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or additions necessary for compliance with applicable codes at no additional cost to Owner.

B. The Contractor shall obtain and pay for all permits and shall comply with all laws and codes that apply to the Work.

C. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

D. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Tennessee Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

E. Referenced Standards:

1. Instrumentation, Systems, and Automation Society (ISA):

   a. S5.1, Instrumentation Symbols and Identification.

   b. S5.4, Standard Instrument Loop Diagrams.

2. National Electrical Manufacturers Association (NEMA):

   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

3. National Fire Protection Association (NFPA):

   a. 70, National Electrical Code (NEC).

4. Underwriters Laboratories, Inc. (UL).

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years documented experience, who issues complete catalog data on total product. Installer shall have an established relationship with Control System Manufacturer.

B. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

C. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

D. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended by the manufacturers and in accordance with specified codes and standards.

E. Touch up and/or repaint to match original finishes for factory finished or painted equipment and materials which are scratched or marred during shipment or installation.

F. The Manufacturer of the TCS digital controllers shall provide documentation supporting compliance with ISO-9000:2000 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the TCS digital controller manufacturer shall contain the ISO-9000:2000 Certification Mark from the applicable registrar.

1.07 ACRONYMS USED IN THIS SPECIFCATION

A. ATC – Automatic Temperature Control.

B. BMS – Building Management System

C. CC – Configurable Controllers.

D. DDC – Direct Digital Control.

E. DRF – Discrete Render Format.

F. GUI – Graphical User Interface.

G. IDC – Interoperable Digital Controller.

H. LACS – Laboratory Airflow Control System

I. LAN – Local Area Network.

J. NAC – Network Area Controller.

K. ODBC – Open Database Connectivity.

L. PICS – Product Interoperability Compliance Statement.

M. SQL – Structured Query Language.

N. VAV – Variable Air Volume.

O. WAB – Web Browser Interface.

P. WAN – Wide Area Network.

Q. XIF – Extended Image Format.

PART 2 -- PRODUCTS

2.01 GENERAL

A. The Plans shall be taken as diagrammatic. The Contractor shall field check the existing site for detail dimensions and clearances for preparation of shop drawings. Design sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown

B. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner

C. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise

2.02 FIELD DEVICES

A. Provide automatic control valves, automatic control dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended

by manufacturer.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Dampers: Size for running torque calculated as follows:

a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.

b. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

c. Coupling: V-bolt and V-shaped, toothed cradle.

d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

e. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.

f. Power Requirements (Two-Position Spring Return): 24 -Vac.

g. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-Vdc.

h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

i. Temperature Rating: Minus 22 to plus 122 deg F.

j. Temperature Rating (Smoke Dampers): Minus 22° to plus 250° F.

k. Provide verify open contacts for dampers as indicated on Plans and Contract Documents.

l. Provide NEMA 4X enclosure around actuator in chemical rooms and process areas.

C. Temperature Switches (ALTERNATE BID):

1. Temperature Switches: Temperature switches shall be linear precision elements with ranges appropriate for each specific application.

2. This section governs temperature switches that control ventilation fan operation. Temperature sensors for electric duct heaters, electric unit heaters, or internal equipment sensors shall be provided per the respective specification sections and schedules for the equipment.

3. Provide a temperature switches as indicated on Plans.

4. Unclassified Spaces

a. Temperature switches shall be an adjustable Setpoint type.

b. The temperature switch shall have a range of at least 0–100 degrees Fahrenheit for interior applications.

c. Temperature switch shall have a NEMA 4X or NEMA 12 rating on its enclosure.

d. The temperature switch shall be Ashcroft G or L series temperature switches (application dependent) or approved equal.

D. Temperature Sensors

a. Temperature sensors shall be a temperature transmitter of the Pt100 sensor type.

b. The temperature transmitter range shall be set from 0 degrees to 110 degrees for space temperatures, supply air temperatures, and return air temperatures. Outside air temperature sensors shall be set from -20 degrees to 110 degrees.

c. The transmitter shall be capable of transmitting an analog 4-20 mA signal.

d. Transmitter shall have an enclosure with a NEMA rating of 4X or 12 space dependent.

e. The instrument shall be loop powered.

f. Temperature transmitters for unclassified areas shall be Omega – EWSE-PT100-TX or approved equal.

E. Room Thermostats (ALTERNATE BID)

1. Provide manufacturer mating room combination humidistat & thermostat with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated.

F. Programmable Thermostats

1. Provide manufacturer mating room combination humidistat & thermostat with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated. Setpoints shall be programmable to take effect at different times of the day and days of the week.

G. Local Malfunction Alarms:

1. Visual Warning Light: Federal Signal Corporation Model 225X Series located at entrances and exits of rooms.

2. Audible Warning Tone: Federal Signal Corporation Model 300GCX Series located at entrances and exits of rooms.

H. Differential Pressure Switch

1. Adjustable range: 0.08 IWC – 5 IWC. Temperature Limits: 0 F-120 F.

2. Provide NEMA 12 body for applications near outside walls, or that may experience wet/high humidity conditions.

3. DP switch shall be compatible with a DDC system.

2.03 CONTROL WIRE

A. Communication wiring shall be plenum rated three conductor cable, twisted, 100% shielded, 18-gauge wire with no splices. The wire shall be “RED (+), Black (-) and WHITE (Gnd)”.

2.04 SEQUENCE OF OPERATIONS

C. Treatment Facility Electrical Building Medium Voltage Room – Lead/Lag Programmable Thermostats

1. ACU-TFEB-1

a. Unit shall be set to maintain 83 F Cooling and 52 F Heating on the following days of the week: Monday, Wednesday, Friday, Sunday.

b. Unit shall be set to maintain 85 F Cooling and 50 F Heating on the following days of the week: Tuesday, Thursday, Saturday.

2. ACU-TFEB-2

a. Unit shall be set to maintain 85 F Cooling and 50 F Heating on the following days of the week: Monday, Wednesday, Friday, Sunday.

b. Unit shall be set to maintain 83 F Cooling and 52 F Heating on the following days of the week: Tuesday, Thursday, Saturday.

D. Treatment Facility Electrical Building Low Voltage Room – Lead/Lag Programmable Thermostats

1. ACU-TFEB-3

a. Unit shall be set to maintain 83 F Cooling and 52 F Heating on the following days of the week: Monday, Wednesday, Friday, Sunday.

b. Unit shall be set to maintain 85 F Cooling and 50 F Heating on the following days of the week: Tuesday, Thursday, Saturday.

2. ACU-TFEB-4

a. Unit shall be set to maintain 85 F Cooling and 50 F Heating on the following days of the week: Monday, Wednesday, Friday, Sunday.

b. Unit shall be set to maintain 83 F Cooling and 52 F Heating on the following days of the week: Tuesday, Thursday, Saturday.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All work described in this section shall be installed, wired, circuit tested and calibrated by the Temperature Control Subcontractor's factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the Drawings.

C. All communication wiring shall be separate from any wiring above 30 volts.

D. All wiring shall be labeled with BRADY style wire markers at each end.

E. Provide signal conditioning devices and surge protection devices for Controllers, Control Panels and peripherals.

F. Drawings of temperature control systems are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Engineer shall be furnished and installed without additional cost.

3.02 WIRING

A. The Temperature Control Subcontractor shall be responsible to furnish and install the control wiring to each control device.

3.03 ACCEPTANCE TESTING

C. Upon completion of the installation, the Temperature Control Subcontractor shall load all system software and start-up the system. The Temperature Control subcontractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

D. The Temperature Control Subcontractor shall perform tests to verify proper performance

of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation

E. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner/Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner/Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

3.04 OPERATOR INSTRUCTION AND TRAINING

A. During system commissioning and at such time acceptable performance of the TCS hardware and software has been established the Temperature Control Subcontractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Temperature Control Subcontractor shall provide 40 hours of instruction to the owner's designated personnel on the operation of the TCS and describe its intended use with respect to the programmed functions specified. Operator orientation of the TCS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:

1. Initial Training: One-day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.

2. First Follow-Up Training: One day (8 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

3. Warranty Follow Up: One day (8 hours total) in no less than 4-hour increments, to be scheduled at the request of the owner during the one-year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

3.05 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the TCS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced

by the Temperature Control Subcontractor at no expense to the Owner.

C. The Owner shall grant to the Temperature Control Subcontractor, reasonable access to the TCS during the warranty period. The Owner shall allow the Contractor to access the TCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

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SECTION 15990

HVAC TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. This Section specifies the requirements and procedures for testing, adjusting, and balancing the HVAC systems. Requirements include measurement and establishment of the fluid quantities of the HVAC systems as required to meet design specifications, and recording and reporting the results.

B. The following HVAC systems shall be tested, adjusted and balanced:

1. Supply air systems, all pressure ranges, including new and existing systems

2. Exhaust air systems (ALTERNATE BID)

3. Outside air systems, including new and existing systems

4. Air Heating systems

5. Air Cooling systems

C. This Section does not include specifications for materials for patching HVAC systems, or specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.

1.02 DEFINITIONS

A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes the balance of air distribution, water distribution, the adjustment of total system to provide design quantities, the electrical measurement, and the verification of performance of all equipment and automatic controls.

1. Test: To determine quantitative performance of equipment.

2. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

3. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

4. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

5. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

6. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets or supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

7. Main: Duct containing the system's major or entire fluid flow.

8. Submain: Duct containing part of the systems' capacity and serving two or more branch mains.

9. Branch Main: Duct serving two or more terminals.

10. Branch: Duct serving a single terminal.

1.03 SUBMITTALS

A. Prior to balancing, the Contractor shall perform Equipment Testing as indicated in section 3.1. Prior to performing System Testing, the Contractor shall have the system balanced as indicated in section 3.1.

B. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. The Contractor shall submit a detailed testing procedure which shall include:

1. Step by step instructions as to how the tests will be performed including but not limited to temporary layout modifications, procedures for testing instrument functionality, steps required to prove that the Control Strategy has been properly implemented, and steps required to compensate for ambient air temperature versus normal operating temperature such as thermostat setpoint adjustment. The steps shall indicate all actions to be taken, the expected result of the actions, and what the expected result verifies in regards to proving that the unit operates as designed.

2. A list of any additional or temporary equipment necessary to perform the tests.

3. Provide a checklist of items that will checked during the test as listed in Section 3.1. Each item shall be initialed by the Contractor’s Testing and Balancing Technician conducting the test. The Contractor’s Testing and Balancing Engineer shall sign and date the bottom of the test sheet verifying all results.

D. The Contractor shall submit the signed results of the equipment testing to the Engineer for approval. The equipment manufacturer’s representative shall be present for all testing. The results shall include a letter from the manufacturer’s representative stating that the

equipment has been installed per the manufacturer's installation requirements and is in satisfactory working order.

E. The Contractor shall submit an adjusting and balancing procedure which shall include:

1. Standard procedure the Contractor will use for balancing the systems.

2. Tables specific to the equipment for this project for recording the required information from Part 3 – Execution.

3. Flow diagrams specific to the systems present on this project. The flow diagrams shall contain at a minimum:

a. A diagrammatic representation of the system

b. All duct or pipe sizes

c. All inline equipment such as fans, pumps, duct heaters, filters, and strainers

d. All air inlet and outlet grilles and registers

e. All dampers, valves, or flow control equipment

4. A list of the equipment the balancing technician will use to balance the system

F. Submit completed adjusting and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been adjusted and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. The adjusting and balancing reports shall contain at a minimum

1. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:

a. General Information and Summary

b. Technician Qualifications and Certificates

c. Completed Adjusting and Balancing Report including procedure

d. Temperature Control System Settings

e. Calibration Certificates of all Instruments Used

2. Report Contents: Provide the following minimum information, forms and data:

   a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer.

   b. Calibration Certificates: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to the date of the start of balancing.

   c. Flow Diagrams

   d. Balancing Datasheets

   e. Balancer Comments: The Balancer shall provide comments, suggestions, and corrective actions to any issues that occur during balancing including excessive noise, excessive vibration, or an inability to meet design conditions.

1.04 QUALITY ASSURANCE

A. Test and Balance Personnel Qualifications: The personnel responsible for testing, adjusting, and balancing the specified systems shall have at least three years' experience in testing and balancing systems similar to this project and shall be an employee of the installer or an independent testing and balancing agency.

B. Codes and Standards:

   1. NEBB, "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

   2. ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

C. Contractor shall provide all necessary instrumentation, tools, ladders, and labor etc. to complete all air balancing, tests and adjustments.

D. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

E. All testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with NEBB, AABC, or SMACNA Organization. Testing, adjusting, and balancing technician shall hold current certification by one of these organizations. Submit certification to Engineer for approval.

F. Contractor shall be solely responsible for the protection and safeguarding of his work and shall provide every protection against accidents, injury, and damage to persons and property.

G. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

H. Contractor shall be fully responsible for removal and reinstallation of ceiling system and replacement of any component damaged.

1.05 SEQUENCING AND SCHEDULING

A. Systems shall be fully operational prior to beginning procedures.

1.06 RELATED SECTIONS

A. Section 15500 - Basic HVAC Requirements

B. Section 15590 – Fans (ALTERNATE BID)

C. Section 15598 – Metallic Ductwork and Duct Accessories

D. Section 15604 – Electric Resistance Heating (ALTERNATE BID)

E. Section 15800 – Air Conditioning Units

F. Section 15950 – HVAC Electric Control Systems

PART 2 - MATERIALS

(NOT USED)

PART 3 - EXECUTION

3.01 HVAC TESTING

A. Equipment to be tested shall include at a minimum all fans, unit heaters, Air Conditioning units, and electric control systems. The specific requirements for equipment indicated below shall be performed in addition to any requirements of the Manufacturer for startup and initial operation.

B. The equipment manufacturer’s representative shall be present for all testing.

C. Fans (ALTERNATE BID):

1. Pre Startup Inspection:

a. Verify proper equipment mounting and setting

b. Verify that control, interlock and power wiring is complete

c. Verify alignment of motors and drives

d. Verify proper belt tension

e. Verify proper duct connections and accessories

f. Verify that lubrication is completed

g. Verify that equipment is in good condition and free from damage

h. Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed

i. Verify that equipment and associated ducts are free from debris

j. Verify that equipment is installed per the Manufacturer's requirements

2. Equipment Test:

a. Prior to energizing motor, verify and record voltage of power supply

b. Bump motor to verify direction of rotation

c. Run the fan for 1 hour of continuous trouble free operation. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure.

d. Monitor heat build-up in bearings

e. Monitor for any abnormal noises or vibration

f. Check motor loads against nameplate data

g. Record fan sound levels ten (10) feet from the surface of the fan in five (5) minute intervals during 1 hour run period. The sound levels shall not be used for any sound rating verification. The sound levels shall be used for information by the owner to identify areas that will require hearing protection.

3. System Test:

a. Verify the system operates per the respective equipment specification 15590-Fans, 15800-Heating and Air Conditioning, and Section 15950-HVAC Electric Control Systems including all modes of operation, interlocks, alarms, and safeties.

D. Electric Unit Heaters (ALTERNATE BID):

1. Pre Startup Inspection:

    a. Verify proper equipment mounting and setting

    b. Verify that control, interlock and power wiring is complete

    c. Verify that equipment is in good condition and free from damage

    d. Verify that all packing materials, temporary stops, and temporary supports

    e. Used during shipping have been removed

    f. Verify that equipment is free from debris

    g. Verify that equipment is installed per the Manufacturer's requirements

2. Equipment Test:

    a. Prior to energizing, verify and record voltage of power supply

    b. Run the unit heater for 1 hour of continuous trouble free operation. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure. Any safety trips will cause this testing to be restarted from the beginning of this procedure. If the ambient air temperature is too high to have the coils energized constantly for 1 hour, the Contractor shall adjust the setpoint temperature of the duct heater. The Contractor shall coordinate this testing with all other trades. The Contractor is responsible for scheduling this testing and shall take into account any additional measures required to accomplish the testing based on the ambient air temperature. The Contractor shall not raise the temperature in the space to a point where it will cause damage to any equipment in the space or create unsafe or uncomfortable working conditions for the workers as determined by the Resident Engineer. If the Resident Engineer determines that the ambient conditions will not allow the testing of this equipment because the Contractor has scheduled the testing for a point in the season known to be warm, the Contractor shall provide any temporary cooling required to run this test including but not limited to temporary fans, ductwork, chillers, generators, cooling towers, make-up water supplies, heat exchangers, or air conditioners at no cost to the project.

    c. Monitor and record the inlet and outlet air temperatures

    d. Monitor for any abnormal noises or temperature fluctuation

    e. Check heater electrical loads against nameplate data

3. System Test:

a. Verify the system operates per Section 15604-Electric Resistance Heaters and 15950 - HVAC Electric Control Systems including all modes of operation, interlocks, alarms, and safeties.

E. Air Handling Units, Packaged DX Units, Split Systems, and Fan Coil Units

1. Pre Startup Inspection:

a. Verify proper equipment mounting and setting

b. Verify that control, interlock and power wiring is complete

c. Verify proper duct connections and accessories

d. Verify that lubrication is completed

e. Verify that equipment is in good condition and free from damage

f. Verify that all packing materials, temporary stops, and temporary supports used during shipping have been removed

g. Verify that equipment and associated ducts are free from debris

h. Verify that the refrigeration system has been evacuated and charged per the Manufacturer's requirements

i. Verify that equipment is installed per the Manufacturer's requirements

2. Equipment Test:

a. Prior to energizing unit, verify and record voltage of power supply

b. Run the unit for 1 hour of continuous trouble free operation. Any issues or stops required for tuning or repairs shall cause the test to be restarted from the beginning of this procedure. If the ambient air temperature is too low to have the refrigeration system running constantly for 1 hour, the Contractor shall take into account any additional measures required to accomplish the testing based on the ambient air temperature. The Contractor shall provide any temporary heating equipment required to run this test including but not limited to temporary fans, ductwork, heaters, generators, heat exchangers, combustion equipment, and fuel storage and pumping at no cost to the project. Use of any heating equipment that was installed as part of this work shall not be permitted to be used as a heat source.

c. Monitor discharge and return air temperatures

d. Monitor for any abnormal noises or vibration

e. Record fan sound levels ten (10) feet from the surface of the equipment in

five (5) minute intervals during 1 hour run period. The sound levels shall not be used for any sound rating verification. The sound levels shall be used for information by the owner to identify areas that will require hearing protection.

3. System Test:

a. Verify the system operates per Section 15800-Heating and Air Conditioning and Section 15950-HVAC Automatic Temperature Controls, including all modes of operation, interlocks, alarms, and safeties.

F. Drip Pans

1. Drip pans and drains shall be hydrostatically tested under gravity of a filled drip pan and drain line for a minimum of 30 minutes. Any leaks shall be corrected and the drip pan/drains retested until a watertight drip pan drainage system is confirmed.

G. Ductwork

1. All openings in the ductwork shall be temporarily sealed and the ductwork shall be pressurized and leak tested to demonstrate that the installation meets the specified SMACNA leakage class requirements. The Contractor shall follow SMACNA procedures for testing as outlined in SMACNA's HVAC Air Duct Leakage Test Manual.

H. At the completion of all of the individual equipment testing, the Contractor perform a HVAC System Run Test. The Run Test shall consist of operating the entire HVAC system as a whole using automatic controls for a period of not less than 15 consecutive days with no significant disruptions, repairs, reprogramming, or outages. Any issues during this period shall reset the testing period until it passes.

3.02 ADJUSTMENT AND BALANCING REQUIREMENTS

A. Identify and list size, type, and manufacturer of all equipment to be balanced, including air terminals and all end user equipment.

B. Test and record motor voltages, running amperes, shaft rpm and power factor including motor nameplate data, and starter heater ratings for each unit listed above.

C. Air Equipment Balancing

1. The Contractor shall start the fan and verify that the fan amperage and speed are within the design requirements. The Contractor shall then proportionally balance the air distribution system using the dampers at the air terminals. When the system is proportionally balanced, the Contractor shall adjust the fan speed to achieve the total design flowrate of the system. Fan speed adjustment shall be accomplished by adjusting variable pitch drives or by replacing the fan sheaves. The Contractor shall

then take final readings for the total system flow as well as readings for each air terminal.

2. For all ducted air systems, the Contractor shall measure the flow rate in cfm at each air inlet, at the fan, and at each outlet for each system. The Contractor shall provide this information in the report to demonstrate that the system as installed meets the seal class rating as indicated in section 15598 - Metallic Ductwork and Duct Accessories and section 15599 – Fiberglass Ductwork and Duct Accessories.

3. Test and record the following:

    a. Fan system static pressure.

    b. All fan speeds.

    c. Air quantity delivered by each grille and register.

    d. Pressure drop across each piece of inline equipment such as a duct heater or filter bank. Filters shall be new and clean at time of testing and balancing.

    e. Final damper and air extractor positions for all dampers and extractors

4. Distribution:

    a. Adjust volume dampers, control dampers, etc., to provide the proper design CFM in ducts.

5. Air Terminals:

    a. Identify each air terminal as to location and determine required flow reading.

    b. Test and adjust each air terminal to within flow rate tolerance of design requirements as listed below. Under no circumstances shall the balancing impact the pressurization of spaces that are required to have a specific pressurization:

        i. Diffusers and Supply Registers: 0% to +10%

        ii. Return Registers: 0% to -10%

        iii. Exhaust Registers: 0% to -10%

6. Verification:

    a. At the completion of the balancing work, the Contractor shall check and record the flow rate and static pressure at all supply, return, and exhaust air points to show final balanced conditions. The Contractor shall provide in the report a table with a summation of readings comparing the required cfm, final cfm, and final static pressure for each supply, return, and exhaust terminal and all final damper positions.

b. Verify design cfm at fans as described above.

c. If the air systems are not properly balanced, the Contractor shall re-balance and recheck all data.

D. The testing and balancing activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Engineer for approval. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for the Owner's operations personnel.

E. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

3.03 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified in accordance with the detailed procedures outlined in the referenced standards.

B. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation, ductwork, and housings using materials identical to those removed.

D. Seal ducts, test, and repair leaks created during the testing and balancing procedures on the hydronic and air systems.

E. Seal insulation to re-establish integrity of the vapor barrier at all locations where the vapor barrier was disturbed during the testing and balancing procedures.

F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.04 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with standard practices and the specific requirements identified in this section.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

- END OF SECTION -

SECTION 16000
BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental to, the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents, and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Contractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in, and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. Reference Section 17000 – Control and Information System Scope and General Requirements as well as General Requirements in Division 1 for scope of work details as they relate to the Division 17 Instrumentation and Control System Subcontractor.

C. The electrical scope of work for this project primarily includes, but is not limited to, the following:

1. Demolition of electrical equipment and raceway systems as shown on the Drawings.

2. Modifications to existing electrical equipment as shown on the Drawings and as specified herein.

3. Furnish and install medium and low voltage motor control equipment including reduced voltage motor starters and variable frequency drives.

4. Furnish and install switchboards, power panelboards, lighting panelboards, dry-type transformers, and other low voltage electrical power distribution equipment.

5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, supports, and other pertinent components.

6. Furnish and install all underground raceway systems including conduit, fittings, manholes, handholes and other pertinent components.

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7. Furnish and install all low and medium voltage wire and cable resulting in a complete and operable electrical system.

8. Furnish and install new lighting systems and wiring devices.

9. Furnish and install facility lightning protection systems and grounding systems where specified or indicated on the Drawings.

10. Other electrical work as specified herein and indicated on the Drawings.

D. All material and equipment shall be the product of an established, reputable, and approved manufacturer; shall be new and of first-class construction; shall be designed and guaranteed to perform the service required; and shall bear the Label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Engineer.

E. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Engineer shall be furnished and installed at no additional cost to the Owner.

F. Where the Contractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Contractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Engineer. The Contractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

G. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

H. All electrical components and systems (e.g., conduit and other raceways, freestanding equipment, etc.) and their anchorage, including electrical equipment foundations, shall be designed to resist the controlling load combination of gravity loads, operational forces, wind forces, seismic forces, thermal loads, and any other applicable forces required in accordance with the governing Building Code and Section 01350 – Anchorage and Bracing of Nonstructural Components. Seismic design shall be in accordance with ASCE 7 Chapter 13 unless the nonstructural component meets the criteria to be exempt.

1.02 EQUIPMENT LOCATION

A. The Drawings show the general location of feeders, transformers, equipment, devices, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Contractor shall carefully investigate the structural and finish conditions affecting the work and shall arrange such work

accordingly. Contractor shall furnish and install such fittings, junction boxes, and accessories as may be required to meet such conditions. The Contractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Contractor shall verify all equipment dimensions to ensure that proposed equipment will fit properly in spaces indicated.

B. Where outlets are shown near identified equipment furnished by this or other Contractors, it is the intent of the Specifications and Drawings that the outlet be located at the equipment to be served. The Contractor shall coordinate the location of these outlets to be near the final location of the equipment served whether placed correctly or incorrectly on the Drawings.

1.03 LOCAL CONDITIONS

A. The Contractor shall examine the site and become familiar with conditions affecting the work. The Contractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction (AHJs). All costs, both temporary and permanent to connect all utilities, shall be included in the Bid. The Contractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.

B. In addition, the Contractor shall relocate all duct banks, lighting fixtures, receptacles, switches, boxes, and other electrical equipment as necessary to facilitate the Work included in this project. Costs for such work shall be included in the Bid.

C. The Contractor is responsible for coordinating all electric utility equipment installations with the serving electric utility. The Contractor shall furnish and install all electric utility equipment required by the electric utility to be installed by the Contractor whether specifically shown on the Drawings or not.

D. The Contractor shall furnish and install the following electric utility equipment as a minimum:

1. Concrete transformer/equipment pads constructed in accordance with utility requirements and/or as instructed by the electric utility.

2. Primary and /or secondary conduits/ductbank and manholes.

3. Metering equipment cabinets and/or bases.

4. Secondary conductors .

5. Secondary terminations.

E. The electric utility will furnish and install the following equipment:

1. Primary conductors and terminations.

2. Utility Transformers.

F. The Contractor is responsible for ensuring all electric utility equipment and construction installed by the Contractor is furnished and installed in accordance with the electric utility's design specifications and requirements. The Contractor is fully responsible for coordinating all required work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Contractor at no additional cost to the Owner.

The contact person at the serving electrical utility is:

Fayetteville Public Works Commission (PWC)
Mailing: P.O. Box 1089, Fayetteville, NC, 28302
Shipping: 955 Old Wilmington Rd, Fayetteville, NC 28301

David Deschamps
Engineering Manager – Electric Systems
david.deschamps@faypwc.com

Electrical Engineering Department
(910) 223-4514
electricalengr@faypwc.com

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals and the requirements of the individual Specification Sections, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Proposed Testing Methods and Reports of Certified Shop Tests

5. Reports of Certified Field Tests

6. Manufacturer's Representative's Certification

B. Submittals shall be sufficiently complete in detail to enable the Engineer to determine compliance with Contract requirements.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Contractor has provided no information.

D. Some individual electrical specification sections may require a Compliance, Deviations, and Exceptions (CD&E) letter to be submitted. If the CD&E letter is required and shop drawings are submitted without the letter, the submittal will be rejected. The letter shall include all comments, deviations, and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of the applicable specification section(s). In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations and exceptions taken to each Drawing related to the applicable specification section(s).

E. Submit design for all nonstructural electrical components and systems and their anchorage in accordance with the governing Building Code and Section 01350 – Anchorage and Bracing of Nonstructural Components.

1.05 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. Unless otherwise noted, all work, equipment, and materials furnished shall conform with the latest available version of the rules, requirements, and specifications of the following:

a. Insurance Rating Organization having jurisdiction.

b. The serving electric utility company.

c. The currently adopted edition of the National Electrical Code (NEC).

d. The National Electric Manufacturers Association (NEMA).

e. The Institute of Electrical and Electronic Engineers (IEEE).

f. The Insulated Cable Engineers Association (ICEA).

g. The American Society of Testing Materials (ASTM).

h. The American National Standards Institute (ANSI).

i. The requirements of the Occupational Safety Hazards Act (OSHA).

j. The National Electrical Contractors Association (NECA) Standard of Installation.

k. National Fire Protection Association (NFPA).

l. InterNational Electrical Testing Association (NETA).

m. All other applicable Federal, State/Commonwealth, and local laws and/or ordinances.

2. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL), if the material and equipment is of the type/class inspected by said laboratories.

B. Nonconformance

1. Any paragraph of requirements in these Specifications or Drawings deviating from the rules, requirements, and specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Contractor shall be held responsible for adherence to all rules, requirements, and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or specification shall not be allowed as an excuse for nonconformity. Acceptance by the Engineer does not relieve the Contractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Where applicable, upon completion of the work, the Contractor shall obtain certificate(s) of inspection and approval from the inspection organization having jurisdiction and shall deliver same to the Engineer and the Owner.

1.06 PERMITS AND INSPECTIONS

A. The Contractor shall reference the General Conditions and Section 01010 – Summary of Work.

1.07 TEMPORARY LIGHTING AND POWER

A. The Contractor shall reference the General Conditions and Section 01510 – Temporary Utilities.

1.08 TESTS

A. Upon completion of the installation, the Contractor shall perform tests for operation, load (Phase) balance, overloads, and short circuits. Tests shall be made with and to the satisfaction of the Owner and Engineer.

B. The Contractor shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Contractor at no cost to the Owner. The Contractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

C. Refer to each individual specification section for detailed test requirements.

D. The Contractor shall complete the installation and field testing of the electrical installation at least two (2) weeks prior to the start-up and testing of any equipment served by that electrical equipment. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Contractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.

E. Before each test commences, the Contractor shall submit a detailed test procedure, and also provide test engineer resume, personnel, and scheduling information for the approval by the Engineer. In addition, the Contractor shall furnish detailed test procedures for any electrical equipment required as part of the field tests of other systems.

1.09 INFRARED INSPECTION

A. Just prior to the final acceptance of a piece of equipment, the Contractor shall perform an infrared inspection to locate and correct all heating problems associated with electrical equipment terminations. The infrared inspection shall be performed by a qualified, independent, third-party testing company, not the Electrical Contractor.

B. Equipment located in hazardous areas shall be excluded from infrared testing requirements since the equipment in those areas is not intended to be operated while the enclosure is open. The infrared inspection shall apply to all new equipment and existing equipment in non-hazardous areas that is in any way modified under this Contract. All heating problems detected with new equipment furnished and installed under the Scope of this Contract shall be corrected by the Contractor at no additional cost to the Owner. All problems detected with portions of existing equipment modified under this Contract shall also be corrected by the Contractor at no additional cost to the Owner.

C. Any issues detected with portions of existing equipment that were not modified under this Contract are not the responsibility of the Contractor. Despite the Contractor not being held responsible for these problems, the Contractor shall report them to the Owner and Engineer immediately for resolution.

D. The infrared inspection report shall include both digital photos and infrared (IR) photos positioned side by side. Both the digital and IR photos shall be clear and high quality. Fuzzy, grainy, or poorly illuminated photos are not acceptable. Each IR photo shall be provided with a temperature scale beside it, and an indication of the hot spot temperature in the photo. Reports shall be furnished in a 3-ring binder, with all pages printed in full color, with equipment assemblies separated by tabs.

1.10 PROTECTIVE DEVICE SETTING AND TESTING

A. The Contractor shall provide the services of a qualified, independent, third-party testing company using NETA certified technicians to adjust, set, calibrate, and test all protective devices in the electrical system. The company shall not be a subsidiary of the electrical equipment manufacturer. The qualifications of the testing company and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted.

B. All protective devices in the electrical equipment shall be set, adjusted, calibrated, and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.

C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity, and polarity tests of power, protective, and metering circuits. Any minor adjustments, repairs, and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.

D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers' recommended test devices and procedures.

E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device.

F. When completed, the Contractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults, and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Engineer.

G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing under simulated load conditions.

1.11 POWER SYSTEM STUDIES

A. The Engineer will provide the Power System studies to the firm providing the protective device setting and testing services. The Contractor shall submit to the Engineer a tabulated listing of all protective devices requiring setting at least three (3) weeks prior to the scheduled date for setting and testing of protective devices. This table shall include the protective device manufacturer, model number, ampere rating (if applicable), instrument transformer ratios, and all other required information.

1.12 SCHEDULES AND FACILITY OPERATIONS

A. Since the equipment testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules shall be submitted to the Engineer for review and approval one (1) month prior to any work beginning. When testing has been scheduled, the Engineer shall be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of facility equipment shall be coordinated with the Owner/Engineer so as not to affect proper facility operations.

B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a facility emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to Owner personnel.

C. In the event of accidental shutdown of Owner equipment, the Contractor shall notify Owner personnel immediately to allow for an orderly restart of affected equipment.

D. Maintaining the operation of these facilities during the duration of the construction period is essential and required. The Contractor shall furnish and install temporary equipment as required to maintain facility operation. Reference Section 01520 – Maintenance of Plant Operations During Construction for construction sequencing and specific operational constraint information.

1.13 EQUIPMENT, MATERIALS, AND SPARE PARTS HANDLING AND STORAGE

A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material will be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Engineer. If space heaters are provided in a piece of electrical equipment, they shall be temporarily

connected to a power source during storage. The Contractor shall store equipment and materials in accordance with Section 01550 – Site Access and Storage.

B. Spare parts lists, included with the shop drawing submittal for each Section, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Spare parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

D. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

1.14 WARRANTIES

A. Unless otherwise specified in an individual specification section, all electrical equipment and electrical construction materials shall be provided with a warranty in accordance with the requirements of Section 11000 – Equipment General Provisions and the General Conditions.

1.15 TRAINING

A. Unless otherwise specified in an individual specification section, all training for electrical equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions.

PART 2 – PRODUCTS

2.01 PRODUCT REQUIREMENTS

A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

C. All equipment and materials shall be new, unless indicated or specified otherwise.

D. The Contractor shall submit proof if requested by the Engineer that the materials, appliances, equipment, and/or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc. with regard to fire and casualty hazards. Documentation indicating Listing and Labeling by Underwriters Laboratories, Inc., will be accepted as meeting this requirement.

E. Where the above items are Labeled by (bearing the certification mark of) an OSHA Nationally Recognized Testing Laboratory (NRTL) other than UL, and the NRTL is authorized by the Occupational Safety and Health Administration (OSHA) to test and certify those items to the same standard(s), then the certification mark of that NRTL shall be considered equivalent to the 'UL' certification mark.

2.02 SUBSTITUTIONS

A. Unless specifically noted otherwise, any reference in the Specifications or on the Drawings to any article, service, product, material, fixture, or item of equipment by name, make, or catalog number shall be interpreted as establishing the type, function, and standard of quality and shall not be construed as limiting competition. The Contractor, in such cases may use any article, device, product, material, fixture, or item of equipment which in the judgment of the Engineer, expressed in writing, is equal to that specified.

2.03 CONCRETE

A. The Contractor shall furnish all concrete required for the installation of all electrical work. Concrete shall be Class A unless otherwise specified. Concrete and reinforcing steel shall meet the appropriate requirements of Division 3 of the Specifications.

B. The Contractor shall provide concrete equipment pads for all free-standing electrical apparatus and equipment located on new or existing floors or slabs. The Contractor shall provide all necessary anchor bolts, channel iron sills, and other materials as required. The exact location and dimensions shall be coordinated for each piece of equipment well in advance of the scheduled placing of these pads. Equipment pads shall be 4 inches high unless otherwise indicated on the Drawings and shall conform to the Standard Detail for equipment pads shown on the Drawings. Equipment pads shall not have more than 3 inches of excess concrete beyond the edges of the equipment.

2.04 RUBBER INSULATING MATTING

A. Rubber insulating matting shall be furnished and installed for each piece of electrical equipment that is located indoors and installed under this Contract. Rubber insulating matting shall not be installed outdoors. Matting shall be installed in the front of all

equipment and in the rear of equipment that is rear accessible. The mat shall be long enough to cover the full length of the equipment. The mat shall be ¼-inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The matting shall meet OSHA requirements and the requirements of ASTM D-178 for Type 2, Class 2 insulating matting. Matting shall be 36 inches wide, minimum. However, matting width shall be no less than the NEC working clearance for the equipment with which it is associated.

B. Matting shall be provided for the following equipment:

1. PLC/RTU Enclosures
2. Motor Control Centers
3. Switchgear Assemblies
4. Switchboard Assemblies
5. Variable Frequency Drives
6. Reduced Voltage Starters
7. Panelboards
8. Automatic Transfer Switches

PART 3 – EXECUTION

3.01 CUTTING AND PATCHING

A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling, and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Contractor shall perform all chasing, channeling, drilling, and patching necessary to the proper execution of this Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Contractor's expense. If, in the Engineer's judgment, the repair of damaged equipment would not be satisfactory, then the Contractor shall replace damaged equipment at the Contractor’s expense.

C. Existing Equipment

1. Provide a suitable cover or plug for openings created in existing equipment as the result of work under this Contract. For example, provide round plugs in equipment enclosures where the removal of a conduit creates a hole and the enclosure. Covers and plugs shall maintain the NEMA rating of the equipment enclosure. Covers and plugs shall be watertight when installed in equipment located outdoors.

3.02 EXCAVATION AND BACKFILLING

A. The Contractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

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SECTION 16111

CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install conduits, conduit fittings, and appurtenances to complete the installation of all electrically operated equipment as specified herein, indicated on the Drawings, and as required.

B. Reference Specification Section 16000 – Basic Electrical Requirements.

C. Requirements for conduit clamps, support systems, and anchoring are not included in this Section. Reference Specification Section 16190 – Hangers and Supports for Electrical Systems, for these requirements.

1.02 CODES AND STANDARDS

A. All equipment and materials shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Conduits, conduit fittings, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

   a. ANSI B1.20.1 – Pipe Threads, General Purpose.

   b. ANSI C80.1 – Electrical Rigid Steel Conduit.

   c. ANSI FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

2. National Electrical Contractors Association (NECA):

   a. NECA 1 – Standard for Good Workmanship in Electrical Construction.

3. National Electrical Manufacturer’s Association (NEMA):

   a. NEMA FB 2.40 – Installation Guidelines for Expansion and Expansion/Deflection Fittings.

   b. NEMA RN 1 – PVC Externally Coated Galvanized Rigid Steel Conduit.

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c. NEMA RV-3 – Application and Installation Guidelines for Flexible and Liquid-tight Flexible Metal and Nonmetallic Conduits.

d. NEMA TC-2 – Electrical PVC Conduit.

e. NEMA TC-3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

4. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

5. Underwriters Laboratories (UL):

a. UL 1 – Standard for Flexible Metal Conduit.

b. UL 6 – Electrical Rigid Metal Conduit-Steel.

c. UL 360 – Standard for Liquid-tight Flexible Metal Conduit.

d. UL 467 – Grounding and Bonding Equipment.

e. UL 514B – Conduit, Tubing, and Cable Fittings.

f. UL 651 – Standard for Schedule 40 and 80 Conduit and Fittings.

g. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

h. UL 1479 – Standard for Fire Tests of Penetration Fire Stops.

i. UL 1660 – Liquid-tight Flexible Nonmetallic Conduit.

6. Others:

a. American Concrete Institute (ACI): ACI 318-19 – Building Code Requirements for Structural Concrete.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for conduits and fittings.

2. Conduit identification methods and materials.

3. Evidence of training for all personnel that will install PVC coated rigid metal conduit.

1.05 DEFINITIONS

A. Conduits are categorized by the circuit type of the wiring to be installed inside. Conduits are defined as follows:

1. Power Conduits – Conduits that carry AC or DC power wiring from a source to a load. Conduits that carry lighting and receptacle wiring.

2. Control Conduits – Conduits that carry AC or DC discrete control wiring between devices and/or equipment. Also, conduits that carry fiber optic cables between devices and/or equipment.

3. Instrumentation Conduits – Conduits that carry AC or DC analog signal wiring between devices and/or equipment. Conduits that carry Category 5e or Category 6 unshielded twisted-pair cables.

B. Conduit categories are indicated on the Drawings by the leading letter of the conduit tag. Conduit tag leading letters are defined as follows:

1. P – Power Conduit

2. C – Control Conduit

3. I – Instrumentation Conduit

PART 2 – PRODUCTS

2.01 GENERAL

A. Conduit and conduit fitting products are specified in the text that follows this article. Reference Part 3 herein for the application, uses, and installation requirements of these conduits and conduit fittings.

B. All metallic conduit fittings shall be UL 514B and UL 467 Listed and constructed in accordance with ANSI FB 1. All metallic conduit fittings for use in Class I, Division 1 hazardous areas shall be UL 1203 Listed. All non-metallic fittings shall be UL 651 Listed and constructed in accordance with NEMA TC-3.

C. Flexible conduit couplings for use in Class I, Division 1 hazardous areas shall have threaded stainless steel end fittings and a flexible braided core. Flexible braid shall be constructed of stainless steel where available in the conduit trade size required for the application. Where stainless steel braid is not available, the braid shall be provided with a PVC coating. No other braid types or materials are acceptable.

D. Where threading is specified herein for conduit fitting connections, the fittings shall be manufactured to accept conduit that is threaded to ANSI B1.20.1 requirements.

E. Conduit expansion fittings for all conduit materials of construction shall be capable of 4 inches of movement along the axis of the conduit for trade sizes 2 inches or less. Expansion fittings shall be capable of 8 inches of movement along the axis of the conduit for trade sizes greater than 2 inches.

F. Conduit deflection fittings for all conduit materials of construction shall be provided with a flexible neoprene outer jacket that permits up to ¾ inch of expansion/contraction along the axis of the conduit as well as up to ¾ inch of parallel misalignment between the conduit axes. Outer jacket shall be secured to the conduit hubs by stainless steel clamps.

G. Conduit seals shall either be Listed and Labeled for 40% fill, or conduit reducing fittings and a trade size larger conduit seal shall be provided to achieve 25% or less fill within the seal. Percentage fill calculation shall be based on the conductors to be installed. Conduit seals shall be provided with breathers and/or drains where required by the NEC.

H. Conduit insulating bushings shall be constructed of plastic and shall have internal threading.

I. Additional conduit and conduit fitting requirements are specified in the articles that follow based on the specific conduit material of construction to be used.

2.02 RIGID GALVANIZED STEEL (RGS) CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.

2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

B. Conduit Bodies for use with Rigid Galvanized Steel

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit bodies shall have integral threaded conduit hubs.

2. Conduit bodies for Class I, Division 1 hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

3. Conduit bodies for all other areas shall be provided with covers that are affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Covers shall be provided with matching gasket.

C. Conduit Couplings, Nipples, and Unions for use with Rigid Galvanized Steel

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish.

D. Conduit Expansion and Deflection Fittings for use with Rigid Galvanized Steel

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy. Expansion and deflection fittings shall have threaded conduit connections.

2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

E. Conduit Seals for use with Rigid Galvanized Steel

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated with an acrylic paint finish. Conduit seals shall have threaded conduit connections.

F. Conduit Termination Fittings for use with Rigid Galvanized Steel

1. Conduit hubs shall be constructed of stainless steel and shall have threaded connections to the conduit and enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.

2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts with integral gasket or seal are not acceptable. Locknuts shall have integral bonding screw where required for proper bonding.

3. Conduit bonding bushings shall be constructed of zinc plated malleable iron. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.03 RIGID NONMETALLIC CONDUIT AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be Schedule 40 or 80 (dependent on application) polyvinyl chloride (PVC) construction, manufactured in accordance with NEMA TC-2, UL 651 Listed, and suitable for conductors with 90 degree C insulation.

B. Conduit Bodies for use with Rigid Nonmetallic Conduit

1. Conduit bodies shall be constructed of PVC. Conduit hubs shall be integral to the conduit body and shall be smooth inside to accept a glued conduit connection.

2. Conduit body shall be provided with cover that is affixed in place by stainless steel screws which thread directly into the conduit body. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

C. Conduit Couplings and Unions for use with Rigid Nonmetallic Conduit

1. Conduit couplings and unions shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

D. Conduit Expansion and Deflection Fittings for use with Rigid Nonmetallic Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection.

E. Conduit Termination Fittings for use with Rigid Nonmetallic Conduit

1. Conduit hubs shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. Hubs shall have external threads and an accompanying PVC locknut, and shall be watertight when assembled to an enclosure.

2. Conduit locknuts shall be constructed of zinc plated steel. Locknuts shall have internal threading. Locknuts constructed of PVC and locknuts with integral gasket or seal are not acceptable.

3. Conduit end bells shall be constructed of PVC and shall be smooth inside to accept a glued conduit connection. End bell shall have a smooth inner surface that curves outward towards the edge of the fitting.

2.04 PVC COATED RIGID GALVANIZED STEEL CONDUIT AND ASSOCIATED FITTINGS

A. General

1. Where an external coating of polyvinyl chloride (PVC) is specified for conduit and fittings, the coating shall be 40 mil (minimum) thickness. Where an internal coating of urethane is specified for conduit and fittings, the coating shall be 2 mil (minimum) thickness.

2. All conduit fittings shall have a sealing sleeve constructed of PVC which covers all connections to conduit. Sleeves shall be appropriately sized so that no conduit threads will be exposed after assembly.

B. Conduit

1. Conduit shall be hot dip galvanized on the inside and outside and made of heavy wall high strength ductile steel. Conduit shall be manufactured in accordance with ANSI C80.1 and shall be UL 6 Listed.

2. Conduit shall be provided with factory-cut 3/4 inch per foot tapered threads at each end in accordance with ANSI B1.20.1. Threads shall be cut prior to galvanizing to ensure corrosion protection adequately protects the threads. Conduit shall be provided with a matching coupling on one end and a color-coded thread protector on the other.

3. Conduit shall be coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit shall be manufactured in accordance with NEMA RN 1.

C. Conduit Bodies for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit bodies shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit bodies shall have integral threaded conduit hubs.

2. Conduit bodies for Class I, Division 1 hazardous areas shall be provided with integrally threaded covers constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

3. Conduit bodies for all other areas shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Covers shall be affixed in place by stainless steel screws which thread directly into the conduit body and have a plastic encapsulated head. Covers that utilize wedge nuts or any other method of attachment to the conduit body are not acceptable. Covers shall be provided with matching gasket.

D. Conduit Couplings, Nipples, and Unions for use with PVC Coated Rigid Galvanized Steel Conduit

1. Couplings and nipples shall be threaded and shall be constructed of hot dipped galvanized steel which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Split-type couplings that use compression to connect conduits are not acceptable.

2. Unions shall be threaded, rain-tight, and constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane.

E. Conduit Expansion and Deflection Fittings for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit expansion fittings and conduit deflection fittings shall be constructed of bronze or an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Expansion and deflection fittings shall have threaded conduit connections.

2. Expansion fittings shall have an integral bonding jumper and deflection fittings shall have an external bonding jumper.

F. Conduit Seals for use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit seals shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Conduit seals shall have threaded conduit connections.

G. Conduit Termination Fittings for Use with PVC Coated Rigid Galvanized Steel Conduit

1. Conduit hubs shall be constructed of an electro-galvanized malleable iron alloy which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Hubs shall have threaded connections to the conduit and

enclosure. Hubs shall have a plastic insulated throat and shall be watertight when assembled to an enclosure.

2. Conduit bonding bushings shall be constructed of zinc plated malleable iron which is coated on the exterior with a PVC jacket and coated on the interior with a layer of urethane. Bonding bushings shall have a threaded conduit connection. Bonding bushing shall be provided with properly sized set screw for connecting bonding conductor and an integral plastic insulator rated for 150 degrees C located in the throat.

2.05 LIQUID TIGHT FLEXIBLE METAL CONDUIT (LFMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Trade size 1-1/4 inch and smaller conduits shall be provided with an integrally woven copper bonding strip.

2. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 360 Listed. Conduits shall be Listed for and marked with maximum temperature ratings as follows:

a. 105 degrees C dry, 60 degrees C wet for all conduit installed against or within 2 inches of equipment capable of having a surface temperature of 80 degrees C or greater (e.g., blowers, incinerators, etc.)

b. 80 degrees C dry, 60 degrees C wet for all other locations

B. Conduit Termination Fittings for use with LFMC

1. Conduit termination fittings shall be constructed of either 304 stainless steel or an electro-galvanized malleable iron alloy which is coated on the exterior with a 40 mil (minimum) PVC jacket and coated on the interior with a 2 mil (minimum) layer of urethane. PVC coated fittings shall have a sealing sleeve constructed of PVC which covers the connection to conduit.

2. Termination fittings shall have a threaded end with matching locknut and sealing ring for termination to equipment and shall have an integral external bonding lug where required for proper bonding. Termination fittings shall have a plastic insulated throat and shall be watertight when assembled to the conduit and equipment.

2.06 LIQUID TIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be constructed of rigid polyvinyl chloride (PVC), fabricated to provide flexibility. Conduit shall be covered with an outside PVC jacket that is UV resistant, moisture-proof, and oil-proof. Conduit shall be UL 1660 Listed and be Type LFNC-B.

B. Conduit Termination Fittings for use with LFNC

1. Conduit termination fittings shall be constructed PVC and shall have a threaded end with matching locknut and sealing ring for termination to equipment. Termination fittings shall be watertight when assembled to the conduit and equipment.

2.07 FLEXIBLE METAL CONDUIT (FMC) AND ASSOCIATED FITTINGS

A. Conduit

1. Conduit shall be manufactured using a single strip of hot dip galvanized high strength steel alloy, helically formed into a continuously interlocked flexible metal conduit. Conduit shall be UL 1 Listed.

B. Conduit Termination Fittings for use with FMC

1. Conduit termination fittings shall be constructed of an electro-galvanized malleable iron alloy. Fittings shall have a threaded end with matching locknut for termination to equipment, and a compression-style connection to the associated conduit.

2.08 CONDUIT BENDS

A. Rigid conduit bends, both factory-fabricated and field-fabricated, shall meet the same requirements listed in the articles above for the respective conduit type and material of construction.

B. Conduit bend radii for standard radius bends shall be no less than as follows:

Trade Size (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
Min. Radius (inches)	4-1/2	5-3/4	7-1/4	8-1/4	9-1/2	10-1/2	13	15	16	24	30

C. Conduit bend radii for long radius bends shall be no less than as follows:

Trade Size (inches)	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4	5	6
Min. Radius (inches)	N/A	12	18	24	30	30	36	36	48	48	60

2.09 MISCELLANEOUS

A. Conduit Periphery Sealing

1. The sealing of the exterior surface of conduits to prevent water and/or air from passing around the conduit periphery from one space to another (where required) shall be through the use of one of the following:

a. A conduit sleeve and pressure bushing sealing system. Acceptable products are FSK by OZ-GEDNEY, Link-Seal by Crouse-Hinds, or Engineer approved equal.

b. A conduit sleeve that is two trade sizes larger than the conduit being sealed, with 2-hour fire rated UL 1479 Listed caulk filling the entire void between the conduit and sleeve. This method is only suitable for penetrations in non-fire rated walls and floors between spaces within buildings. This method shall not be used for the sealing of conduits leaving a building and/or structure.

2. Conduit penetrations through fire-rated walls and floors shall be made with an approved UL 1479 Listed product specifically intended for the trade size of the conduit.

B. Primer and Cement

1. Nonmetallic conduit shall be cleaned with primer and connected to fittings with the manufacturer’s recommended cement that is labeled Low VOC.

C. Galvanizing Compounds

1. Galvanizing compounds for field application shall be the cold-applied type, containing no less than 93% pure zinc.

D. Conduit Interior Sealing

1. For all conduits that have cables inside, the sealing of the inside of the conduits against water ingress shall be achieved through the use of one of the following:

a. Two-part expanding polyurethane foam sealing compound, dispensed from a single tube which mixes the two parts as it is injected into the conduit. Expanding foam shall be compatible with the conduit material of construction as well as the outer jacket of the cables in the conduit. Acceptable products are Q-Pak 2000 by Chemque, FST by American Polywater Corporation, or Hydra-seal S-60 by Duraline.

b. Inflatable bag that provides seal around cables and around inside diameter of conduit. Provide appropriate quantity of additional fittings for applications with three or more cables in the conduit to be sealed. Acceptable products

are Rayflate by Raychem, or Engineer approved equal. This sealing method is only applicable to conduits trade size 2 inch and larger.

c. Neoprene sealing ring provided with the required quantity and diameter of holes to accommodate the cables in each conduit. Sealing ring shall be compressed by two stainless steel pressure plates. Acceptable products are type CSB by OZ-GEDNEY, or Engineer approved equal. This sealing method is only applicable to metallic conduits containing 4 or less cables.

2. The use of aerosol-based expanding foam sealants or any other method of sealing against water ingress not listed above is not acceptable.

3. For conduits identified as spares, the sealing of the inside of the conduit against water ingress shall be achieved by using appropriately sized rubber expanding-style conduit plugs. Plugs that are held in place only by friction are not acceptable.

E. Pull Rope

1. Pull ropes for empty and/or spare conduits shall be woven polyester, ½-inch wide, with a minimum tensile strength of 1250 lbs.

2. Pull ropes for the Contractors use in installing conductors shall be the size and strength required for the pull and shall be made of a non-metallic material.

PART 3 – EXECUTION

3.01 GENERAL

A. All conduit and associated fittings and appurtenances shall be installed in accordance with NECA 1.

B. Minimum trade size for all rigid conduits shall be 3/4 inch in exposed applications and 1 inch in embedded applications. Conduits installed within ductbanks shall be allowed to be increased in size to trade size 2 inch, at the Contractor's option, to accommodate the saddle size of the ductbank spacers. However, no combining of circuits shall be allowed in the larger conduits.

C. Minimum trade size for flexible conduits (where specifically allowed herein) shall be 1/2 inch in all applications.

D. Conduit routing and/or homeruns within structures is not shown on the Drawings. Conduits shall be installed concealed wherever practical and within the limitations specified herein. All other conduits not capable of being installed concealed shall be installed exposed.

E. Empty and/or spare conduits shall be provided with pull ropes which have no less than 12 inches of slack at each end.

F. Nonmetallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, cleaned of debris, and primer shall be applied to ready each joint for fusing. Conduits shall then be fused together with the conduit manufacturer's approved cement compound.

G. Metallic conduits for installations requiring less than a factory length of conduit shall be field cut to the required length. The cut shall be made square, be cleaned of all debris and be de-burred, then threaded. Conduit threading performed in the field shall be ¾ inch per foot tapered threads in accordance with ANSI B1.20.1.

H. Conduits shall be protected from moisture, corrosion, and physical damage during construction. Install dust-tight and water-tight conduit fittings on the ends of all conduits immediately after installation and do not remove until conductors are installed.

I. Conduits shall be installed to provide no less than 12 inches clearance from pipes that have the potential to impart heat upon the conduit. Such pipes include, but are not limited to, hot water pipes, steam pipes, exhaust pipes, and blower air pipes. Clearance shall be maintained whether conduit is installed in parallel or in crossing of pipes.

J. Where non-metallic instrumentation conduits are installed exposed, the following clearances to other conduit types shall be maintained:

    1. Instrumentation conduits installed parallel to conduits with conductors energized at 480V or above shall be 18 inches.

    2. Instrumentation conduits installed parallel to conduits with conductors energized at 240V and below shall be 12 inches.

    3. Instrumentation conduits installed at right angles to conductors energized at 480V and below shall be 6 inches.

    4. Instrumentation conduits installed at right angles to conductors energized at voltages above 480V shall be 12 inches.

K. Where conduit fittings do not include an integral insulated bushing, an insulated bushing shall be installed at all conduit termination points.

L. Conduits which serve multi-section equipment shall be terminated in the section where wiring terminations will be made.

M. Conduits shall not penetrate the floors or walls inside liquid containment areas without specific written authorization from the Engineer. Liquid containment areas are indicated on the Drawings.

N. Conduits that terminate at roof mounted equipment shall be installed through the roof curb for the associated equipment to avoid additional roof penetrations wherever possible. Conduits that are installed horizontally on roof surfaces shall be supported by roof blocks that do not impact the roof manufacturer's warranty and shall be installed at least 7/8 inch above the roof surface to avoid the need to further de-rate the conductors inside.

O. In no case shall conduit be supported or fastened to another pipe or be installed in a manner that would prevent the removal of other pipes for repairs.

P. All field fabricated threads for rigid galvanized steel conduit shall be thoroughly coated with two coats of galvanizing compound, allowing at least two minutes to elapse between coats for proper drying.

Q. The appropriate specialized tools shall be used for the installation of PVC coated conduit and conduit fittings. No damage to the PVC coating shall occur during installation. Conduit and conduit fittings with damaged PVC coating shall be replaced at the Contractor's cost. The use of PVC coating touch-up compounds is not permitted.

R. Conduits which emerge from within or below concrete encasement shall be PVC coated rigid galvanized steel in accordance with Standard Detail 1611102 where the conduit is not protected by an equipment enclosure that surrounds the conduit on all sides at the point where it emerges from the encasement.

3.02 CONCEALED AND EMBEDDED CONDUITS

A. Conduits are permitted to be installed concealed and/or embedded with the following requirements:

1. Conduits shall not be installed horizontally when concealed within CMU walls, only vertical installation is acceptable.

2. Conduits installed embedded within concrete floors or walls shall be located so as not to affect the designed structural strength of the floor or wall. Embedded conduits shall be installed in accordance with Standard Detail S-03-0403 and ACI-318.

3. Where conduit bends emerge from concrete embedment, none of the curved portion of the bend shall be visible. Only the straight portion of the bend shall be visible. The straight portion shall emerge perpendicular to the embedment (i.e., neatly oriented 90-degrees to floor/slab/grade). Conduits that emerge in a non-perpendicular orientation are not acceptable.

4. Where multiple conduits emerge from concrete embedment or from concealment below a concrete floor, ample clear space shall be provided between conduits to allow for the appropriate and required conduit termination fittings to be installed.

5. Conduits installed embedded within concrete encasement of any kind shall be installed such that conduit couplings for parallel conduits are staggered so that they are not side by side.

B. Conduits are NOT permitted to be installed concealed and/or embedded for the following situations:

1. Conduits shall not be installed embedded within any water-bearing floors or walls. Conduits shall not be installed embedded within any liquid containment area floors or walls.

2. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to Class I and II hazardous areas (Division 1 and Division 2).

3. Conduits shall not be installed concealed within CMU walls or gypsum walls that are adjacent to indoor Type 1 or Type 2 chemical storage/transfer areas.

3.03 CONDUIT USES AND APPLICATIONS

A. Rigid Conduit

1. Rigid conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

Rigid Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	**Instrumentation**
Exposed in indoor wet process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in indoor Type 1 chemical storage/transfer areas	Schedule 80 rigid non-metallic PVC conduit	Same as Power and Control
Exposed in indoor Type 2 chemical storage/transfer areas	Rigid galvanized steel conduit	Same as Power and Control
Exposed in outdoor areas	PVC coated rigid galvanized steel conduit	Same as Power and Control

Rigid Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	**Instrumentation**
Concealed within underground direct-bury or concrete-encased ductbanks	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within non-elevated (i.e., "slab-on-grade" construction) concrete slabs	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within elevated concrete slabs	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material)	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within concrete walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Concealed within CMU walls	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit
Emerging from concealment within or below a concrete floor and transitioning to exposed conduit (Reference Detail 1611102)	PVC coated rigid galvanized steel conduit	Same as Power and Control

2. Rigid conduit for hazardous areas shall be furnished and installed in the materials of construction as follows:

Rigid Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	**Instrumentation**
Exposed in Class I and II areas (Division 1 and Division 2)	Rigid Galvanized Steel Conduit	Same as Power and Control
Concealed within concrete slabs in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs (within earth or fill material) in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control

Rigid Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	**Instrumentation**
Concealed within concrete walls in Class I and II areas (Division 1 and Division 2)	Rigid galvanized steel conduit	Same as Power and Control
Concealed below concrete slabs encased in at least two inches of concrete and buried 24 inches below top of slab in Class I, Division 1 areas	Schedule 40 rigid non-metallic PVC conduit	Rigid galvanized steel conduit

3. The tables for the materials of construction for rigid conduits are intended to exhaustively cover all possible scenarios and installation areas under this Contract. However, if a scenario or installation area is found that is not explicitly governed by these tables, it shall be assumed for bid purposes that the conduit material of construction is to be rigid galvanized steel. This discrepancy shall be brought to the attention of the Engineer (in writing) immediately for resolution.

B. Conduit Bends

1. All conduit bends shall be the same material of construction as the rigid conduit listed in the tables above, with the following exceptions:

   a. All 90-degree bends or combinations of adjacent bends that form a 90-degree bend where concealed within concrete or below a concrete slab shall be rigid galvanized steel.

2. Field fabricated bends of metallic conduit shall be made with a bending machine and shall have no kinks. Field fabricated standard radius and long radius bends shall have minimum bending radii in accordance with the associated tables in Part 2 herein.

3. Field bending of non-metallic conduits is not acceptable, factory fabricated bends shall be used.

4. Long radius bends shall be furnished and installed for the following specific applications, all other bends shall be standard radius:

   a. All conduits containing medium voltage cable.

   b. All conduits containing fiber optic cable.

   c. Where specifically indicated on the Drawings.

C. Flexible Conduit

1. Flexible conduit shall only be installed for the limited applications specified herein. Flexible conduit shall not be installed in any other application without written authorization from the Engineer. Acceptable applications are as follows:

   a. Connections to motors and engine-generator sets (and similar vibrating equipment)

   b. Connections to solenoid valves and limit switches

   c. Connections to lighting fixtures installed in suspended ceilings

   d. Connections to lighting transformers and combination power units

   e. Connections to pre-fabricated equipment skids

   f. Connections to HVAC equipment

   g. Connections to instrument transmitters and elements

   h. Where specifically indicated in the Standard Details

2. Flexible conduit length shall be limited to three (3) feet, maximum. Flexible conduit shall not be installed buried or embedded within any material.

3. Unless otherwise specified herein, flexible conduits shall be installed in accordance with the Installation Guidelines published within NEMA RV-3.

4. Flexible conduit for non-hazardous areas shall be furnished and installed in the materials of construction as follows:

Flexible Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	**Instrumentation**
Exposed in indoor wet process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry process areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in indoor dry non-process areas	Flexible metal conduit	Same as Power and Control

Flexible Conduit for Non-Hazardous Areas

Installation Area Designation / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in indoor Type 1 chemical storage/transfer areas	Liquid-tight flexible non-metallic conduit	Same as Power and Control
Exposed in indoor Type 2 chemical storage/transfer areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in outdoor areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings (all indoor areas)	Same material as exposed conduit in same area	Same as Power and Control

5. For Class I, Division 1 hazardous areas, the NEC does not permit the installation of flexible conduit. In lieu of flexible conduit in these areas, flexible conduit couplings shall be installed as specified in Part 2 herein. Flexible conduit for all other hazardous areas shall be furnished and installed in the materials of construction as follows:

Flexible Conduit for Hazardous Areas

Installation Area Hazard / Scenario	Conduit Category by Wiring / Circuit Type	
	Power and Control	Instrumentation
Exposed in Class I, Division 2 areas	Liquid-tight flexible metal conduit	Same as Power and Control
Exposed in Class II (Division 1 and Division 2) areas	Liquid-tight flexible metal conduit	Same as Power and Control
Concealed above suspended ceilings in Class I (Division 2) and Class II (Division 1 and Division 2) areas	Same material as exposed conduit in same area	Same as Power and Control

3.04 CONDUIT FITTING USES AND APPLICATIONS

A. General

1. Conduit fittings shall be furnished and installed in the materials of construction as indicated in Part 2, herein. Conduit fitting materials of construction are dependent on the material of construction used for the associated conduit.

2. Conduit fittings shall be provided in the trade size and configuration required to suit the application.

B. Conduit Bodies

1. Conduit bodies shall be installed where wire pulling points are desired or required, or where changes in conduit direction or breaking around beams is required.

2. Where conduit bodies larger than trade size 2 inches are intended to be used as a pull-through fitting during wire installation, oversized or elongated conduit bodies shall be used. Oversized or elongated conduit bodies shall not be required if the conduit body is intended to be used as a pull-out point during wire installation.

C. Conduit Nipples and Unions

1. Conduits with running threads shall not be used in place of 3-piece couplings (unions) or close nipples. After installation of a conduit fitting of any kind, there shall be no more than ¼ inch of exposed threads visible. Factory fabricated all-thread nipples may be used between adjacent enclosures, however, the same restriction applies regarding the length of exposed threads that are visible.

D. Conduit Expansion and Deflection Fittings

1. Conduit expansion fittings shall be installed where required by the NEC and where indicated on the Drawings. Expansion fittings shall also be installed for exposed straight metallic conduit runs of more than 75 feet, in both indoor and outdoor locations. Expansion fittings for runs of non-metallic conduit shall be installed in accordance with the NEC.

2. Conduit deflection fittings shall be installed where required by the NEC and where conduits are installed (exposed and concealed) across structural expansion joints.

3. Unless otherwise specified herein, conduit expansion and deflection fittings shall be installed in accordance with the Installation Guidelines published within NEMA FB 2.40.

E. Conduit Seals

1. Conduit seals shall be installed for conduits installed within or associated with hazardous areas and other areas as required by the NEC.

F. Conduit Termination Fittings

1. Where conduits terminate at enclosures with a NEMA 4, 4X, or 3R rating and the enclosure does not have integral conduit hubs, an appropriately sized watertight conduit hub shall be installed to maintain the integrity of the enclosure. The use of locknuts with integral gasket in lieu of watertight conduit hubs is not acceptable.

2. Where conduits terminate at enclosures that do not require conduit hubs, a two-locknut system shall be used to secure the conduit to the enclosure. One locknut shall be installed on the outside of the enclosure, and the other inside, drawn tight against the enclosure wall. The locknut on the interior of the enclosure shall be the type with integral bonding lug, or a conduit bonding bushing may be used in place of the interior locknut.

3. Conduits shall not be installed such that conduit fittings penetrate the top of any enclosure located outdoors, except in cases where specifically required by the serving electric utility. Conduits which serve outdoor equipment or an enclosure from above shall instead be routed into the side of the enclosure at the bottom. The conduit termination fitting shall be provided with a conduit drain to divert moisture from the raceway away from the enclosure.

3.05 MISCELLANEOUS

A. Conduit Periphery Sealing

1. All conduit penetrations through exterior walls shall be sealed around the periphery using the appropriate products specified in Part 2 herein to prevent air and/or water entry into the structure.

2. All conduit penetrations through interior walls and floors shall be sealed through the use of conduit sleeves and caulk as specified in Part 2 herein. Alternatively, mortar may be used to seal around the conduit periphery.

3. Conduit penetrations through fire-rated walls as floors shall be made with the appropriate fire rated penetration product.

B. Conduit Interior Sealing

1. All conduits (including spares) entering a structure below grade shall be sealed on the interior of the conduit against water ingress. Sealing shall be at an accessible location in the conduit system located within the building structure and shall be via one of the methods specified in Part 2 herein. If conduit sealing cannot be achieved at an accessible location within the building structure, sealing shall be placed in the conduits in the nearest manhole or handhole outside the structure.

2. Conduit interior sealing shall not be installed until conductors inside are tested and test results are deemed acceptable by the Engineer. Conduit interior sealing shall be installed prior to energization of the conductors inside.

3.06 CONDUIT IDENTIFICATION

A. Exposed conduits shall be identified at the source, load, and all intermediate components of the raceway system. Examples of intermediate components include but are not limited to junction boxes, pull boxes, and disconnect switches. Identification shall be by means of an adhesive label with the following requirements:

1. Labels shall consist of an orange background with black text. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.

2. In addition, at the source end of the conduit, a second line of text shall be included to indicate the load equipment name. This second line shall consist of the word “TO:” and the text in the ‘TO’ column of the conduit and wire schedule (e.g., TO: RTU 1). At the load end of the conduit, a second line of text shall be included to indicate the source equipment name. This second line shall consist of the word “FROM:” and the text in the ‘FROM’ column of the conduit and wire schedule (e.g., FROM: RTU-3). This requirement applies only to the source and load ends of the conduit, and not anywhere in between.

3. For conduits trade sizes 3/4 inch through 1-1/2 inch, the text shall be a minimum 18-point font. For conduits trade size 2 inch and larger, the text shall be a minimum 24-point font.

4. Label height shall be 3/4 inch minimum, and length shall be as required to fit required text. The label shall be installed such that the text is parallel with the axis of the conduit. The label shall be oriented such that the text can be read without the use of any special tools or removal of equipment.

5. Labels shall be installed after each conduit is installed and, if applicable, after painting. Labels shall be printed in the field via the use of a portable label printing system using thermal transfer technology. Handwritten labels are not acceptable.

6. Labels shall be made of permanent vinyl with adhesive backing. Labels made of any other material are not acceptable.

B. Conduits that are not exposed but installed beneath free standing equipment enclosures shall be identified by means of a plastic tag with the following requirements:

1. The tag shall be made of white Tyvek material, and have an orange label with black text, as described above, adhered to it. Text for the label shall be the conduit number as indicated in the conduit and wire schedules.

2. The tag shall be affixed to the conduit by means of a nylon cable tie. The tag shall be of suitable dimensions to achieve a minimum text size of 18 points.

C. Conduits for lighting and receptacle circuits shall not require identification.

D. Any problems or conflicts with meeting the requirements above shall immediately be brought to the attention of the Engineer for a decision.

3.07 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. All conduit installed below grade or concrete encased shall be tested to ensure continuity and the absence of obstructions by pulling through each conduit a swab followed by a mandrel 85% of the conduit inside diameter. After testing, all conduits shall be capped after installation of a suitable pulling rope.

3.08 TRAINING OF INSTALLATION PERSONNEL

A. All Contractor personnel that install PVC coated RGS conduit shall be trained by the PVC coated RGS conduit manufacturer. Training shall include proper conduit system assembly techniques, use of tools appropriate for coated conduit systems, and field bending/cutting/threading of coated conduit. Training shall have been completed within the past 24 months prior to the Notice to Proceed on this Contract to be considered valid. Contractor personnel not trained within this timeframe shall not be allowed to install coated conduit or shall be trained/re-trained as required prior to commencement of conduit installation.

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SECTION 16114

CABLE TRAYS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Under this Section, the Contractor shall furnish and install all cable tray systems as specified herein and as indicated on the Drawings.

B. The Drawings indicate the general location of the trays, however, the Contractor shall install these trays in such a manner to avoid all interferences.

C. The cable tray systems shall be manufactured and installed in accordance with the following:

1. National Electrical Code (NEC), Article 392 - Cable Trays

2. National Electrical Manufacturers Association (NEMA) Standard VE-1 - Metallic Cable Tray Systems

3. National Electrical Manufacturers Association (NEMA) Standard VE-2 – Cable Tray Installation Guidelines

4. UL 467 – Grounding and Bonding Equipment

D. The cable tray systems shall be listed and labeled by U.L. as suitable for the purpose.

E. Reference Section 16000, Basic Electrical Requirements and Section 16190 Supporting Devices

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

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1. Equipment specifications and product data sheets for trays, fittings, supports, and other components identifying all materials used and methods of fabrication.

2. Layout drawings showing plan and isometric views of each tray system. Drawings shall indicate tray dimensions, support points, and other pertinent layout information. Drawings shall also include details for penetrations through fire rated walls, non-fire rated walls and bldg. exterior walls. Penetration details shall include the applicable UL design designation.

3. Manufacturer's instructions indicating application conditions and limitations of use stipulated by the specified testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of the tray systems.

4. Manufacturer's warranty statement.

1.04 SYSTEM DESCRIPTION

A. Cable tray systems shall include straight trays, fittings, covers, splice plates, barrier strips, and related accessory and support items.

B. Performance requirements for power and control circuit tray systems shall be as follows:

1. Concentrated load supporting capacity shall be a minimum of 200 pound concentrated load applied to the middle 6 inches without permanent deformation.

1. Uniform load supporting capacity shall be 50 pounds per linear foot when supported at minimum 20 feet on center with a safety factor of 1.5.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable manufacturers whose products have been in satisfactory use in similar service for not less than 5 years. Material shall be fabricated, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

B Metallic cable tray systems shall be as manufactured by Eaton’s B-Line, Square D Company, or Engineer approved equal.

2.02 MATERIALS

A. The metallic cable tray systems shall be aluminum, alloy 6063-T6 with natural finish.

2.03 COMPONENTS

A. Barrier strips shall be full depth capable of separating cables in tray as required by NEC.

B. Fittings shall be horizontal and vertical elbows, tees, and cross fittings with minimum radii equal to cable bending radii as recommended by cable manufacturer. Molded fittings shall be formed with a minimum 3” tangent portion following the radius.

C. Furnish and install accessories such as dropouts, end plates, splice plates and mounting supports, clamps and other devices required for a complete installation.

D. Tray bolts, nuts, washers, and fasteners shall be Type 304 or 316 stainless steel.

E. Grounding conductor, to be furnished and installed to the outside tray bottom flange, shall be No. 2/0 bare copper, minimum.

F. Fault rated cable cleats shall be provided to hold cables in place under maximum fault current conditions. Cable cleats shall be provided by the cable tray manufacturer. The use of plastic “zip ties” or any other method of holding cables in place is not acceptable.

G. Conduit to cable tray clamps shall be UL 467 Listed.

2.04 TRAY TYPES

A. Cable trays shall be NEMA Class 20A, ladder type with:

1. Double or box type rungs, free of sharp edges and corners, at minimum 9 inches on center as required to provide adequate cable bearing surface.

2. Sides of minimum 5-3/8 inch interior cable loading depth for metallic trays. "Z" shaped sides of minimum 4 inch interior cable loading depth for fiberglass tray.

3. Widths as indicated on the approved shop drawings.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Install the cable tray systems in accordance with NEMA Standards VE-2, the National Electrical Code (NEC), NFPA 70B, and the manufacturer's instructions.

B. Support the tray systems as required by NEMA VE-2. Cantilever tray systems from walls or, when conditions dictate, suspend trays from ceiling or structure. Space support brackets at least once per straight section. Provide tray supports with channels under entire width of tray. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions. Submit proposed support system to Engineer for review.

C. Install cable tray 2 inches from wall surfaces, and with a minimum of 18 inches between the ceiling and tray bottom and between tray bottoms vertically to provide no less than 12" of space to access cables from the sides of the cable tray. Where multiple trays are installed parallel to each other and at the same elevation, working space shall be provided between the cable trays to provide access to the cables.

D. Secure tray to supports with fittings approved for the purpose in accordance with tray manufacturer. Do not weld trays to supports. Where aluminum trays are supported on steel supports, separate and isolate aluminum and steel in accordance with Section 16190 - Supporting Devices. Provide seismic supports as required, reference Section 01350.

E. Install expansion joints at a minimum of every 50 feet on straight runs and as recommended by tray manufacturer. Expansion joints shall also be provided concurrent with building / structure expansion joints.

F. Securely bond a grounding conductor with lugs to the outside of tray bottom flange for metallic trays. Run grounding conductor continuously for the full length of tray system. Attach grounding conductor to the facility grounding system. Verify continuity of the bond by a resistance test.

G. Group cables in trays by circuit type. Lash grouped cables with lashing ties at approximately 36 inches on center for vertical runs and at approximately 10 feet on center for horizontal runs. Put sharp ends of lashing ties under cable tray runs or where ties will not damage the cable jacket or insulation. Label the cable groups to identify the circuit or cable group by plan designation.

H. Install tray covers in exterior locations, under stairs and gratings, and where indicated on the Drawings. Cable tray in exposed outdoor locations shall have "peaked" covers to shed water.

I. Cable trays installed where subject to foot traffic, shall be provided with suitable heavy duty covers to prevent damage to the cable.

J. Cable Trays shall be installed parallel to or at right angles to ceilings, walls and structural members.

K. Cable Trays shall not penetrate fire rated walls. Where it is necessary for cables to extend through a fire rated wall, the cable tray shall stop 10" from each side of the wall and steel conduit nipples with bushings shall be installed through the wall and sealed according to the appropriate UL design detail. The required grounding conductor shall be extended through the wall to bond both cable tray sections together.

L. Cable trays shall not penetrate exterior walls, or walls separating different environments, such as an air conditioned space verses a non-air conditioned space. Where it is necessary for cables to extend through such a wall, the cable tray shall stop 10" from each side of the wall and steel conduit nipples with bushings shall be installed through the wall and sealed to prevent air movement from one space to another. The required grounding conductor shall be extended through the wall to bond both cable tray sections together.

M. Cable tray shall not penetrate walls separating areas of different hazard classifications.

N. Cables shall not be spliced within cable tray. Unless otherwise shown on the drawings, tray rated cables shall be continuous from source or origin to the respective load or end device.

O. Conduits carrying cables entering or leaving the cable tray shall utilize fittings that are UL listed for the purpose and securely attached to the cable tray.

P. Cable trays shall not be installed above suspended or lay-in type ceilings unless approved by the engineer.

Q. The cable tray mechanically continuous and shall provide continuous support of the cables contained within it from origin to destination or conduit to cable tray adapter.

R. Lighting or receptacle circuitry shall not be installed in cable tray. Circuitry associated with heating, ventilation or air conditioning equipment shall not be installed in cable tray.

S. Separate cable trays shall be provided for power and control cables. Discreet and analog control cables may share a common cable tray, but shall be separated with a metallic barrier strip securely attached to the cable tray rungs. For fiberglass or FRP cable trays, the barrier strip shall be fiberglass or FRP.

3.02 WARNING LABELS

A. Furnish and install warning labels with black letters on a yellow background which reads as follows:

WARNING! DO NOT USE CABLE TRAY AS A WALKWAY, LADDER, OR SUPPORT. USE ONLY AS A MECHANICAL SUPPORT FOR CABLES!

B. Install warning labels at 10 feet intervals along the length of the tray system, located to be visible.

- END OF SECTION -

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SECTION 16118
UNDERGROUND ELECTRICAL

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install underground duct systems, electric manholes, and electric handholes as specified herein and as indicated on the Drawings. The work shall be complete and shall include excavation, concrete construction, backfilling, and all materials, items, and components required for a complete system.

B. The provisions of this Section are applicable to all underground conduit work. All work shall be coordinated with that of the various utility companies and other Contractors. The Contractor shall adhere to all utility company requirements including the serving electric utility.

C. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements
2. Section 16111 – Conduit for Electrical Systems
3. Section 16121 – Medium Voltage Cables
4. Section 16170 – Grounding and Bonding for Electrical Systems
5. Applicable sections of Division 2, Earthwork
6. Section 03200 – Reinforcing Steel
7. Section 03300 – Cast-In-Place Concrete
8. Section 03480 – Pre-Cast Concrete Specialties

1.02 CODES AND STANDARDS

A. Products specified herein shall be designed, manufactured, and/or listed to the following standards as applicable:

1. AASHTO H20
2. ANSI/SCTE 77-2010 – Specification for Underground Enclosure Integrity

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1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 13000 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit Shop Drawings. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to, the following:

1. Product data sheets.

2. Outline and dimensional drawings including detailed sections of the manholes and/or handholes.

3. Materials specifications and structural calculations for the manholes sealed by a Professional Engineer licensed in the State or Commonwealth in which the project is located.

1.05 IDENTIFICATION

A. Each electric manhole and handhole cover shall be lettered with the word “Electric”, the manhole or handhole identification number (e.g., EMH-1, EHH-1, etc.), manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The material covered by this Specification is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings.

2.02 DUCT SYSTEM

A. The underground duct system shall be comprised of conduits, conduit bends, and conduit fittings as specified in Section 16111 – Conduit for Electrical Systems. Conduits shall be encased in reinforced concrete envelopes, unless otherwise specified herein or indicated on the Drawings.

B. Base and intermediate conduit spacers shall be furnished to provide a minimum of two-inch (2") separation between conduits. Conduit spacers shall be provided in the proper size as required for the conduit that they secure. For example, a 4" conduit spacer shall not be used to secure a 2" conduit. Conduit spacers shall be as manufactured by Carlon Electrical Products Company, Aeroquip Corporation, Underground Devices, Incorporated, or Engineer approved equal.

2.03 ELECTRIC MANHOLES

A. The concrete manholes shall be complete with metal frames and covers of size and location as specified herein and shown on the Drawings.

B. Manhole frames and covers shall be Neenah R-1640C1, or equal, with Type A anchor ring. Entire manhole assembly shall be AASHTO H20 heavy duty rated. Precast manholes shall be constructed in accordance with the applicable requirements of Section 03480 – Pre-Cast Concrete Specialties. Covers shall be furnished with drop handles.

C. All medium voltage cables installed in the manholes shall be arc and fireproofed in accordance with specification Section 16121 – Medium Voltage Cables.

D. All electric manholes shall be provided with non-metallic cable racks. Cable racks shall be rated for the application, with a minimum loading capacity of 450 lbs. per rack arm. Cable rack system shall be Heavy Duty type as manufactured by Underground Devices, Incorporated or Engineer approved equal.

2.04 ELECTRIC HANDHOLES

A. The electric handholes shall be a precast polymer concrete enclosure suitable for use as part of an underground electric raceway system. The enclosure shall meet or exceed the requirements of ANSI/SCTE 77-2010.

B. The enclosure and cover design and test load rating shall be Tier 15. Covers shall be provided with cover hooks.

C. The enclosure shall be the straight side design to allow easy adjustment of box to grade. The box shall be stackable for increased depth.

D. Handhole opening size shall be as required to suit the application, 6" x 8", minimum.

E. The electric handholes shall be manufactured by Hubbell, Pencell Plastics equivalent, Highline Products equivalent, or Engineer approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. The underground duct system, manholes, and handholes shall be installed as specified herein, indicated on the Drawings, and in accordance with manufacturers' instructions.

3.02 DUCT SYSTEM

A. All underground conduits shall be encased in concrete and shall be reinforced. Encasement and reinforcement shall be as indicated in the Standard Details. Concrete shall be furnished and installed in accordance with Section 03300 – Cast-In-Place Concrete. Reinforcing steel shall be furnished and installed in accordance with Section 03200 – Reinforcing Steel.

B. Concrete pours shall be complete from handhole to handhole and from manhole to manhole where practicable. Partial pours in general shall not be permitted. Where a complete pour is impractical, written authorization shall be obtained from the Engineer for the partial pour.

C. Conduit ductbank elevations at the manholes and handholes shall be based on minimum ductbank cover as indicated in the Standard Details, or deeper to avoid conflicts with other obstacles. Where deviation is necessary to clear unforeseen obstacles, the elevations may be changed after authorization by the Engineer.

D. Slope all conduits continuously away from structures and buildings with a minimum slope of 3" per 100' unless otherwise indicated on the Drawings.

E. The minimum clearance from the top of the concrete encasement and finished grade shall be as indicated in the Standard Details, except where otherwise accepted in writing by the Engineer or shown on the Drawings.

F. Care shall be exercised during excavation for the duct banks to prevent digging too deep. Backfilling of low spots with earth fill will not be permitted unless thoroughly compacted and acceptable to the Engineer.

G. If a specific ductbank arrangement is shown on the Drawings, the conduits in that ductbank shall be arranged as shown. Where no specific ductbank arrangement is shown on the Drawings, the Contractor shall arrange conduits within each ductbank based on field conditions. Spare conduits shown going from ductbanks into buildings or structures shall be stubbed up in the location(s) as indicated on the Drawings.

H. The ends of the bare copper cables embedded in the concrete ductbank shall be connected to structure and/or building ground rings where the ductbanks terminate, and to each other in manholes and handholes as specified herein.

I. Care shall be exercised and temporary plugs shall be installed during installation to prevent the entrance of concrete, mortar, or other foreign matter into the conduit system. Conduit spacers shall be utilized to support conduit during the pouring of concrete to prevent movement and misalignment of the conduits. Conduit spacers shall be installed in accordance with manufacturer's instructions unless otherwise noted. Horizontal spacing of conduit spacers along ductbank shall be as indicated on the Standard Details.

J. Where connections to existing underground conduits are indicated, excavate to the maximum depth necessary. After addressing the existing conductors, cut the conduits and remove loose concrete from the conduits before installing new concrete encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct line, to take the shear at the joint of the duct lines.

K. Construct concrete-encased conduits connecting to underground structures to have a flared section adjacent to the manhole to provide shear strength. Construct underground structures to provide shear strength. Construct underground structures to provide for keying the concrete encasement of the duct line into the wall of the structure. Use vibrators when this portion of the encasement is poured to ensure a seal between the encasement and the wall of the structure.

L. Six (6) inches above all duct banks, the Contractor shall furnish and install a two (2) inch wide red plastic electrical hazard tape. Tapes shall be metallic detectable type and shall have a continuous message in bold black letters: "ELECTRIC LINE BURIED BELOW." Tape shall be Detectable Identoline by Brady or Engineer approved equal.

M. The Contractor shall perform all earthwork including excavation, backfill, bedding, compaction, shoring and bracing, grading, and restoration of surfaces and seeded areas disturbed during the execution of the Work.

N. All conduit joints in the duct system shall be staggered such that adjacent conduits do not have joints in the same location.

3.03 ELECTRIC MANHOLES

A. Electric manholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 14" from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to the roof. All manholes shall be built on or placed over a 6" layer of well-tamped gravel.

B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.

C. All concrete work and fully assembled manholes shall be completely watertight and shall be furnished with sloped floors that pitch towards a sump pit. The outside surfaces shall be coated with an approved asphaltic waterproofing compound (all sides, bottom, and roof). Precast concrete manholes may be installed; however, all requirements of this Section and other Divisions of the Specifications and the details shown on the Drawings shall apply.

D. Install pulling eye irons imbedded in walls opposite each duct entrance securely fastened to manhole reinforcing rods. All hardware shall be hot-dipped galvanized steel.

E. A ground rod and a ground bar, furnished in accordance with Section 16170 – Grounding and Bonding for Electrical Systems, shall installed at each manhole. Ground rod shall be driven within each manhole. The ground bar shall be installed inside each manhole. A No. 4/0 AWG bare copper ground cable shall be connected between the ground rod and the ground bar. The bare copper ground cable located within each duct bank shall also be connected to the ground bar. No. 6 AWG bare copper cables shall be connected from all non-current carrying metal parts in the manhole to the ground bar. All cable connections at the ground bar shall be NEMA 2-hole style lugs with irreversible compression style barrel made of copper or aluminum. Aluminum lugs shall be marked with an AL/CU rating for use on copper conductors.

F. All cables shall be well supported by non-metallic cable racks. The cable racks shall be heavy-duty type for medium and low voltage power cables and light -duty type for control, signal, communications, and similar small conductors. All racks shall be rigidly attached to the wall and equipped with adjustable rack arms.

3.04 ELECTRIC HANDHOLES

A. Electric handholes shall be installed to a sufficient depth to accommodate the required grading of ducts as well as maintaining a minimum distance of 9” from the bottom of the lowest duct centerline entrances to finished floor line and/or highest duct centerline entrance to roof. All handholes shall be installed in accordance with Standard Detail E-33-0103.

B. Duct envelopes and conduit with bell ends shall enter at approximately right angles to the walls, except as may otherwise be shown on the Drawings.

C. All individual cables and/or bundles of conductors shall be identified and “dressed” along the wall of the enclosure. Cable racks as specified herein shall be provided if any handhole dimension exceeds 24 inches.

3.05 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field tests

   a. Field tests for all completed duct systems shall consist of pulling a swab through each conduit followed by a mandrel equal in size to 85% of the conduit inside diameter.

   b. After testing, all conduits shall be capped after installation of a suitable pull rope. All field tests shall be witnessed by the Engineer.

END OF SECTION

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SECTION 16121
MEDIUM VOLTAGE CABLES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition, ready for service, all medium voltage cables indicated on the Drawings, as specified herein, or required for proper operation of the installation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of medium voltage cable systems shall be furnished and installed by the Contractor.

B. The scope of this Section does not include internal wiring factory installed by medium voltage electrical equipment manufacturers.

C. The manufacturer(s) shall furnish a twenty-five (25) year product warranty on all supplied medium voltage cables and a ten (10) year warranty on splices and terminations.

D. All Contractor personnel installing medium voltage splices or terminations shall be trained as specified in Part 3 – Execution of this Specification.

E. Reference Section 16000 – Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Medium voltage cables and appurtenances shall be designed, manufactured, and/or listed to the following standards as applicable:

1. Underwriters Laboratories (UL)

   a. UL 486A-486B – Standard for Safety Wire Connectors

   b. UL 1072 – Standard for Medium-Voltage Power Cables

   c. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

2. American National Standards Institute (ANSI)

   a. ANSI C119.4 – Electric Connectors – Connectors for use between aluminum-to-aluminum and aluminum-to-copper conductors designed for normal operation at or below 93 degrees C and copper-to-copper conductors designed for normal operation at or below 100 degrees C

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b. ANSI WC 53 – Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test

3. American Society for Testing and Materials (ASTM)

a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire

b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

c. ASTM B496 – Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

d. ASTM D149 – Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

e. ASTM D150 – Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

f. ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension

g. ASTM D2303 – Standard Test Methods for Liquid-Contaminant, Inclined-Plane Tracking and Erosion of Insulating Materials

h. ASTM D2754 – Standard Specification for High-Temperature Glass Cloth Pressure-Sensitive Electrical Insulating Tape

4. National Electrical Manufacturers Association

a. NEMA WC 53 – Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test

b. NEMA WC 74 – 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

5. Insulated Cable Engineers Association (ICEA)

a. ICEA T-27-581 – Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test

b. ICEA S-93-639 – 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy

c. ICEA S-97-682 – Standard for Utility Shielded Power Cables Rated 5 Through 46 kV

6. Institute of Electrical and Electronics Engineers (IEEE)

    a. IEEE 48 – Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

    b. IEEE 386 – Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600 V

    c. IEEE 404 – Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV

    d. IEEE 1202 – Standard for Flame Testing of Cables

7. Association of Edison Illuminating Companies (AEIC)

    a. AEIC CS8 – Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the cable manufacturer and submit the following:

    1. Shop drawings

    2. Reports of certified shop and field tests

    3. Wiring identification methods

    4. Manufacturer’s warranty statements

    5. Certificates of training for termination and splice installers

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed materials’ compliance with the Contract Documents.

B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Product data sheets.

3. Cable pulling calculations.

4. Cable identification methods and materials.

5. Medium voltage splicing and termination product data sheets.

6. The cable manufacturer’s recommended maximum test voltage and time duration values for field acceptance testing.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 IDENTIFICATION

A. Each cable shall be identified as specified in Part 3 – Execution of this Specification.

1.06 CABLE PULLING CALCULATIONS

A. The Contractor shall submit cable pulling calculations for approval at least 5 working days prior to making each cable pull. These calculations, to be performed by a currently registered Professional Engineer in the State or Commonwealth in which the project is located, shall define pulling tension and sidewall loading (sidewall bearing pressure values) for all medium voltage cable installations.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The cables to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing medium voltage cables for a minimum of ten (10) years. Cables shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each cable type shall be permitted.

B. The cable manufacturer shall be ISO 9000 registered.

2.02 SHIELDED POWER CABLE (ALL VOLTAGE CLASSES)

A. Except where specified otherwise herein, the requirements of this Article shall apply to all voltage classes of medium voltage shielded power cable.

B. The cable to be furnished and installed for medium voltage circuits shall be shielded power cable, UL Listed as NEC Type MV-105. The voltage class of the cable for each circuit shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. In no case shall the voltage rating of the shielded power cable be less than the voltage rating of the circuit being supplied by the cable.

C. The conductor shall be annealed bare copper per ASTM B3, Class B compact or compressed stranded per ASTM B8 or B-496, with an extruded thermoset semiconducting EPR conductor shield/screen (i.e. strand shield/screen). The conductor screen shall meet or exceed the electrical and physical requirements of ICEA S-93-639 (NEMA WC74) and S-97-682, AEIC CS8, and UL 1072.

D. The insulation shall be an ethylene-propylene rubber (EPR) based thermosetting compound which meets or exceeds the electrical and physical requirements of ICEA S-93-639 (NEMA WC74) and S-97-682, AEIC CS8, and UL 1072. Insulation level shall be 133% for the respective voltage class, and as specified elsewhere herein.

E. A thermoset extruded semiconducting insulation screen shall be extruded directly over the insulation and shall be easily strippable without the use of a release agent. The insulation screen shall meet or exceed the electrical and physical requirements of ICEA S-93-639 (NEMA WC74) and S-97-682, AEIC CS8, and UL 1072. The insulation thickness and voltage rating shall be as specified herein.

F. The semiconducting conductor shield/screen, insulation, and semiconducting insulation screen shall be simultaneously extruded utilizing an enclosed, true triple extrusion process to prevent contamination of the conductor shield/screen, insulation, and insulation shield.

G. The metallic insulation shield shall be a 5-mil bare copper tape helically applied over the insulation with a nominal 25% percent overlap. Cables using corrugated shield/drain wires are not acceptable.

H. The cable jacket shall be flame-retardant, moisture, abrasion, and sunlight-resistant PVC which meets or exceeds the electrical and physical requirements of ICEA S-93-639 (NEMA WC74) and S-97-682, and UL 1072. Sizes #1/0 AWG and larger shall be listed and marked “Sunlight- Resistant FOR CT USE” in accordance with the NEC.

I. The shielded power cable shall be Okoguard-Okoseal as manufactured by the Okonite Company, Uniblend XLF PVC High Speed as manufactured by General Cable, SIMpull CT1 ET as manufactured by Southwire Company equivalent, or equal.

2.03 5KV/8KV SHIELDED POWER CABLE

A. The insulation for 5kV/8kV shielded power cables shall be 115 mils, rated 5kV-133% insulation level or 8kV-100% insulation level.

2.04 SHIELDED POWER CABLE TERMINATIONS

A. Shielded power cable termination kits shall be factory engineered for the application, rated for the voltage class of the associated cable. The insulator material for the termination shall be suitable for outdoor applications and made from UV-stable, non-tracking (per ASTM D2303) materials. Sealant materials to help prevent moisture ingress and contamination shall also be included. All terminations shall meet or exceed all rating requirements for IEEE 48 Class 1 terminations. These terminations shall meet the test sequence requirements prescribed by IEEE 48, including 130°C load cycling and 130°C impulse withstand.

B. In “Heavy” or “Extremely Heavy” environments, as classified by IEEE-48, terminations shall consist of a heat shrinkable outer insulating tubing coated internally with a stress control material or a heat shrinkable outer insulating tubing and a separate heat shrinkable stress control tubing. Heat-activated sealant materials to help prevent moisture ingress and contamination shall also be included. These terminations shall meet the test sequence requirements prescribed by IEEE 48, including 140°C load cycling and 140°C impulse withstand.

C. Terminations for outdoor exposed locations shall be provided with insulating skirts. Terminations for indoor locations, or within weather-protected outdoor equipment shall not be required to have insulating skirts, so long as the termination length does not require the termination to be partially installed into the associated conduit. Insulating skirts shall be provided where termination would otherwise be partially installed into the associated conduit.

D. Conductor termination lugs shall either be constructed of tin-plated copper or be constructed of aluminum that is marked as CU-AL for use with a copper conductors.

Lugs shall be NEMA 2-hole type with hydraulically compressed or shear bolt type barrel. Shear bolt lugs shall be continuous pressure type, utilizing friction plates to maintain the contact force. Lugs with set-screw type barrels are not acceptable. Lugs shall have a Class 2 conductor pull-out strength in accordance with ANSI C119.4.

E. The terminations shall be manufactured by The 3M Company, Tyco Electronics (Raychem), or equal.

2.05 SHIELDED POWER CABLE SPLICES

A. Power cable splices shall be factory-engineered kits that rebuild the primary cable insulation, shielding and grounding systems, and outer jacket equivalent to that of the original cable. When assembled on the cable, the splice shall be capable of passing the electrical test requirements of IEEE 404, and the water immersion tests of ANSI C119.4. Splices shall be suitable for direct-burial, manhole, cable tray, and UV exposed areas. Pre-molded splices are not acceptable. Taped splices are not acceptable.

B. The splices shall provide a positive moisture seal provided by heat activated or pressure activated sealant.

C. The splices shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances. Splices shall be capable of being properly installed on out-of-round cables per relevant ICEA and AEIC standards.

D. Splices for armored cables shall provide a means of reinstating the armor over the span of the installed splices.

E. Heat shrinkable splices shall meet the 140°C load cycling and 140°C impulse withstand requirements of IEEE 404.

F. Heat shrinkable splices shall be of a uniform-cross-section heat shrinkable polymeric construction. Internal moisture seals shall inhibit migration of moisture from other sections of the cable where jacket damage may have occurred.

G. Single component cold shrinkable splices shall be molded from silicone rubber and have integrated stress relief cones and a faraday cage. It is preferred to have integrated on a single spiral holdout: the splice body, metallic shield, and re-jacketing sleeve. The integrated metallic shield shall be a flexible copper sock capable of carrying the neutral current with ampacity greater than or equal to 1/0AWG copper. The re-jacketing sleeve shall be extruded from EPDM rubber. The re-jacketing sleeve shall provide a tight interference fit with the cable jacket and supplied sealing mastic in order to assure an environmental seal per IEEE 404.

H. In "Heavy" or "Extremely Heavy" environments as classified by IEEE 48, heat shrinkable splices are required.

I. The splice manufacturer shall provide a test report demonstrating compliance with the above requirements.

J. Modular splicing kits, utilizing separable connectors which bolt together, may only be used if specifically approved, in writing, by the Engineer. Modular splicing kits shall be rated for the voltage class of the cable, and an ampacity of 600A, and shall meet or exceed the requirements of IEEE 386.

K. The splices shall be manufactured by The 3M Company, Tyco Electronics (Raychem), or equal.

2.06 CABLE PULLING LUBRICANTS

A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 – EXECUTION

3.01 GENERAL

A. The cables shall be installed as specified herein and indicated on the Drawings.

B. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.

C. Splices shall not be allowed in any medium voltage cables. If splices are required, the Contractor shall obtain approval in writing from the Engineer prior to splicing. Splicing material shall be as specified herein and as accepted by the Engineer.

D. Cable Sizes

1. The sizes of cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer.

E. Cable Identification

1. Cables shall be identified as follows:

a. 5kV/8kV Class cables shall be provided with two (2) strips of identification tape

2. All cables shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a cable identification system prior to

installation of any cables. Cable numbers, where applicable, shall not be duplicated.

3. Cable identification in manholes, pull boxes, vaults, and other accessible components in the raceway system where the cables are continuous shall be accomplished by means of a tag installed around the bundled group of conductors. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all of the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that particular conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the cable bundle by the use of nylon wire ties and shall be made of polyethylene as manufactured by Brady, Seton equivalent, Panduit equivalent, or equal.

F. Cable Arc and Fireproofing

1. All medium voltage cables installed in manholes, pull boxes, vaults, and other accessible components in the raceway system shall be arc and fireproofed utilizing one of the following tape systems:

2. Plymouth Rubber Group

a. 53 PLYARC Arc and Fireproofing Tape

1) 3 inches wide with a thickness of 30 mils.

2) Tape shall be wrapped around cable in one half-lapped layer.

b. 77 PLYGLAS Glass Cloth Tape

1) 7 mils thickness.

2) Tape shall be utilized to secure the 53 PLYARC.

3) Tape shall be in accordance with ASTM D-2754.

3. The 3M Company

a. Scotch 77 Fire and Electric Arc Proofing Tape

1) 1.5 inches or 3 inches wide, depending upon cable diameter and in accordance with the manufacturer's installation instructions, with a thickness of 30 mils.

2) Tape shall be wrapped around cable in one half-lapped layer.

b. Scotch 69 Glass Cloth Tape

1) 7 mils thickness.

2) Tape shall be utilized to secure the Scotch 77.

3) Tape shall be in accordance with ASTM D-2754.

4. Each individual cable shall be individually arc and fireproofed 6” into the duct. Multiple cables within a single wrap of fireproofing tape shall not be permitted.

G. Training of Cable

1. The Contractor shall furnish all labor and material required to train cables around cable vaults within buildings, and in manholes in the outdoor underground duct system. Sufficient length of cable shall be provided in each manhole and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall be not less than the manufacturer's recommendation. All manhole cables shall be arc and fire-proofed. The training shall be done in such a manner as to minimize chaffing. Reference Section 16118 – Underground Electrical.

H. Connections at Equipment

1. Connections at equipment shall be made in accordance with the best practices of the trade, and the cable and/or termination product manufacturer's instructions for the particular type of cable.

I. Pulling Temperature

1. Cable shall not be flexed or pulled when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the workday for which the cable is removed from the protected storage. Any remaining cable reels shall be returned to storage at the completion of the workday.

3.02 MEDIUM VOLTAGE CABLE INSTALLATION

A. Medium voltage cable shall be installed so that no damage occurs to the insulation or outer jacket. Cable shall not be bent or twisted such that the tape shield is pulled apart. The tape shield shall be twisted and grounded at each termination.

B. Terminations shall be made with stress control kits in freestanding equipment and loadbreak elbows in pad mounted equipment. Terminations shall meet or exceed the ratings of the cable and the interrupting capacity of the connected equipment. Terminations shall be as specified in Part 2, Products, of this Specification.

C. All splices and terminations shall be in compliance with the cable and splice/termination manufacturer's recommendations. These recommendations shall be submitted to the Engineer for review one (1) week prior to making any splices or terminations.

D. Installers shall be trained by the factory supplying medium voltage terminations and splices in the proper installation of the products. Installers shall be able to produce evidence of such training within the past three (3) years. This evidence shall be

submitted to the Engineer for review one (1) week prior to making any splices or terminations.

3.03 MATERIAL STORAGE AND HANDLING

A. The Contractor shall inspect the cable and reels upon receipt for visible or hidden damage. Reels should not be shipped on their side and should be shipped with a protective cover over the cable on the reel. Reels turned over onto their side are subject to damage. Reels shall not be rolled-off the truck or lifted by forks on the drum. Reels shall be lifted by a chain connected to a spreader bar through the arbor hole. Reel ends shall be covered by a heat-shrinkable end cap upon shipment, and again each time a cable end has been cut from the reel. The Contractor shall note any damage that has been identified on the bill of lading and take photos of the damage at the time of delivery. Any damage shall be reported to the Engineer, project management, and cable distributor, and such report(s) shall include the photos of the damage.

B. Cable reels shall be stored in areas away from high traffic (where it may be subject to damage).

3.04 TESTING

A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Tests

a. Cables shall be tested in accordance with the applicable ICEA Standards. Cables shall be physically and electrically tested in accordance with the manufacturer’s standards.

b. Cable shall be tested at the factory in accordance with AEIC CS8 (latest revision) except that the cable shall be corona free when tested at 200 VAC per mil and 363 VDC per mil. Corona test results to be available on an X-Y plot. Tests shall be as described by ICEA S-93-639 (NEMA WC74), Section 6 or ICEA T-27-581 (NEMA WC53).

2. Field Tests

a. Field testing shall be performed in accordance with NETA Acceptance Testing Specifications (ATS), latest edition.

b. After installation, all medium voltage cables shall be tested for insulation levels and continuity in accordance with NETA test documents and the cable manufacturer’s recommendations. Insulation resistance between conductors of the same circuit and between conductor and ground shall be tested. Testing for insulation levels shall be as follows:

1) Cable shall be given a conductor continuity check and a high voltage DC field acceptance test after installation. The DC test voltage shall be in accordance with AEIC CS8, however shall not exceed the cable manufacturer's recommended maximum test voltage and time duration.

B. Medium voltage cables shall be tested before being connected to equipment.

C. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.

D. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

END OF SECTION

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SECTION 16123

LOW VOLTAGE CONDUCTORS AND CABLES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test, and place in satisfactory operating condition all low voltage wire and cable indicated on the Drawings, as specified herein, and/or required for proper operation. The work of connecting cables to equipment and devices shall be considered a part of this Section. All appurtenances required for the installation of wire and cable systems shall be furnished and installed by the Contractor.

B. The scope of this Section does not include internal wiring factory installed by electrical equipment manufacturers.

C. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16130 – Boxes for Electrical Systems

3. Section 16440 – Enclosed Switches

1.02 CODES AND STANDARDS

A. All low voltage wire, cable, and appurtenances shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Low voltage wire, cable, and appurtenances shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

a. IEEE 1202 – Standard for Flame Testing of Cables.

2. American Society for Testing and Materials (ASTM):

a. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire.

b. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

c. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

d. ASTM D69 – Standard Test Methods for Friction Tapes.

e. ASTM D4388 – Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.

3. Insulated Cable Engineers Association (ICEA):

a. ICEA S-58-679 – Standard for Control, Instrumentation and Thermocouple Extension Conductor Identification.

b. ICEA T-29-250 – Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210,000 B.T.U./Hour.

4. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

5. Underwriters Laboratories (UL):

a. UL 13 – Standard for Power-Limited Circuit Cables.

b. UL 44 – Thermoset-Insulated Wires and Cables.

c. UL 83 – Thermoplastic-Insulated Wires and Cables.

d. UL 1277 – Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

e. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords.

f. UL 1685 – Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

g. UL 2250 – Standard for Instrumentation Tray Cable.

h. UL 2556 – Wire and Cable Test Methods.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the wire and cable manufacturer and submit the following:

1. Shop Drawings

2. Reports of Field Tests

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed material's compliance with the Contract Documents.

B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for the following:

a. Wire and cable

b. Power and control wire terminations, including wire ferrules

c. Instrumentation cable terminations

d. Pulling lubricant.

2. Cable pulling calculations (if required).

3. Wiring identification methods and materials.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 CABLE PULLING CALCULATIONS

A. Prior to the installation of the wire and cable specified herein, the Contractor shall submit cable pulling calculations for Engineer review and approval when all of the following are true:

1. The amount of cable to be installed will be greater than 200 linear feet between pull points.

2. The installation will have one or more bends.

3. The wire/cable is size #1/0 AWG and larger.

B. Cable pulling calculations shall be performed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located. Calculations shall define pulling tension and sidewall loading (sidewall bearing pressure values).

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The wire and cable to be furnished and installed for this project shall be the product of manufacturers who have been in the business of manufacturing wire and cable for a minimum of ten (10) years. Wire and cable shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and indicated on the Drawings. Only one (1) manufacturer for each wire and cable type shall be permitted.

2.02 POWER AND CONTROL WIRE AND CABLE

A. Power wire installed between the output terminals of a VFD and the respective motor shall consist of insulated copper conductors. Conductor insulation shall be rated for 90°C in both wet and dry locations, and 600V. Insulated conductors shall be UL 44 Listed as NEC Type XHHW-2.

B. Power wire for all other loads and control wire shall consist of insulated copper conductors with a nylon (or equivalent) outer jacket. Conductor insulation shall be rated 90°C for dry locations, 75°C for wet locations, and 600V. Insulated conductors shall be UL 83 Listed as NEC Type THHN/THWN.

C. Unless specified otherwise herein, conductors shall be stranded copper per ASTM B-8 and B-3, with Class B or C stranding contingent upon the size. Power conductors for lighting and receptacle branch circuits shall be solid copper per ASTM B-3.

D. Power conductor size shall be no smaller than No. 12 AWG and Control conductor size shall be no smaller than No. 14 AWG.

E. Multi-conductor cable assemblies shall include a grounding conductor and an overall PVC jacket. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Multi-conductor cable assemblies shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

F. Power wire and cable shall be as manufactured by the Okonite Company, the Southwire Company, General Cable, Encore Wire, or Engineer approved equal.

2.03 INSTRUMENTATION CABLE

A. For single-analog signal applications, instrumentation cable shall consist of a single, twisted pair or triad of individually insulated and jacketed copper conductors with an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

B. For multiple-analog signal applications, instrumentation cable shall consist of multiple, twisted pairs or triads (i.e., groups) of individually insulated and jacketed copper conductors with individual pair/triad shields (i.e., group shields) and an overall cable shield and jacket. Conductor insulation shall be rated 90°C in both wet and dry locations, and 600V. The jacket shall be PVC and resistant to abrasion, sunlight, and flame in accordance with UL 1277. Cable shall be UL 1277 Listed as NEC Type TC (Power and Control Tray Cable).

C. Cable and group shields shall consist of overlapped aluminum/polyester tape/foil providing 100% coverage. Instrumentation cables shall include an overall copper shield drain wire. Cables containing multiple twisted pairs or triads shall also include group shield drain wires.

D. Conductors, including drain wires, shall be tin or alloy coated (if available), soft, annealed copper, stranded per ASTM B-8, with Class B stranding unless otherwise specified.

E. Instrumentation signal conductor size shall be no smaller than No. 16 AWG.

F. Instrumentation cable shall be Okoseal-N Type P-OS (for single pair or triad applications) or Okoseal-N Type SP-OS (for multiple pair or triad applications) as manufactured by the Okonite Company, Belden equivalent, Southwire Company equivalent, or Engineer approved equal.

2.04 OTHER CABLES

A. Category 6 UTP communication cables and fiber optic cables shall be as specified in Specification Section 17180 – Process Control System Networks.

2.05 CONDUCTOR IDENTIFICATION

A. Conductors shall be identified using a color-coding method. Color coding for individual power, control, lighting, and receptacle conductors shall be as follows:

1. 480/277V AC Power

a. Phase A – BROWN

b. Phase B – ORANGE

c. Phase C – YELLOW

d. Neutral – GREY

2. 120/208V or 120/240V AC Power

a. Phase A – BLACK

b. Phase B – RED

c. Phase C – BLUE

d. Neutral – WHITE

3. DC Power

a. Positive Lead – RED

b. Negative Lead - BLACK

4. DC Control

a. All wiring – BLUE

5. 120 VAC Control

a. 120 VAC control wire shall be RED except for a wire entering a motor control center compartment, motor controller, or control panel which is an interlock. This interlock conductor shall be color coded YELLOW. For the purposes of this Section, an interlock is defined as any wiring that brings voltage into the above-mentioned equipment from a source outside that equipment.

6. 24 VAC Control

a. All wiring - ORANGE

7. Equipment Grounding Conductor

a. All wiring - GREEN

B. Individual conductors No. 2 AWG and smaller shall have factory color coded insulation. It is acceptable for individual conductors larger than No.2 AWG to be provided with factory color coded insulation as well, but it is not required. Individual conductors larger than No.2 AWG that are not provided with factory color coded insulation shall be identified by the use of colored tape in accordance with the requirements listed in Part 3

herein. Insulation colors and tape colors shall be in accordance with the color-coding requirements listed above.

C. Conductors that are part of multi-conductor cable assemblies shall have black insulation. The conductor number shall be printed on each conductor's insulation in accordance with ICEA S-58-679, Method 4. Each conductor No.2 AWG and smaller within the cable assembly shall also be identified with a heat shrink tag with color coded background. Each conductor larger than No.2 AWG within the cable assembly shall also be identified by the use of colored tape. Heat shrink tags and colored tape shall be in accordance with the requirements listed in Part 3 herein. Tape color and heat shrink tag background color shall be in accordance with the color-coding requirements listed above.

2.06 CABLE PULLING LUBRICANTS

A. Cable pulling lubricants shall be non-hardening type and approved for use on the type of cable installed. Lubricant shall be Yellow #77 Plus by Ideal, Cable Gel by Greenlee, Poly-Gel by Gardner Bender, or equal.

PART 3 – EXECUTION

3.01 WIRE AND CABLE INSTALLATION

A. General

1. All wire and cable furnished under this Contract, including wire and cable furnished under other Divisions, shall be installed in raceways (e.g., conduit) unless specifically noted otherwise.

2. Wire and cable shall be installed as specified herein and indicated on the Drawings. Unless specifically indicated otherwise on the Drawings, wire and cable shall be installed in separate raceways according to wiring type. For example, power wiring shall not be combined with control wiring, and control wiring shall not be combined with instrumentation wiring.

3. Wire shall be furnished and installed as single conductor cables, with limited exceptions. Multi-conductor cable assemblies shall only be installed where indicated on the Drawings, required by the NEC, or after obtaining written permission from the Engineer.

4. Where instrumentation cables are installed in control panels, motor controllers, and other locations, the Contractor shall arrange wiring to provide maximum clearance between these cables and other conductors. Instrumentation cables shall not be installed in same bundle with conductors of other circuits.

5. Instrumentation cable shielding shall be continuous and shall be grounded at one point only.

B. Splices

1. Splices shall not be allowed in power or control wire and cable unless approved in writing by the Engineer. If unique field conditions exist or pulling calculations indicate that splices may be required, the Contractor shall submit a detailed request indicating why splices are required to the Engineer. The Engineer shall be under no obligation to grant such request.

2. Splicing materials shall be UL 486A Listed barrel type butt splice connectors and heat shrink tubing as manufactured by 3M, Ideal, or equal. The use of screw-on wire connectors (wire nuts) shall only be permitted for lighting and receptacle circuits.

3. No splicing of instrumentation cable is permitted.

C. Wire and Cable Sizes

1. The sizes of wire and cable shall be as indicated on the Drawings, or if not shown, as approved by the Engineer. If required due to field routing, the size of conductors and respective conduit shall be increased so that the voltage drop measured from source to load does not exceed 2-1/2%.

D. Additional Conductor Identification

1. In addition to the color-coding identification requirements specified in Part 2 herein, individual conductors shall be provided with heat shrinkable identification tags. Identification tags for individual conductors shall have a white background where the conductor insulation is colored. Identification tags for individual conductors shall have a colored background where the conductor insulation is black. Background color shall match that of the taping provided on the individual black conductors.

2. Multi-conductor cables shall be provided with heat shrinkable identification tags in accordance with Part 2 herein.

3. All wiring shall be identified at each point of termination. This includes but is not limited to identification at the source, load, and in any intermediate junction boxes where a termination is made. The Contractor shall meet with the Owner and Engineer to come to an agreement regarding a wire identification system prior to installation of any wiring. Wire numbers shall not be duplicated.

4. Wire identification shall be by means of a heat shrinkable sleeve with appropriately colored background and black text. Wire sizes #14 AWG through #10 AWG shall

have a minimum text size of 7 points. Wire sizes #8 AWG and larger shall have a minimum text size of 10 points. Sleeves shall be of appropriate length to fit the required text. The use of handwritten text for wire identification shall not be permitted.

5. Sleeves shall be suitable for the size of wire on which they are installed. Sleeves shall not be heat-shrunk onto control cables. Tags shall remain loose on cable to promote easier identification. For all other applications, sleeves shall be tightly affixed to the wire and shall not move. Sleeves shall be heat shrunk onto wiring with a heat gun approved for the application. Sleeves shall not be heated by any means which employs the use of an open flame. The Contractor shall take special care to ensure that the wiring insulation is not damaged during the heating process.

6. Sleeves shall be installed prior to the completion of the wiring terminations and shall be oriented so that they can be easily read.

7. Sleeves shall be polyolefin as manufactured by Brady, Seton, Panduit, or equal.

8. Wire identification in manholes, handholes, pull boxes, and other accessible components in the raceway system where the wiring is continuous (no terminations are made) shall be accomplished by means of a tag installed around the bundled group of individual conductors or around the outer conductor jacket of a multi-conductor cable. Identification shall utilize a FROM-TO system. Each group of conductors shall consist of all the individual conductors in a single conduit or duct. The tag shall have text that identifies the bundle in accordance with the 'FROM' and 'TO' column for that specific conduit number in the conduit and wire schedule. Minimum text size shall be 10 point. The tag shall be affixed to the wire bundle using nylon wire ties and shall be made of polyethylene as manufactured by Brady, Seton, Panduit, or equal.

9. Where colored tape is used to identify cables, it shall be wrapped around the cable with a 25% overlap and shall cover at least 2 inches of the cable.

E. Wiring Supplies

1. Rubber insulating tape shall be in accordance with ASTM D4388. Friction tape shall be in accordance with ASTM D69.

F. Training of Cable in Manholes, Handholes, and Vaults

1. The Contractor shall furnish all labor and material required to train cables around cable vaults, manholes, and handholes. Sufficient length of cable shall be provided in each handhole, manhole, and vault so that the cable can be trained and racked in an approved manner. In training or racking, the radius of bend of any cable shall

be not less than the manufacturer's recommendation. The training shall be done in such a manner as to minimize chaffing.

2. Instrumentation cable shall be racked and bundled separate from AC wiring to maintain the required separation as follows:

    a. 18 inches for 480/277 VAC wiring

    b. 12 inches for 208/120 VAC wiring

    c. 6 inches for 24 VAC wiring

G. Conductor Terminations

1. Where wires are terminated at equipment which requires lugs, connections shall be made by solderless mechanical lug, crimp type ferrule, or irreversible compression type lugs. Reference individual equipment Specification Sections as applicable for additional termination requirements.

2. For conductors with stranding other than Class B or C, a UL 486A Listed wire ferrule shall be installed prior to each conductor termination. Ferrules shall be suitable for the size of conductors and shall be made of a material that is compatible with the conductors. Ferrules shall be crimped on in accordance with the ferrule manufacturer’s instructions.

3. Where enclosure sizes and sizes of terminals at limit switches, solenoid valves, float switches, pressure switches, temperature switches, and other devices make terminations impractical due to the size of the field wiring, the Contractor shall terminate field wiring in an adjacent junction box per the requirements of Section 16130 – Boxes for Electrical Systems, complete with terminal strips. Contractor shall install the smaller wiring from the device to the junction box in a conduit, using the terminal strip as the means for joining the two different wire sizes. Splicing of wires in lieu of using terminal strips is not acceptable.

4. The cables shall be terminated in accordance with the cable and/or termination product manufacturer's instructions for the particular type of cable.

5. To minimize oxidation and corrosion, selected wire and cable shall be terminated using an oxide-inhibiting joint compound recommended for electrical connections. The compound shall be Penetrox E for copper-to-copper connections, and Penetrox A for all other connections, as manufactured by Burndy Electrical, or equal. The joint compound shall be used in the following installations:

    a. Termination of aluminum conductors, where aluminum conductors are specifically allowed by the Engineer.

b. Terminations in all Class I and Class II, Division 1 and 2 hazardous areas.

6. All spare conductors shall be terminated on terminal blocks mounted within equipment or junction boxes. Unless otherwise noted, coiling up of spare conductors within enclosure is not acceptable.

H. Pulling Temperature

1. Cable shall not be installed when the temperature of the jacket is such that damage will occur due to low temperature embrittlement. When cable will be pulled with an ambient temperature of 40°F or less within a three (3) day period prior to pulling, the cable reels shall be stored three (3) days prior to pulling in a protected storage area with an ambient temperature of 55°F or more. Cable pulling shall be completed during the workday for which the cable is removed from the protected storage. Any cable reels with wire remaining on them shall be returned to storage at the completion of the workday.

3.02 TESTING

A. All testing shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Test

a. Wires and cables shall be tested in accordance with the applicable ICEA Standards. Wire and cable shall be physically and electrically tested in accordance with the manufacturer’s standards.

2. Field Tests

a. After installation, all wires and cables shall be tested for continuity. Testing for continuity shall be “test light” or “buzzer” style.

b. After installation, wires and cables shall be tested for insulation resistance levels between conductors of the same circuit and between conductor and ground as follows:

1) For #8 AWG and larger 600V wire and cable, apply 1,000 VDC from a Megohmmeter for one (1) minute. Resistance shall be no less than 100 Megohms.

2) Instrumentation signal cable shall be tested from conductor to conductor, conductor to shield, and conductor to ground using a Simpson No. 260 volt-ohmmeter or approved equal. The resistance value shall be 200 Megohms or greater.

3) Insulation resistance testing is not required for power and control cables smaller than #8 AWG.

c. Wires and cables shall be tested after required terminations are made, but before being connected to any equipment.

d. If tests reveal defects or deficiencies, the Contractor shall make the necessary repairs or shall replace the cable as directed by the Engineer, without additional cost to the Owner. All conductors of a multi-phase circuit shall be replaced if one conductor fails the required testing. If part of a multi-set (parallel conductors per phase) circuit fails testing, only the set containing failure shall be replaced.

e. All tests shall be made by and at the expense of the Contractor who shall supply all testing equipment. Test reports shall be submitted to the Engineer.

Exhibit A
Test Data – Megohms
Test No. ____

Date:			Company:				
Time:			Location:				
Circuit:	Circuit Length:	Aerial:	Duct:	Buried:	No. of Conductors	Size:	AWG MCM Shield:
Insulation Material:			Insulation Thickness:		Voltage Rating:		Age:
Type: _____ Pothead _____ Terminal					Location: Indoors _____ Outdoors _____		
Number and Type of Joints:							
Recent Operating History:							
Manufacturer:							
State if Potheads or Terminals were grounded during test:							
List associated equipment included in test:							
Miscellaneous Information:							

Exhibit A
Test Data – Megohms
Test No. ____

Part Tested:	Test Performed: _____ Hours/Days: _____ After Shutdown: _____
Grounding Time:	Dry Bulb Temperature: _____ Wet Bulb Temperature: _____
Test Voltage:	Equipment Temperature: _____ How Obtained: _____ Relative Humidity: _____ Absolute Humidity: _____ Dew Point: _____

Megohmmeter: Serial Number: _____ Range: _____
Voltage: _____ Calibration Date: _____

Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground	Test Connections	To Line To Earth To Ground	To Line To Earth To Ground	To Line To Earth To Ground
1/4 Minute				5 Minutes			
1/2 Minute				6 Minutes			
3/4 Minute				7 Minutes			
1 Minute				8 Minutes			
2 Minutes				9 Minutes			
3 Minutes				10 Minutes			
4 Minutes				10/1 Minute Ratio			

Remarks:

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SECTION 16130
BOXES FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all pull boxes, junction boxes, and outlet boxes as specified herein, indicated on the Drawings, and as required. Requirements for other boxes and enclosures are not necessarily included in this Section. Reference each specific equipment specification section for requirements related to that equipment's respective enclosure.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16111 – Conduit for Electrical Systems

3. Section 16195 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

A. All boxes shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Boxes shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. National Electrical Manufacturers Association (NEMA):

   a. NEMA 250 – Enclosures for Electrical Equipment.

2. National Fire Protection Association (NFPA):

   a. NFPA 70 – National Electrical Code (NEC).

3. Underwriters Laboratories (UL):

   a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.

   b. UL 50E – Enclosures for Electrical Equipment, Environmental Considerations.

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c. UL 514A – Metallic Outlet Boxes.

d. UL 514C – Standard for Non-metallic Outlet Boxes, Flush Device Boxes, and Covers.

e. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer(s) and submit the following:

1. Shop Drawings

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible Submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets for boxes, terminal strips, and all accessories

2. Overall bill of material for all boxes included under this Contract to summarize exactly what is being submitted for review. Bill of material shall at a minimum show each box type (i.e., pull, junction, or outlet), quantity, material of construction, dimensions, and proposed installation location.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

B. As-built drawings showing dimensions, internal box layout, terminal strip information, and terminal strip identification information shall be provided for all junction boxes. As-built drawings are not required for pull boxes or outlet boxes.

1.06 IDENTIFICATION

A. Each pull and junction box shall be identified with the box name as indicated on the Contract Drawings (e.g., PPB-TF, CJB-TF) or as directed by the Engineer. A nameplate shall be securely affixed in a conspicuous place on each box. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 PULL AND JUNCTION BOXES

A. General

1. All pull and junction boxes shall be UL Listed and Labeled.

2. Pull and junction boxes shall not be provided with eccentric or concentric knockouts.

3. Pull and junction boxes mounted embedded in concrete shall be UL Listed for embedment.

4. Where metallic boxes are used, they shall be of all welded construction. Tack welded boxes are not acceptable.

B. Pull Boxes

1. Metallic pull boxes in non-hazardous locations and in hazardous locations where general-purpose enclosures are permitted (e.g., Class I, Division 2 locations) shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.

2. Metallic pull boxes in hazardous locations where general-purpose enclosures are not permitted (e.g., Class I, Division 1 locations) shall be provided with a matching gasketed cover. Cover shall be hinged and held in place by stainless steel bolts.

Hinge pins shall be removable. Covers shall be installed and bolts torqued in accordance with manufacturer requirements to maintain the hazardous location rating of the enclosure.

3. Non-metallic pull boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., “flip”) latches. Latch material of construction shall match the box material, and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.

4. Pull boxes shall not have any wire terminations inside, other than those for grounding/bonding. A ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the pull box (minimum of two) shall be provided as spare terminations. Boxes requiring any other wire terminations shall be furnished and installed in accordance with the requirements for junction boxes herein.

5. Pull boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC.

6. Barriers shall be provided in pull boxes to isolate conductors of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:

    a. Power wiring

    b. AC control wiring

    c. DC control wiring

    d. Instrumentation wiring

C. Junction Boxes

1. Metallic junction boxes in non-hazardous locations shall be provided with a matching gasketed cover. For covers with dimensions of less than 12 inches by 12 inches, the cover shall be held in place by stainless steel machine screws. Other screw types are not acceptable. For covers with dimensions 12 inches by 12 inches and larger, the cover shall be hinged and held in place by 1/4-turn style latches. Latch mechanism shall be all stainless steel. Hinge pins shall be removable.

2. Metallic junction boxes in hazardous locations shall be provided with a matching gasketed cover. Cover shall be hinged and held in place by stainless steel bolts.

Hinge pins shall be removable. Covers shall be installed and bolts torqued in accordance with manufacturer requirements to maintain the hazardous location rating of the enclosure.

3. Non-metallic junction boxes shall be provided with a matching gasketed cover. The cover shall be hinged and held in place by quick-release (e.g., “flip”) latches. Latch material of construction shall match the box material and include stainless steel hasps. For covers with dimensions 24 inches by 24 inches and larger, a 3-point latching mechanism with external pad-lockable handle may be substituted. Latch mechanism and handle shall be all stainless steel. Hinge pins shall be removable.

4. Barriers shall be provided in junction boxes to isolate conductors and terminal blocks of different voltages, types, and functions. Barrier material of construction shall match that of the box. Isolation shall be provided between the following groups:

    a. Power wiring

    b. AC control wiring

    c. DC control wiring

    d. Instrumentation wiring

5. Junction boxes used for lighting and receptacle circuits only shall be allowed to have screw-on (wire nut) type connectors for wire terminations/junctions.

6. Junction boxes for all uses other than lighting and receptacle circuits shall be provided with terminal strips, consisting of the necessary number of screw type terminals. Current carrying parts of the terminal blocks shall be of ample capacity to carry the full load current of the circuits connected, with a 10A minimum capacity. Terminal strips shall be rated for the voltage of the circuits connected. A separate ground bar shall be provided with the necessary number of screw type terminals. Twenty (20) percent of the total amount of terminals otherwise required for the junction box (minimum of two) shall be provided as spare terminations. When barriers are provided within the box, separate terminal strips shall be provided in each barrier area. Terminals shall be lettered and/or numbered to conform to the wiring labeling scheme in place on the project.

7. Junction boxes shall be 6 inches wide by 6 inches tall by 4 inches deep, minimum. For applications requiring larger boxes, the box shall be sized in accordance with the fill requirements and dimensional requirements of the NEC. Terminal blocks (including spare terminals) shall be considered when sizing the junction box.

D. Enclosure Types and Materials

1. In non-hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or PVC
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. In hazardous locations, pull and junction boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 4X, Type 304 Stainless Steel

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

4. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.

2.03 OUTLET BOXES

A. General

1. Outlet boxes shall be provided with a trim appropriate for the wiring device installed inside. Reference Section 16141 – Wiring Devices for outlet box trim

requirements. An appropriate outlet box trim is required to achieve the NEMA rating of the outlet boxes as specified herein.

B. Surface Mount Outlet Boxes

1. Outlet boxes shall be the deep type, no less than 2.5 inches deep.

2. Outlet boxes shall be provided in single or multi-gang configuration as required, sized in accordance with the requirements of the NEC.

3. In non-hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	**Enclosure Type and Material**
Indoor Wet Process Area	NEMA 4X, Cast Aluminum
Indoor Dry Process Area	NEMA 1, Cast Aluminum
Indoor Dry Non-process Area	NEMA 1, Cast Aluminum
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, PVC
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Cast Aluminum
All Outdoor Areas	NEMA 4X, PVC Coated Steel

4. In hazardous locations, outlet boxes shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	**Enclosure Type and Material**
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 4X, Cast Aluminum

5. Outlet boxes shall be provided with integral threaded conduit hubs mounted external to the box. Boxes with threaded conduit hubs mounted internal to the box or as a part of the box wall are not acceptable.

C. Flush Mount Outlet Boxes

1. Outlet boxes shall be no less than 2-1/8 inches deep, and 4-11/16 inches square. Boxes shall be UL Listed and labeled. Pre-punched single diameter conduit knockouts are acceptable; however, concentric and eccentric knockouts are not acceptable.

2. Outlet boxes mounted flush in CMU walls shall be made of galvanized, tack welded steel, and suitable for installation in masonry walls. Sectional type boxes are not acceptable for this application.

3. Outlet boxes mounted flush in gypsum walls shall be made of galvanized pressed steel. Tack welded boxes are not acceptable for this application. Sectional type boxes are not acceptable for this application.

4. Outlet boxes mounted cast into concrete shall be concrete tight and made of galvanized steel or PVC.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Pull and Junction Boxes

1. Pull boxes and junction boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.

2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.

3. Box penetrations for conduits shall be made with a punch tool, and penetrations shall be of the size required for the conduit entry and/or hub. Oversized penetrations in boxes are not acceptable.

4. Watertight conduit hubs shall be provided for boxes where a NEMA 4X enclosure rating is specified. Reference Section 16111 – Conduit for Electrical Systems for conduit hub requirements.

5. Pull and junction boxes may be installed flush mounted in gypsum, concrete, or CMU walls where appropriate provided that covers are easily removed or opened.

6. Pull and junction boxes shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. Outlet Boxes

1. Outlet boxes shall be solidly attached to structural members prior to installation of conduit and set true and plumb. Boxes shall not be supported by their associated conduits.

2. Wooden plugs are not permitted for securing boxes to concrete. Appropriately rated anchors specifically suited for use in concrete shall be used.

3. Flush mounted outlet boxes shall be arranged and located so that tile and grout lines fit closely around the boxes, and so placed that the cover or device plate shall fit flush to the finished wall surface.

4. Outlet boxes shall be flush mounted in finished areas and other areas where practical. Flush mounted outlet boxes shall not be installed in hazardous areas and type 1 or 2 chemical storage/transfer areas.

5. Depending on the type of wiring device to be installed in the outlet box, mounting heights from the finished floor or finished grade (as applicable) to the center of the box shall be as follows, unless otherwise specified herein, indicated on the Drawings, or required by the Americans with Disability Act (ADA):

    a. Light switches, 48 inches

    b. Receptacles in indoor dry process/non-process areas, 18 inches

    c. Receptacles in indoor wet process areas and all indoor chemical storage/transfer areas, 42 inches in open areas, or 6 inches (minimum) above adjacent surfaces (e.g., countertops, tables, etc.) where applicable

    d. Receptacles in outdoor locations, 26 inches

    e. Flush mounted outlet boxes in CMU walls shall be adjusted to a slightly greater height than required above to align the center of the box with the center of the CMU block.

6. Outlet boxes shall be provided in the material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

END OF SECTION

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SECTION 16141

WIRING DEVICES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all switches, and receptacles as shown on the Drawings.

B. All switches and receptacles shall be furnished and installed in outlet boxes. Reference Section 16130 – Boxes for Electrical Systems for outlet box requirements.

C. Reference Section 16000 – Basic Electrical Requirements and Section 16123 – Low-Voltage Conductors and Cables.

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Wiring devices shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

2. Underwriters Laboratories (UL):

a. UL 20 – General Use Snap Switches.

b. UL 498 – Standard for Attachment Plugs and Receptacles.

c. UL 943 – Ground Fault Circuit Interrupters.

d. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

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1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include, but not be limited to:

1. Product data sheets.

1.05 SPARE PARTS

A. The Contractor shall furnish 10% (minimum of 1) spare of each receptacle, switch, and plug furnished and installed for this project.

A. Reference Section 26 05 00 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.06 IDENTIFICATION

A. Each switch and receptacle shall be identified with the equipment item number, manufacturer's name or trademark, and such other information as the manufacturer may consider necessary, or as specified, for complete identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these Specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Contractor shall use the products of a single manufacturer for each type of wiring device.

C. The Contractor shall use the products of a single manufacturer for all device plates. Plate variations are allowed for the following devices:

1. Where the selected plate manufacturer does not manufacture a suitable finish plate.

2. For heavy-duty receptacles rated at more than 30A.

3. Where non-standard plates are required, specified, or shown.

D. The Contractor shall furnish and install all wiring devices and device plates.

E. In non-hazardous areas, provide specification grade devices manufactured by Appleton, Crouse-Hinds, Leviton, Hubbell, Pass & Seymour, or Engineer approved equal.

F. In hazardous areas, provide devices manufactured by Appleton, Cooper Crouse-Hinds, Hubbell-Killark, or Engineer approved equal.

2.02 WIRING DEVICES

A. Wall switches for non-hazardous areas shall be rated for the current required to suit the application, but not less than 20A. Double -pole, three-way, and four-way switches shall be provided where indicated on the Drawings, and as required. Switches shall be rated for 120-277VAC and shall be UL 20 Listed.

B. Convenience receptacles for non-hazardous areas shall be rated for 20A at 125VAC and shall be UL 498 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.

C. Special purpose receptacles (e.g., welders, lab equipment, etc.) shall be provided with the proper NEMA configuration and ampacity as indicated on the Drawings. The coordinating plug for each special purpose receptacle shall be provided with the equipment which it is serving.

D. Ground fault circuit interrupter receptacles shall be rated for 20A at 125VAC and shall be UL 943 Listed. Receptacles shall be weather -resistant where installed in wet or damp locations.

E. Wall switches for hazardous areas shall be the factory sealed type, UL 1203 Listed for use in the hazardous area. Wall switches shall be rated for 120-277VAC, and shall be rated for the current required to suit the application, but not less than 20A.

F. Receptacles for hazardous areas shall be rated 20A at 120-240VAC. Receptacles shall be UL 1203 listed for use in the hazardous area, utilizing delayed-action construction.

G. Wiring devices shall be approved for use with stranded conductors if stranded conductors are to be used with the device. Reference Section 16123 – Low-Voltage Conductors and Cable for conductor requirements

2.03 DEVICE PLATES

A. Device plates for indoor flush-mounted receptacles and switches shall be made of Type 304 stainless steel, not less than 0.032 of an inch thick, with beveled edges and milled

on the rear so as to lie flat against the wall. Devices plates shall be provided with a gasket.

B. Device plates for outdoor installations, indoor wet process areas, and chemical storage/transfer areas shall be Appleton Type FSK-1VS-A, Crouse-Hinds #DS185, or Engineer approved equal for wall switches. Device plates for receptacles shall be “in-use” style, and shall be fully closable when a plug/cord is inserted. “In-use” weatherproof covers shall be rugged, minimum 3 ¼” depth, die-cast aluminum as manufactured by Thomas & Betts "Red Dot," Intermatic International, Inc., or Engineer approved equal.

C. Device plates for indoor dry process and non-process areas with surface mounted boxes shall be Crouse-Hinds DS32 or Engineer approved equal for switches, and Crouse-Hinds DS23 or Engineer approved equal for receptacles.

2.04 PLUGS

A. The Contractor shall furnish suitable plugs with equipment furnished under the respective Specification Section. Plugs shall be black rubber or plastic. For waterproof receptacles, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided with clamping nuts and stuffing gland cable outlets.

2.05 PROCESS INSTRUMENTS

A. The Contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument, etc.) to disconnect the 120VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch without overload protection as manufactured by Crouse-Hinds, Appleton equivalent, or Engineer approved equal. For hazardous locations, the device shall be UL 1203 Listed.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Where more than one (1) switch occurs at one (1) location, gang plates shall be used.

B. All device plates shall be set true and plumb and shall fit tightly against the finished wall surfaces and outlet boxes.

C. Wiring device box (outlet box) mounting heights shall be as specified in Section 16130 – Boxes for Electrical Systems.

D. When indicated height would place any of the equipment at an unsuitable location such as at a molding or break in wall finish, the Contractor shall bring it to the attention of the Engineer for a decision.

E. Receptacles installed in toilet, locker, and bathrooms, and within 6 feet of a sink, shall be of ground fault circuit interrupter (GFCI) type. GFCI receptacles shall also be furnished and installed in additional locations where indicated on the Drawings, and as required by the NEC.

F. All receptacles shall have a self-adhesive label installed on the top at the respective device plate that indicates which panel and which circuit number the receptacle is supplied from. Labels shall have a white background and black lettering in 14-point font.

3.02 CIRCUITING

A. Convenience receptacles shall be grouped on circuits separate from the lighting circuits. A maximum of eight (8) convenience receptacles are permitted per 20A, 120V circuit, unless otherwise indicated on the Drawings.

END OF SECTION

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SECTION 16170
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install grounding systems complete in accordance with the requirements established by Article 250 of the NEC. Article 250 of the NEC shall be considered a minimum requirement for compliance with this Specification.

B. Grounding of all instrumentation and control systems shall be furnished and installed in accordance with the manufacturer/system requirements and IEEE 1100. Conflicts shall be promptly brought to the attention of the Engineer.

C. In addition to the NEC requirements, building structural steel columns and metallic chemical storage tanks shall be permanently and effectively grounded:

D. Reference Section 16000 – Basic Electrical Requirements

1.02 CODES AND STANDARDS

A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

   a. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

   b. IEEE 1100 – Recommended Practice for Power and Grounding Electronic Equipment.

2. National Fire Protection Association (NFPA):

   a. NFPA 70 – National Electrical Code (NEC).

3. Underwriters Laboratories (UL):

   a. UL 467 – Grounding and Bonding Equipment.

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1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittal Procedures, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Reports of certified field tests.

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Drawings and written description of how the Contractor intends to furnish and install the grounding system.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these specifications shall be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 GROUND RODS AND GRID

A. Ground rods shall be rolled to a commercially round shape from a welded copper-clad steel manufactured by the molten-welding process or by the electro-formed process (molecularly bonded). They shall have an ultimate tensile strength of 75,000 pounds per square inch (psi) and an elastic limit of 49,000 psi. The rods shall be not less than 3/4 inch in diameter by 10 feet in length; and the proportion of copper shall be uniform throughout the length of the rod. The copper shall have a minimum wall thickness of

0.010 inch at any point on the rod. Ground rods shall be UL 467 Listed. The ground rods shall be manufactured by Erico Products, Blackburn, or Engineer approved equal.

B. Except where specifically indicated otherwise, all exposed non -current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductors in nonmetallic raceways, and neutral conductors of wiring systems shall be grounded.

C. The ground connection shall be made at the main service equipment and shall be extended to the ground grid surrounding the structure. The ground grid shall also be connected to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp or lug connection to a plugged tee. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flanged connection.

D. Where ground fault protection is employed, care shall be taken so that the connection of the ground and neutral does not interfere with the correct operation of the ground fault protection system.

2.03 FITTINGS

A. Grounding connections to equipment shall be bolted. Cable end connections shall be made by hydraulic crimp or exothermically welded. Split bolt type connectors are not acceptable. Fittings shall be UL 467 Listed.

2.04 EQUIPMENT GROUNDING CONDUCTORS

A. An insulated equipment grounding conductor, which shall be separate from the electrical system grounded (neutral) conductor, shall be furnished and installed for all circuits. Insulation shall be of the same type as the ungrounded conductors in the raceway and shall be green in color. Equipment grounding conductors shall be furnished and installed in all conduits. Use of conduits as the NEC required equipment grounding conductor is not acceptable.

2.05 EQUIPMENT GROUNDS

A. Equipment grounds shall be solid and continuous from a connection at earth to all distribution panelboards. Ground connections at panelboards, outlets, equipment, and apparatus shall be made in an approved and permanent manner.

B. For all control panels, disconnect switches, and other electrical enclosures, equipment grounds, and bonding jumpers shall be terminated individually on a ground bar or mechanical lugs. No wire nuts will be permitted.

2.06 GROUND BARS

A. Ground bars shall be furnished and installed where indicated on the Drawings and where required in the Specifications. Ground bars shall be tin-plated copper, 1/4-inch thick (minimum) with hole pairs spaced for NEMA 2-hole cable termination lugs. The number of hole pairs shall be as required for the number of cables terminated, plus four (4) spares (minimum). Ground bars shall be provided with insulated mounting hardware.

2.07 EXOTHERMIC WELDS

A. All exothermic welding shall be completed per welding kit manufacturer's instructions. Exothermic welds shall be CadWeld by Erico or ThermoWeld.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Metal surfaces where grounding connections are to be made shall be clean and dry. Steel surfaces shall be ground or filed to remove all scale, rust, grease, and dirt. Copper and galvanized steel shall be cleaned with emery cloth to remove oxide before making connections.

B. Ground Grid

1. A main ground grid shall be provided for each structure and interconnecting structure grids consisting of driven ground rods as shown on the Drawings. Ground rods shall be driven straight down into the earth, or if objects are encountered, at an angle to avoid the obstruction.

2. The ground rods shall be interconnected by the use of copper cable sized as shown on the Drawings. The interconnecting cables shall be connected to ground rods by hydraulic crimp or exothermic weld where buried, and removable bolted clamp where shown to be installed in test wells. The grounding cables shall be installed after the excavations for the building have been completed and prior to the pouring of concrete for the footings, mats, etc. Copper "pigtails" shall be connected to the ground grid and shall enter the buildings and structure from the outside, and shall be connected to steel structures, equipment as described in this Section, and as required to provide a complete grounding system. The copper pigtails shall be hydraulically crimped or exothermically welded to the ground grid and connected to building reinforcement steel by hydraulic crimp.

3. Grounding conductors shall be continuous between points of connection; splices shall not be permitted.

4. Where conductors are exposed and subject to damage from personnel, traffic, etc., conductors shall be installed in metal raceway. The raceway shall be bonded to the grounding system.

5. Where subsurface conditions do not permit use of driven ground rods to obtain proper ground resistance, rods shall be installed in a trench or plate electrodes shall be provided, as applicable and necessary to obtain proper values of resistance.

6. Buried hydraulic crimp connections, exothermic welds, and ground ring shall not be backfilled until inspected by Engineer.

C. Raceways

1. Conduit which enters equipment such as switchgear, switchboards, motor control centers, transformers, panelboards, variable frequency drives, instrument and control panels, and similar equipment shall be bonded to the ground bus or ground lug, where provided, and as otherwise required by the NEC.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

b. Fall of potential tests shall be performed on the ground grid per IEEE 81 recommendations by a third party, independent testing firm. A fall of potential plot shall be submitted at the conclusion of testing for Engineer review. Documentation indicating the location of the rod and grounding system as well as the resistance and soil conditions at the time the measurements were made shall be submitted. Testing shall show that the ground grid has 5 ohms resistance or less. Due to soil conditions and/or unforeseen field conditions, ground resistances greater than 5 ohms may be acceptable if specifically approved in writing by the Engineer. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground grid under test isolated from other grounds.

c. Continuity tests for the grounding electrode conductor shall be performed. Test will be accepted when a resistance of less than 1 ohm is shown for this conductor.

END OF SECTION

SECTION 16190

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install structural supports for mounting and installing all conduits, electrical equipment, lighting, alarm systems, instrumentation, and control and communications equipment furnished under this Contract.

B. Equipment shall be installed strictly in accordance with recommendations of the manufacturer and best practices of the trade resulting in a complete, operable, and safe installation. The Contractor shall obtain written installation manuals from the equipment manufacturer prior to installation.

C. Support design for all nonstructural electrical components (e.g., conduit and other raceways, freestanding equipment, etc.) shall be provided in accordance with the governing Building Code and Section 01350 – Anchorage and Bracing of Nonstructural Components.

D. Reference Specification Section 16000 – Basic Electrical Requirements.

1.02 CODES AND STANDARDS

A. Equipment and materials covered under this Section shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American Society for Testing and Materials (ASTM):

a. ASTM A123 – Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

b. ASTM A153 – Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

c. ASTM A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

d. ASTM A276 – Standard Specification for Steel Bars and Shapes.

e. ASTM B783 – Standard Specification for Materials for Ferrous Powder Metallurgy Structural Parts.

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2. National Fire Protection Association (NFPA):

    a. NFPA 70 – National Electrical Code (NEC).

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

    1. Shop drawings

    2. Structural support calculations and designs in accordance with the governing Building Code and Section 01350 – Anchorage and Bracing of Nonstructural Components.

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

    1. Product data sheets.

    2. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 MATERIALS

A. Support channel shall be 1-5/8” by 1-5/8” minimum, with 12-gauge material thickness.

B. Support channel, support channel fittings, and threaded rod shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Material of Construction
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Hot Dipped Galvanized Steel
Indoor Dry Non-process Area	Hot Dipped Galvanized Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

C. Fastening hardware (bolts, nuts, washers, and screws) shall be furnished with the following material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Material of Construction
Indoor Wet Process Area	Type 304 Stainless Steel
Indoor Dry Process Area	Type 304 Stainless Steel
Indoor Dry Non-process Area	Type 304 Stainless Steel
Indoor Type 1 Chemical Storage/Transfer Area	Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	Type 304 Stainless Steel
All Outdoor Areas	Type 304 Stainless Steel
All Hazardous Areas	Type 304 Stainless Steel

PART 3 – EXECUTION

3.01 INSTALLATION

A. Concrete or Masonry Inserts

1. The Contractor shall be responsible for the furnishing and installation of all anchor bolts, masonry inserts, and similar devices required for installation of equipment furnished under this Contract.

2. If a time delay for the arrival of any special inserts or equipment drawings, etc. occurs, the Contractor may, if permitted by the Engineer, make arrangements for providing approved recesses and openings in the concrete or masonry and, upon subsequent installation, the Contractor shall be responsible for filling in such recesses and openings. Any additional costs that may be incurred by this procedure shall be borne by the Contractor.

3. The Contractor shall furnish leveling channels for all switchgear, switchboards, motor control centers, and similar floor mounted equipment. The leveling channels shall be provided for embedment in the equipment housekeeping pads. Coordination of the installation of these channels with the concrete pad is essential and required. Pad height shall be as required to maintain concrete coverage of the reinforcement bars while not causing associated equipment to exceed the maximum mounting height requirements of the NEC.

B. Support Fastening and Locations

1. All equipment fastenings to columns, steel beams, and trusses shall be by beam clamps or welded. No holes shall be drilled in the steel.

2. Unless otherwise indicated on the Drawings or in the Specifications, guards/handrails shall not be utilized as supports for electrical equipment, devices, or appurtenances. Guards/handrails shall not be cut, drilled, or otherwise modified in order to accommodate electrical supports without written approval from the Engineer.

3. All holes made in reflected ceilings for support rods, conduits, and other equipment shall be made adjacent to ceiling grid bars, where possible, to facilitate removal of ceiling panels.

4. Support channel shall be provided wherever required for the support of starters, switches, panels, and miscellaneous equipment.

5. Equipment, devices, and raceways that are installed on the dry side of a water bearing wall shall not be installed directly onto the wall. Support channel shall be used to allow ventilation air to pass behind the equipment, devices, or raceway.

6. All supports shall be rigidly bolted together and braced to make a substantial supporting framework. Where possible, control equipment shall be grouped together and mounted on a single framework.

7. Aluminum support members shall not be installed in direct contact with concrete. Stainless steel or non-metallic "spacers" shall be used to prevent contact of aluminum with concrete.

8. Actual designs for supporting framework should take the nature of a picture frame of support channels and bracket with a plate for mounting the components. The Contractor is responsible for the design of supporting structure; Contractor shall submit design details to the Engineer for acceptance before proceeding with the fabrication.

9. Wherever dissimilar metals come into contact, the Contractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

10. For all installations where fiberglass supporting materials are required, the Contractor shall submit structural calculations and the details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.

11. For the following installations where conduits are provided with a support system suspended from the above or attached to a vertical structure, the Contractor shall submit structural calculations and details of the proposed system of support. Structural calculations shall be signed and sealed by a Professional Engineer (P.E.) licensed in the State or Commonwealth in which the project is located.

    a. A quantity of twelve (12) or more conduits trade size 1” and smaller are proposed for a conduit support rack.

    b. A quantity of eight (8) or more conduits trade sizes 1 ½” to 2 1/2” are proposed for a conduit support rack.

    c. A quantity of four (4) or more conduits trade sizes 3” and larger are proposed for a conduit support rack.

12. Single conduits installed exposed along walls and ceilings shall be secured to the wall or ceiling with a one-hole conduit clamp and clamp-back. Where multiple conduits are installed exposed together, support channel and conduit clamps shall be used.

C. Equipment, boxes, and enclosures which are factory-constructed with integral mounting provisions (such as brackets, mounting feet, bolt holes, etc.) shall be installed/supported utilizing those mounting provisions. Equipment, boxes and enclosures shall not be field-modified by any means which compromises the UL Listing or NEMA rating of the enclosure/assembly.

END OF SECTION

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SECTION 16195
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. All electrical equipment shall be properly identified in accordance with these Specifications and the Contract Drawings. All electrical equipment shall be identified in the manner described, or in an equally approved manner.

B. The types of electrical identification specified in this Section include, but are not limited to, the following:

1. Operational instructions and warnings.

2. Danger signs.

3. Equipment/system identification signs.

4. Nameplates.

1.02 SIGNS

A. "DANGER-HIGH-VOLTAGE" signs shall be securely mounted on the entry doors of all electrical rooms.

1.03 LETTERING AND GRAPHICS

A. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit shop drawings. Each submittal shall be identified by the applicable Specification Section.

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1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The material covered by these Specifications is intended to be standard material of proven performance as manufactured by reputable concerns. Material shall be fabricated, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as specified herein and shown on the Drawings.

2.02 NAMEPLATES

A. Nameplates shall be engraved, high pressure plastic laminate, Choose an item. lettering.

B. Nameplates shall be attached to NEMA 4X enclosures utilizing UL-recognized mounting kits designed to maintain the overall UL Type rating of the enclosure. Mounting kit fasteners shall be stainless steel Type AHK10324X as manufactured by Hoffman, or Engineer approved equal.

2.03 HIGH VOLTAGE SIGNS

A. Standard "DANGER" signs shall be of baked enamel finish on 20 gauge steel; of standard red, black, and white graphics; 14 inches by 10 inches size except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where a larger size is needed for adequate identification.

2.04 CONDUIT IDENTIFICATION

A. Conduit identification shall be as specified in Section 26 05 33.13 – Conduit for Electrical Systems.

2.05 WIRE AND CABLE IDENTIFICATION

A. Field installed wire and cable identification shall be as specified in Section 16123 – Low Voltage Conductors and Cable and Section 16121 – Medium Voltage Cables.

B. A plastic laminate nameplate shall be provided at each panelboard, motor control center, switchgear assembly, and switchboard assembly. This nameplate shall be used to clearly convey the conductor identification means used at that piece of equipment (i.e., Phase A=Brown, Phase B=Orange, C = Yellow).

C. Wiring identification for factory installed wiring in equipment enclosures shall be as specified in the respective Section.

2.06 BOX IDENTIFICATION

A. Pull, junction and device box identification shall be as specified in Section 16130 – Boxes for Electrical Systems.

PART 3 – EXECUTION

3.01 NAMEPLATES

A. Nameplates shall be attached to the equipment enclosures with two (2) stainless steel sheet metal screws for nameplates up to 2-inches wide. For nameplates over 2-inches wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. The utilization of adhesives is not permitted.

3.02 OPERATIONAL IDENTIFICATION AND WARNINGS

A. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install plastic signs or similar equivalent identification, instruction, or warnings on switches, outlets, and other controls, devices, and covers or electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for the intended purposes. Signs shall be attached as specified above for nameplates.

3.03 POWER SOURCE IDENTIFICATION

A. After installation of all field equipment (e.g., valves, motors, fans, unit heaters, instruments, etc.) install nameplates at each power termination for the field equipment. Nameplate data shall include equipment designation (tag number), power source (MCC

number, panelboard, etc.), circuit number, conduit number from schedule and voltage/phase.

B. Contractor to coordinate with the Engineer and the Owner regarding exact nameplate placement during construction.

C. Nameplates shall be as specified herein.

END OF SECTION

SECTION 16280
SURGE PROTECTIVE DEVICES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, and place in satisfactory operation the surge protective devices (SPD) as specified herein and indicated on the Drawings.

B. Reference the following Specification Sections:

1. Section 16123 – Low-Voltage Conductors and Cables

2. Section 16195 – Identification for Electrical Systems.

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical & Electronic Engineers (IEEE):

a. C62.41.1 – IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.

b. C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low -Voltage (1000 V and less) AC Power Circuits.

c. C62.45 – IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.

d. C62.62 – IEEE Standard Test Specifications for Surge -Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and less) AC Power Circuits.

2. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

3. Underwriters Laboratories (UL):

072523

a. UL 1283 – Electromagnetic Interference Filters.

b. UL 1449 – Surge Protective Devices.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for re-submittal.

C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.

D. Shop drawings for each SPD shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Product Data Sheets.

3. Detailed drawings showing weights and dimensions.

4. Wiring diagrams showing field connections.

5. Proof that all products provided under this Section are UL Listed and Labeled by Underwriters Laboratories to UL1449, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc.) will be considered acceptable.

6. Proof of Short Circuit Current Ratings (SCCR), Voltage Protection Ratings (VPRs) for all modes, Maximum Continuous Operating Voltage rating (MCOV), Nominal Discharge Current (In), and device listing Type shall be submitted using the same means as described in the paragraph above.

7. Proof that all products provided under this Section are UL Listed and Labeled by Underwriters Laboratories to UL 1283, latest Edition. This proof shall be a copy of the data listed under the UL File Number for the manufacturer, which may be obtained from the UL Online Certification Directory. No other means of proving compliance (such as manufacturer data sheets, marketing material, etc.) will be considered acceptable.

8. Manufacturer’s Warranty Information

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.

B. The Contractor shall furnish one (1) spare field replacement module of each type and rating provided under this Contract.

C. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each SPD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each SPD. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

1.08 WARRANTY

A. All SPDs, associated hardware, and supporting components shall be warranted to be free from defects in materials and workmanship, under normal use and in accordance with the instructions provided, for a period of five (5) years after acceptance of the equipment by the Owner.

B. Any component or subassembly contained within the surge protection system that shows evidence of failure or incorrect operation during the warranty period, shall be replaced by the manufacturer at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 GENERAL

A. The SPD units shall be UL 1449 Listed and shall bear the UL mark. Units that are “manufactured in accordance with” UL 1449 or tested by other testing agencies “in accordance with” UL 1449 are not acceptable and will be rejected.

B. Type II SPD units shall be UL 1283 Listed and shall bear the UL mark. Units that are “manufactured in accordance with” UL 1283 or tested by other testing agencies “in accordance with” UL 1283 are not acceptable and will be rejected. Further, SPD units using UL 1283 capacitors but not tested to UL 1283 will be rejected.

2.02 PRODUCTS

A. Type I surge protective devices (SPD) shall be furnished and installed when shown without upstream overcurrent protection on the Drawings. Type II SPDs shall be provided in all other locations. Type II SPDs shall not require the use of a specific upstream overcurrent device. SPDs shall be provided in the location and quantity as shown on the Drawings.

B. Each SPD shall be rated for the voltage and configuration of the equipment to which it is connected.

C. Each Type II SPD shall have UL 1283 EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.

D. The short circuit current rating of each SPD shall match or exceed the rating of the equipment to which it is connected. The Contractor shall reference the Drawings for short circuit current rating of each piece of equipment.

E. Each SPD system shall provide surge protection in all possible modes. Surge protection shall be as follows:

System Configuration	Modes of Protection	Number of Modes
3-Phase Wye	L-N, L-G, N-G	7
3-Phase Delta	L-L, L-G	6
3-Phase Impedance Grounded	L-L, L-G	6
Single-Phase	L-N, L-G, N-G	3

F. Each SPD shall have a Maximum Continuous Operating Voltage (MCOV) of at least 115% of the nominal voltage of the equipment to which it is connected.

G. The Nominal Discharge Current (In) of each SPD shall be 20kA. Peak surge current ratings shall not be used as a basis for applying the SPD to the system.

H. The Voltage Protection Rating (VPR) of each SPD shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
208Y/120	800V	800V	1200V	800V
480Y/277	1200V	1200V	1800V	1200V
480 DELTA	N/A	1800V	1800V	N/A
240 DELTA	N/A	1200V	1200V	N/A
120/240	800V	800V	1200V	800V

I. The surge current rating for each SPD shall be as indicated on the Drawings. Surge current ratings are indicated on single line diagrams and in panel schedules. Surge current rating indicated is on a per phase basis.

J. SPDs which are indicated to be installed externally mounted from the equipment that they protect shall be provided within a separate enclosure. The enclosure shall match or

exceed the NEMA rating of the enclosure for the equipment that it is serving (e.g., NEMA1, NEMA 12, NEMA 4X, etc.).

K. Each SPD shall be provided with the following accessories:

1. Each individual module shall feature an LED indicating the individual module has all surge protection devices active. If any single component is taken off-line, the LED shall turn off and another LED shall illuminate, providing individual module as well as total system status indication.

2. Surge counter and audible alarm with reset/silence switch.

3. One set of Form C (SPDT) dry contacts rated for at least 5A at 120VAC.

L. SPDs which are indicated to be installed integral to (within) the equipment that they protect shall be manufactured by the same manufacturer as the equipment. SPDs which are indicated to be installed externally/separately mounted from the equipment that they serve shall be manufactured by Eaton, ASCO/Emerson Network Power, Current Technologies, GE by ABB, or Square D.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The SPD units shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. SPDs which are indicated to be integral with the equipment that they protect shall be installed within the enclosure for that equipment.

C. Externally mounted SPDs shall be installed as follows:

1. The SPD units shall be mounted such that the conductor lengths are as short as possible, but no greater than 36 inches. Any installation resulting in a conductor length of greater than 36 inches shall be reviewed with the Engineer as a special type of cable may need to be installed. For equipment such as panelboards, the Contractor shall relocate the circuit breaker that is to be connected to the SPD as needed to achieve the shortest conductor length possible.

2. The Contractor shall use a close nipple to enclose the conductors between the SPD and the equipment served. However, if due to field conditions a 90 degree conduit bend is required to connect the SPD to the equipment that it serves, the bend shall have a minimum radius of 36 inches to eliminate any potential for sharp bends in the conductors.

3. Conductors between the equipment served and the SPD shall be 600V power wire and cable as specified in Section 16123 – Low-Voltage Conductors and Cables. The individual conductors shall be gently twisted and sized as indicated on the Drawings.

D. Prior to energizing, the following shall be performed for each SPD:

1. Verify that the SPD unit voltage and configuration is suitable for the system to which it is connected.

2. Verify that any neutral-to-ground bonding jumpers are installed as required.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Shop Tests

a. Standard factory tests shall be performed on the equipment under this Section. All tests shall be in accordance with the latest version of NEMA, ANSI, and UL standards.

b. All surge protective devices, subassemblies, and components shall be 100% tested and certified by the manufacturer to meet their published performance parameters.

2. Field Tests

a. None required.

END OF SECTION

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SECTION 16305
MEDIUM VOLTAGE MOTOR CONTROL CENTERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operating condition medium voltage motor control centers (MVMCCs) as specified herein and indicated on the Drawings.

B. The MVMCC line-up shall include all equipment and accessories as specified herein and indicated on the Drawings to result in a complete equipment assembly.

C. The Contractor shall obtain the MVMCCs from a single manufacturer who shall also manufacture the structure and major equipment components. Subcontracting of wiring is not acceptable.

D. The MVMCCs shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured and labeled in compliance with IEC standards is not acceptable.

E. Reference Section 16000 – Basic Electrical Requirements; Section 16195 – Electrical Identification; and Section 16902 – Electrical Controls and Relays.

1.02 CODES AND STANDARDS

A. The MVMCCs shall be designed, manufactured, assembled, and tested in accordance with the following standards:

1. ANSI/NEMA ICS-3-Part 2

2. UL 347

3. EEMAC E14-1.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300– Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

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2. Operation and Maintenance Manuals

3. Spare Parts List

4. Reports of Certified Shop and Field Tests

5. Manufacturer’s Field Start-up Report

6. Manufacturer's Representative's Installation Certification.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submissions will be returned to the Contractor without review for resubmittal.

C. Shop drawings for each MVMCC assembly shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Product data sheets.

3. Complete assembly, layout, installation, and foundation drawings with clearly marked dimensions.

4. Weights of all major component parts, assembled weight of units and approximate total shipping weight.

5. Example equipment nameplate data sheet.

6. Plan, front and side view drawings, including overall dimensions of each motor control center. Identify shipping splits and show conduit entry/exit locations indicated on the drawings.

7. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.

8. Complete one-line diagram for each motor control center showing loadbreak switches, isolating switches, fuses, vacuum contactor, instrument transformers, meters, protective relays, motor protection module, timers, control devices, and other equipment comprising the complete assembly. Clearly indicate electrical ratings of all devices. Ratings include contactor size and type, fuse rating, transformer ratings, motor horsepower, speed, full load current, and similar information.

9. Bill of material for each section comprising the MVMCC assembly.

10. Nameplate schedule for each section.

11. Manufacturer's installation instructions.

12. Manufacturer's warranty statement.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books, descriptive bulletins, technical bulletins, application data booklets, and other applicable instructional information.

2. Recommended spare parts list.

3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process.

1.06 SPARE PARTS

A. The MVMCCs and accessories shall be furnished with all spare parts as recommended by the equipment manufacturer. The Contractor shall furnish the following additional spare parts for each motor control center assembly:

Number Required	Description
1 set	Fuses of each size provided

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each MVMCC shall be identified with the identification number indicated on the Drawings (e.g. MVMCC-TF). A nameplate shall be securely affixed in a conspicuous place on each MVMCC section. Nameplates shall be as specified in Section 16195 – Electrical Identification.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the MVMCCs be produced by a single manufacturer who shall be responsible for matching all components and providing equipment which functions together as a system.

C. The MVMCCs shall be Ampgard as manufactured by Eaton, Motorpact as manufactured by the Square D Company, or Limitamp MV as manufactured by ABB.

2.02 MEDIUM VOLTAGE MOTOR CONTROL CENTERS

A. Ratings

1. MVMCCs shall be designed for operation on a 4.16 kV, three-phase, 60 hertz system.

2. Each complete MVMCC assembly shall have a minimum short circuit current rating of 50,000 amperes symmetrical at rated voltage.

B. Construction

1. Each MVMCC section shall be of two-high cabinet design with bolted field wiring terminations. Enclosures shall be NEMA 1A (gasketed) unless otherwise noted, made of 12-gauge steel, painted as specified herein. Enclosures shall be completely front accessible, allowing for free-standing, against a wall, or back-to-back mounting.

2. Each section shall accept bottom or top entry of cables.

3. Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils. The finish shall have the following properties:

Impact resistance (ASTM D-2794)	60 Direct/60 Indirect
Pencil Hardness (ASTM D-3363)	H
Flexibility (ASTM D-522)	Pass 1/8" mandrell
Salt Spray (ASTM B117-85)[20])	600 hours
Color	ANSI 61 Gray

C. Bus

1. Buses and main connections shall consist of flat tin-plated copper bars. All main and ground buses shall be extended through the entire length of the switchgear assembly. Access to the main bus shall be from the front of the structure.

2. Main and vertical bus shall be fully insulated for its entire length with a flame retardant and track-resistant epoxy coating installed by the fluidized bed process. Provide the 3-phase bus of each unit with insulation to completely encase each bar except provide removable, insulating boots at bus joints.

3. Bus supports between units shall be indoor NEMA class insulators made of flame-retardant, track-resistant glass polyester. All bus joints shall silver plated and be insulated with easily installed boots. The bolted bus joints shall use constant pressure washers for positive contact.

4. A ground bus of adequate capacity shall be furnished and installed throughout the switchgear structure. The ground bus shall be of sufficient size to conduct the rated two-second current of the switchgear assembly. Each stationary unit at a bare metal surface shall be effectively connected to this ground bus.

D. Load Break Switches

1. Load break switches shall be three-pole, manually operated, quick-make, quick-break. The fixed mounted switches shall fit in one-half of a standard vertical structure when supplied with 400A or smaller fuses. Provide mechanical interlocks such that the switch door cannot be opened when the switch is on, and when the door is open the switch cannot be closed. A safety screen shall be provided behind the switch door.

2. Each load break switch shall have the following ratings:

Maximum Voltage	5.5 kV
Basic Impulse Level	60 kV
Continuous and Load Interrupting Current	As shown on the Drawings
Fault Close Current	40 kA Asym.
Fault Withstand Current	25 kA Sym.

E. Low Voltage Control

1. The low voltage control shall be isolated and barriered from the high voltage area and provided on a panel with a separate low voltage access door. The control shall be accessible by sliding the panel out of the low voltage control compartment.

2. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit with the high voltage de-energized and isolated and the contactor in its normal position or in its draw-out inspection position. In the test mode, the control circuit shall be capable of being energized through a polarized plug connector from an external 115 VAC supply.

F. Warning Signs

1. Warning signs shall be of red and white laminated phenolic materials engraved through red exterior lamination to white center with approximately 1/2 high letters.

2. Signs shall read "DANGER – HIGH VOLTAGE – KEEP OUT" in compliance with NEC Article 110.34(C). All new and existing MVMCC sections shall have a warning sign installed in the appropriate location.

G. Reduced Voltage Starters

1. The reduced voltage solid-state controller shall be Eaton type MV4S, Square D equivalent, or GE by ABB equivalent. The starter shall be UL and CSA listed. The SCR-based power section shall consist of back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating as shown in the ratings section. Units

using triacs or SCR/diode combinations shall not be acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.

2. The fully-rated run bypass contactor shall energize when the motor reaches 90% of full speed. The solid-state power stack assembly shall be mounted on a roll-out truck for ease of maintenance. The full-voltage starting feature of the RVSS shall be programmatically disabled at the factory to ensure the motor will only be start and ran using the SCRs.

3. Reduced voltage solid-state controllers shall include protection and ramp features programmable via the integrated keypad or a laptop computer including:

   a. Dual ramp adjustments with current limit to 600% FLA, acceleration time of 1 to 120 seconds

   b. Kick start, 0.1 to 2.0 seconds at 10% to 100% voltage

   c. Selectable ramp profiles to match any application

   d. Pump deceleration, 1 to 60 seconds with begin and end torque adjustments

4. Reduced voltage solid-state controllers shall include a fiber-optically isolated low voltage compartment.

5. The reduced voltage solid-state starters shall have the following ratings:

Description	Specification
Horsepower	HP as shown on the drawings
Power Ratings	600% FLA for 30 Sec. 125% Continuous
PIV Ratings	5000 Vac: 14000 V
Starting Torque	5 to 85%
Ramp Time	0 to 180 Seconds
Maximum Voltage Rating	5000 Vac
BIL Rating	60 KV
Rated Short Circuit Amperes	50 kA rms Sym.
Overall Efficiency	99.7% without bypass/99.94% with bypass
Transient Protection	DV/DT Circuits/Phase

H. Protective Relays

1. Each medium voltage motor controller shall be provided with a microprocessor based, motor protector to protect, monitor, and control the respective motor.

2. The motor protector shall be capable of monitoring electrical current; receive commands from remote sources either by contact closures or digital data; give

commands (e.g. fail, trip, etc.) to the motor controller and other devices under its control; and communicate by alphanumeric display with the operator and by digital signals with other equipment.

3. True rms current shall be constantly monitored, separated into positive and negative sequence components to determine the heating effects caused by both, and processed to provide maximum motor utilization. The motor protector shall be mounted on the low voltage compartment door. Current transformers shall be provided as indicated on the Drawings and as required.

4. Specific data entry to suit the actual motor application shall be accomplished by means of an operator panel. Entered data shall be stored in "non-volatile" memory so as not to require battery back-up.

5. A digital display of monitoring functions including, but not limited to, the following shall be provided:

    a. Line current in each phase in rms amperes

    b. Running time (cumulative in hours)

    c. Remaining starts

    d. Motor starts exceeded

    e. Total energy consumption

    f. Power factor

    g. Power in kilowatts

    h. Voltage reading

    i. Alarm status

6. The following protection and control functions including, but not limited to, the following shall be provided:

    a. Motor running time overcurrent: Device 49/51

    b. Zero-sequence ground fault: Device 50G/51G

    c. Adjustable instantaneous overcurrent: Device 50

    d. Underload trip with start and run time delays: Device 37

    e. Current unbalance: Device 46

f. Incomplete sequence delay: Device 48

g. Limitation on number of starts per time-period: Device 66

h. JAM trip with start and run time delays

i. Phase loss (voltage)

j. Phase unbalance (current)

k. Phase reversal (voltage)

l. Undervoltage

I. Motor protectors shall be 859 as manufactured by GE/Multilin, or 710 as manufactured by SEL.

J. Accessories

1. Provide a fuse puller for each MVMCC.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The MVMCCs shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment. The equipment shall be suitably protected until accepted by the Owner.

B. The Contractor shall check all bolted connections to assure that they are in accordance with the manufacturer's recommended torque requirements.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit certified copies of all test reports.

c. As a minimum, the entire MVMCC shall go through a quality inspection before shipment. This inspection shall include, but is not limited to, the following:

1) Physical inspection of the structure and the electrical conductors including bussing, general wiring, and MVMCC sections.

2) General electrical tests including power circuit phasing and device electrical operation.

3) AC dielectric tests of the power circuits.

4) Markings/labels, including instructional type, Underwriters Laboratory (U.L.), and inspector's stamps.

d. The following standard factory tests shall be performed on the equipment provided under this Section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1) Wiring check.

2) Dielectric Test (Hi Pot) per NEMA ICS 3 Part 2 at 2000 volts plus 2.25 times nominal voltage, for 60 seconds, phase-to-phase and phase-to-ground.

3) Style/part no. check of components.

e. The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the MVMCC.

3. Field Tests

a. Field tests shall be performed in accordance with requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified, factory-trained manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

B. The manufacturer’s technical representative shall perform all startup and field acceptance testing as specified herein.

C. The Contractor shall provide training for the Owner’s personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner’s personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall not take place until after the MVMCC has been installed and tested. Training shall be conducted at times coordinated with the Owner.

D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One (1) trip of one (1) working day during installation of the MVMCC.

2. One (1) trip of five (5) working days to perform startup and field acceptance testing of the MVMCC.

3. One (1) trip of one (1) working day to perform training as specified herein.

4. One (1) trip of one (1) working day two (2) months before the expiration of the warranty to identify any issues to be corrected under warranty.

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

3.04 PAINTING

A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

-END OF SECTION-

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SECTION 16395

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFDs) as specified herein and indicated on the Drawings.

B. **VFDs shall be suitable for use with existing synchronous type motors. See Drawings for important existing motor nameplate information.**

C. Reference the following Specification Sections:

1. 16000 – Basic Electrical Requirements

2. 16195 – Identification for Electrical Systems

3. 16902 – Electric Controls and Relays

D. The Contractor is responsible for coordinating with the driven equipment manufacturer and the VFD manufacturer to ensure that the VFD is sized properly to meet all of the requirements herein. This includes, but is not limited to, accounting for motor RPM and variable or constant torque applications. The Contractor is responsible for including any costs related to equipment upsizing, conduit and wire upsizing, etc. that results from selecting equipment with a higher full load amp rating than was specified or used as the basis for design.

E. The variable frequency drives shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

1.02 CODES AND STANDARDS

A. VFDs shall be designed, manufactured, and/or listed to the following standards as applicable:

1. NEMA 250 – Enclosure for Electrical Equipment

2. IEEE 519 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

080519

3. NEMA ICS 61800-4 – Rating Specifications for AC Power Drive Systems Above 1000VAC and Not Exceeding 35kV

4. UL 347A – Standard for Medium Voltage Power Conversion Equipment

1.03 DEFINITIONS

A. The following definitions are provided for clarity with regard to the language used in this Specification:

1. Variable Frequency Drive (VFD) – The complete custom-engineered VFD as packaged within an overall enclosure, including the VFD unit and all other components within that enclosure as specified herein.

2. VFD Unit – The solid-state power electronic device or devices within the VFD.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Reports of Certified Shop and Field Tests

5. Manufacturer’s Field Start-up Report

6. Manufacturer’s Representative’s Installation Certification

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings <u>for each VFD</u> shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and

Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Complete bill of material and catalog data sheets for all equipment and devices comprising the VFD.

3. Heat loss data for each VFD.

4. Manufacturer’s warranty information.

5. Product data sheets for all system components, including but not limited to:

    a. VFD units

    b. Input power transformer and rectifier

    c. Harmonic correction devices and/or equipment

    d. Output reactors and/or output filters

    e. Pilot lights and pilot devices

    f. Control and timing relays

    g. Enclosure fans

    h. Contactors

    i. Power supplies

    j. Control power transformers

    k. Current transformers

    l. Potential transformers

    m. Circuit breakers and/or motor circuit protectors

    n. Fuses

o. Terminal blocks (power, control, and shorting)

6. Layout drawings of the VFD that include:

   a. All cabinet or enclosure dimensions, access details, and weights.

   b. Required clearances around the enclosure, e.g. ventilation.

   c. Conduit entry areas and/or stub-up locations.

   d. Nameplate sizes, colors, and locations.

   e. Physical arrangement of door mounted devices located on the variable frequency drive enclosure.

   f. Physical arrangement of **all** interior components, including DIN-rail-mounted devices.

   General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

7. Custom schematic and interconnection wiring diagrams of all electrical work, including but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, terminal blocks and identification numbers, wire numbers, and other equipment comprising the complete system.

   a. These drawings shall be circuit specific for each motor-load combination (e.g. High Service Pump No.6). Specific equipment names consistent with the Drawings shall appear on each respective diagram.

   b. Indicate all devices, regardless of their physical location, on the schematic diagrams.

   c. Electrical ratings of all equipment and devices shall be clearly indicated on the schematic diagrams.

   d. Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable.

8. Confirmation of spare parts requirements as specified herein.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01300 – Submittals and Section 11000 – Equipment General Provisions.

B. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD. These final drawings shall be included in the O&M manuals and an additional copy that is plastic laminated shall be securely placed inside each VFD.

C. The O&M manual shall include the “as-commissioned” parameters of each VFD in both print and digital formats.

D. If the VFDs require computer software or configuration, the O&M manual shall include copies of all programming guides/manuals.

1.07 SPARE PARTS

A. The VFDs and accessories shall be furnished with all spare parts as recommended by the equipment manufacturer. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts:

1. Two (2) sets of fuses for each size and type of fuse provided.

2. One (1) HMI per type of HMI provided.

3. Two (2) sets of fully functional control boards.

4. Two (2) fully functional power phase modules and one phase module removal kit.

5. Two (2) spare cooling fans.

6. Three (3) sets of enclosure air filters.

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.08 QUALIFICATION OF MANUFACTURERS

A. References

1. Provide a minimum of three (3) references with VFDs of the same model and type, and of similar size, for systems installed and operating in the United States. At least two (2) of the references shall include systems that also operate on standby generators. At least two (2) of the references shall include systems that operate on synchronous motors. References names, addresses, and telephone contact numbers shall be submitted as part of the Reference List.

B. Qualification of Manufacturers

1. The drive manufacturer shall have been in the drive business for a minimum of ten (10) years and shall have been manufacturing Medium Voltage VFDs for 4160 VAC motors (without using output transformers) for at least five (5) years.

2. The drive manufacturer shall maintain factory trained and authorized service facilities for their drives within 250 miles of the project site and have a demonstrated record of service for Medium Voltage VFDs for at least the five (5) years. Full-time service support shall be employed by the manufacturer.

3. The drive manufacturer shall own and operate its factory testing facilities. Factory testing, as specified herein, shall be performed at these facilities, which shall have the capability of running tests with full motor load. Manufacturers using third party testing facilities and manufacturers using simulated loads for testing will be rejected.

4. The drive manufacturer shall manufacture the enclosure, the variable frequency controller itself, and the custom controls required under this Contract. Drive assemblies fabricated by an integrator who does not manufacture the key components of the drive will not be permitted.

1.09 WARRANTY

A. Contractor shall warrant that the material and workmanship of all components and the operation of the VFDs and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty shall include, but not be limited to the following:

1. Replace components found to be faulty and make changes in equipment arrangement or make adjustments necessary to meet the equipment or functional requirements or this Specification.

2. System rewiring and component substitution/rebuild.

3. All accessories and appurtenances provided by the VFD manufacturer.

C. Warranty shall be in effect for a period of 36 months following final acceptance of each VFD.

1.10 MAINTENANCE SUPPORT

A. The manufacturer shall guarantee that service support shall be domestically available for a minimum of 20 years.

B. The maximum response time for trouble calls shall be two (2) hours. A qualified service technician shall be on site within 24 hours of a qualified request.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Contractor shall obtain the VFDs from one manufacturer who shall also manufacture and assemble the enclosure and major equipment components including, but not limited to the VFD unit and bypass starters. The manufacturer shall have five years minimum of experience in the manufacture of similar units and shall have a general distribution to the electrical trade. Subcontracting of wiring and/or third-party assembly is not acceptable.

C. The VFDs shall be manufactured by Toshiba, Eaton, TMEIC, ABB, or Rockwell Automation (Allen-Bradley).

D. The Contractor shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the appropriate sources and integrating these into a VFD that fulfills the requirements of this Specification.

2.02 VFD SYSTEMS

A. Operating Conditions

1. The following operating conditions are applicable for all equipment of this Specification.

    a. Humidity: 0-95%.

    b. Ambient Temperature: 0 degrees Celsius to plus 40 degrees Celsius.

    c. Altitude: up to 3,300 feet

B. Basic Design and Performance

1. Each VFD shall be a complete alternating current electric drive system including all hardware and software necessary to accomplish variable speed operation of a motor and load combination. VFDs shall be provided in accordance with the requirements indicated on the Drawings and as described in these Specifications.

2. Each VFD shall be suitable for operation as part of a 4160 VAC, 3-phase, 60 Hertz power distribution system. The complete VFD system shall have a minimum short circuit current rating of 65,000 amperes symmetrical at rated voltage.

3. **The Contractor** is fully responsible for the review of the full Contract Documents to determine specified motor speed, horsepower and full load ampere requirements for each motor-driven load. In addition, the Contractor shall size and select the VFD and components as follows:

    a. Each VFD shall provide, continuously, motor load current equal to 100% of the direct on-line motor nameplate full load current.

    b. Each VFD shall be selected for Variable Torque (Normal Duty.

4. Each VFD shall be provided with control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks. Each VFD shall be designed such that specific control and protection functions can be attained through simple programming by either factory engineers or Owner's trained operating personnel.

5. Motor control circuits shall be wired in accordance with the requirements specified herein and/or indicated on the Drawings.

C. Components

1. Each VFD shall contain the number of VFD units as shown on the Drawings and required for the applications.

2. Each VFD shall contain the harmonic correction equipment as shown on the Drawings and required for the applications. Harmonic correction equipment shall be as specified elsewhere in this Specification.

3. Each VFD shall contain the number of auxiliary contacts, control power transformer(s), pilot devices and indicating lights, control relays, elapsed time meters, and other devices as specified herein, shown on the Drawings and required for the applications. The following components shall meet the requirements of Section 16902 – Electric Controls and Relays:

    a. Pilot devices (switches, indicating lights, etc.)

    b. Relays and timers

    c. Terminal blocks

4. Each VFD shall be provided with full-capacity-rated vacuum-style isolation contactors as shown on the Drawings. Contactors shall be electrically and mechanically interlocked as shown on the Drawings.

5. Power terminal blocks for VFD output to the motor shall be fixed-mounted to a backplane or the enclosure. Mounting the terminal blocks on DIN rails is not acceptable.

6. Electrical bus, including ground bus, shall be tin-plated copper. All connections shall be bolted or continuously welded. Ground bus shall span the entire width of the enclosure base.

7. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.

8. Each VFD shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

9. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100% redundant. New and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be provided in lieu of 100% redundant auxiliaries if accepted in writing by the Engineer.

10. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished.

11. VFDs shall be furnished with motor management and protection relays as specified elsewhere in this Specification.

12. Power Disconnect Devices

    a. Each VFD shall include an integral main disconnect device with an interlocked and padlockable handle mechanism. The disconnecting device shall be a medium voltage vacuum contactor with a bolted pressure disconnect switch whose blades are externally visible from outside the enclosure. The disconnect device and respective fuses shall have a momentary withstand rating of 250 MVA minimum.

13. Input Power Transformer and Rectifier

a. The VFD shall contain an incoming dry-type isolation transformer if required to mitigate common mode voltage, whose primary voltage shall be as specified herein and indicated on the Drawings.

b. The transformer, if required, shall include three-phase secondary windings that provide the proper phase shifting to supply a minimum of 24-pulse rectification or active front end rectifier to reduce harmonic currents and voltages reflected to the primary power system.

c. The transformer shall be copper wound and shall have a 220 degrees C insulation system to operate at 95 degrees C rise at full load conditions.

d. The transformer shall have an electrostatic shield for protection from voltage transients.

e. The rectifiers shall be protected by fuses with blown fuse indication.

f. The transformer and rectifier shall be an integral part of the VFD assembly with primary disconnect switch, input vacuum contactor, and secondary fusing eliminating the need for separate field installation or wiring.

g. If required, soft charge of the DC bus capacitors shall be accomplished by use of an input reactor on the primary of the input transformer. A vacuum contactor rated for drive full load current shall short the reactor after charge is accomplished.

14. Current Transformers

a. Provide window-type current transformers of the quantity as indicated on the Drawings. Current ratings shall be selected by the manufacturer.

b. Transformers shall be rated in accordance with ANSI Standard C37.20.1, with accuracy of the current transformers suitable for BO.5 metering accuracy at rated burden. The transformers shall be sized for the necessary burden for the required devices, minimum.

c. Identify the current transformers for polarity with standard marking or symbols. The transformers shall be capable of carrying rated primary current continuously without damage.

d. Run secondary wiring from current transformers in suitable wiring trough, or conduit, to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

e. Provide door mounted test blocks for all current transformers in the VFD.

15. Potential Transformers:

a. Potential transformers shall be indoor dry type, single-phase, 60 hertz.

b. Potential transformers shall have an accuracy classification determined according to ANSI Standards. The potential transformers shall be suitable for metering accuracy, the burden to be served for the required devices plus 20 percent, and shall meet the following minimum requirements:

1) BIL: 10kV

2) Primary Voltage: 4160 VAC

3) Secondary Voltage: 120 VAC

4) Metering Accuracy Class: 0.3 at rated burden

c. Identify polarity with standard markings or symbols. Connect secondaries to potential buses as required. Protect potential transformers with primary and secondary fuses. Protect primary side with current-limiting fuses.

d. Provide door mounted test blocks for all potential transformers in the VFD. Test switch wiring shall be plainly marked to indicate the respective circuits to each pole of the switch. Test switches shall be ABB Flexitest Type FT-1 with clear cover, GE/Multilin equivalent, or equal.

16. Control Power Transformers

a. Provide 4160 VAC to 120 VAC control power transformers as required. Verify that control power transformers have adequate capacity for the load to be served.

b. Protect control power transformers with both primary and secondary fuses. Protect primary side with current limiting fuses. Provide a manual disconnect ahead of the primary fuses.

c. Control power transformers for space heaters, lighting, receptacles and other ancillary loads shall be separate from those used for control circuits.

D. Controls

1. Each VFD shall be provided with automatic and manual controls as shown on the Drawings and as required to comply with all Specifications. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings.

2. The Elementary Control Schematics shown on the Drawings are **representative of design intent only**. The manufacturer shall be responsible for providing all

additional components, controls, and internal wiring necessary to meet the design intent.

3. VFD circuitry shall be designed such that the enclosure cooling fans only run when the VFD unit is producing output power or during a cool-down period after operation. Designs that allow the enclosure cooling fans to run continuously when the VFD unit is energized but not producing output power are not acceptable. Fans that are used exclusively to provide cooling for the VFD unit (and not the overall enclosure) are permitted to run continuously if required by the VFD manufacturer's design standards/practices.

    a. Ventilation controls shall include a Loss of Cooling Fault. In the event of clogged filters or fan failure, the drive shall produce an alarm and then, in a predetermined time, shutdown safely without electronic component failure. Redundant fans shall be included in the drive design as backup in the event of fan failure.

    b. VFD shall have air flow detection switches to monitor proper operation of the system. Use of temperature detectors alone to determine loss of cooling is not acceptable.

E. Enclosures

1. Equipment within the VFD enclosure shall be arranged so that it does not interfere with the entry of conduits and cables into the enclosure.

2. All pilot devices (selector switches, pushbuttons, indicating lights, etc.) and the human machine interface (HMI, specified elsewhere herein) shall be door mounted on the exterior of each VFD enclosure. Manipulation of the pilot devices or HMI, viewing of the information on the HMI, or viewing that status of pilot devices shall not require the VFD enclosure door to be opened.

3. Unless otherwise indicated on the Drawings, VFDs in non-hazardous locations, shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

4. VFDs shall not be installed in hazardous locations.

5. NEMA 1 and NEMA 12 VFD enclosures shall be force ventilated with front accessibility and the following:

    a. Enclosures shall be provided with washable enclosure air intake filters that can be replaced while the enclosure door remains closed.

    b. Enclosures shall be designed for bottom or top entry of conduits and cables as required.

    c. Enclosures shall be finished in ANSI-61 gray enamel or in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

6. NEMA 4X VFD enclosures shall be air conditioned, dead-front, with front accessibility and the following:

    a. The air conditioning system shall utilize a heat-exchange method that allows for cooling of the enclosure interior without circulating outside air through the enclosure.

    b. Enclosures shall be furnished with tubular type enclosure space heaters. Space heaters shall be rated at 500V or 250V and operated at 240V or 120V, respectively.

    c. VFDs shall be furnished with an additional control power transformer sized to provide power exclusively for the air conditioning system and enclosure space heater.

    d. VFDs shall be furnished with a tamper-resistant hinged cover with a clear polycarbonate viewing window over the door-mounted pilot devices.

    e. VFDs shall be designed for bottom entry of cables/conduits only.

7. Each VFD enclosure shall be designed such that rear or side cabinet access is not required for operations, maintenance, cooling, and repair tasks.

8. Enclosure doors shall have heavy duty hinges. Brace each door to prevent sag when fully open.

9. The Contractor shall reference the Drawings for maximum dimensions of the VFDs. No exceptions to the dimensions indicated on the Drawings will be permitted.

10. Integrating VFDs into a motor control center assembly is not permitted.

11. When operating at full load, the maximum noise level of the VFD assembly shall not exceed 85 dBA as per OSHA standards at a distance of 1 meter from the unit and at a height of 1.5 meters from the floor.

F. Nameplates and Legend Plates

1. Provide engraved plastic nameplates and legend plates to identify each VFD and associated door mounted devices and internal components. Nameplates shall be as specified in Section 16195– Identification for Electrical Systems.

2. Equipment names and/or numbers and device identification text shown on the Drawings shall be used as the basis to engrave the nameplates and legend plates. Where the equipment identification text would exceed the capacity of the VFD manufacturer’s standard nameplate/legend plate size, the manufacturer shall provide larger nameplates and/or additional nameplates as necessary. Abbreviating equipment names/numbers and device identification text is not acceptable.

3. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked with identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

2.03 VFD UNITS

A. The VFD unit shall be the Toshiba T300MV2 series, Eaton SC9000 series, TMEIC MVe2 series, ABB ACS2000 series, or Allen-Bradley PowerFlex 7000 series.

B. Basic Design and Performance

1. Each VFD unit shall be of adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 4160 VAC NEMA Design A or B synchronous motors. Units for other than NEMA Design A or B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.

2. Each VFD unit shall consist of a semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the motor at the desired speed. The inverter shall also conform to the following requirements:

a. The inverter shall consist of modular power cells. Output devices shall be Insulated Gate Bipolar Transistors (IGBTs) or Symmetrical Gate Commutated Thyristors (SGCTs).

b. The IGBTs or SGCTs shall be designed in a bridge connection such that when used in combination with the other bridges, a multi-level output motor voltage waveform is constructed.

c. The IGBTs or SGCTs shall be cooled using a sealed cooling system utilizing modern heat plate technology or forced air cooling.

d. Each cell shall communicate to the controller through optical communications. No other isolation method is permitted.

e. A high resistance ground detection circuit at the neutral point or a motor protection relay shall be included for alarm or warning in the event the load develops a ground leakage current or fault.

f. Three (3) Hall Effect current transformers shall be used for current feedback on the VFD output.

g. PWM firing pulses shall result in an output voltage and current waveform that will have less than one percent (1 percent) torque ripple over a 20:1 speed range on the motor.

h. The output of the inverter shall produce harmonic current of not more than 3 percent at full load.

3. Each VFD unit shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

4. The overall efficiency of each VFD unit shall be a minimum of 95% when operating the specified motor-load combination at rated voltage, frequency, and current.

5. Each VFD unit shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed. The VFD unit shall be provided with adjustable maximum and minimum frequency limits.

6. Each VFD unit shall maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5% of rated frequency of 60 Hertz for a 24 hour period and a repeatability of 0.1% of rated frequency of 60 Hertz.

7. Each VFD unit shall be capable of operating the specified load continuously at any speed within the operating speed range of 10% to 100% of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

8. Each VFD unit shall be capable of controlled linear acceleration and deceleration. Each VFD unit shall be capable of ramping the speed of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Each VFD unit shall have two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.

9. Voltage or current unbalance between phases of the VFD unit output voltage shall not exceed 3% of the instantaneous values. The VFD unit shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3%. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

10. Each VFD unit shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10% for a duration of 15 cycles. VFD unit output voltage regulation shall be plus or minus 2%.

C. Features and Characteristics

1. Each VFD unit shall be furnished with a Human Machine Interface (HMI) to provide controls and indication to accomplish maintenance and operational functions as specified herein and shown on the Drawings. The HMI shall be password protected after startup to prevent unauthorized personnel from making changes. The HMI shall at minimum provide indication of the following:

   a. Input Voltage

   b. Output Voltage

   c. Output Current

   d. Output Frequency

   e. Output Speed from 0-100%

   f. Alarm Read-out

2. Each VFD unit shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback/ indication to external equipment.

3. Each VFD unit shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed equal to or less than 0.1% of rated speed.

4. Each VFD unit shall shut down during a power outage or sustained undervoltage event. A sustained undervoltage event is defined as voltage that is less 75% of nominal, for more than 0.5 seconds. Upon restoration of normal power and after an adjustable time delay (0-2 minutes; motor has coasted to zero speed and there is no backspin), the VFD unit shall automatically restart and then ramp up to speed as required by the control system. Personnel shall not be required to reset the system manually after a shutdown caused by a power outage or sustained undervoltage event.

5. Provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the VFD unit, this feature shall be capable of being disabled.

6. Each VFD unit shall have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The VFD unit shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

7. Each VFD unit shall be furnished with programmable electronic overload and torque limits.

8. Each VFD unit shall have an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall lock-out the VFD unit and indicate the fault only upon the following conditions:

    a. Output voltage unbalance (trip threshold field set).

    b. Loss of phase on output.

    c. Motor overload.

    d. Motor stator winding fault (phase-to-ground, phase-to-phase).

    e. Unacceptable voltage variation.

f. High variable frequency drive equipment temperature.

g. VFD failure as determined by the manufacturer.

h. Component failure.

i. Overcurrent.

9. Provide each VFD unit with transmitted and received radio interference protection.

10. Each VFD unit shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure.

    a. Diagnostics shall operate a visual alarm indicator on the HMI.

    b. Diagnostics shall provide an easily readable output that can be used to isolate a failure.

    c. The HMI shall display in narrative English the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.

    d. Provide normally open and/or normally closed dry contacts as indicated on the Drawings for VFD failure conditions.

11. Each VFD unit shall communicate the following parameters to the facility control system via Ethernet/IP protocol. Provide any necessary hardware gateways to provide this communication capability. The following parameters, at a minimum, shall be communicated:

    a. Current (all phases)

    b. Voltage (all phases)

    c. KW, KVAR, KVA

    d. Power Factor

12. Each VFD unit shall be provided with input/output (I/O) cards including expansion cards as necessary to facilitate connection of all I/O specified herein and shown on the Drawings.

2.04 MOTOR PROTECTION RELAYS

A. Provide a motor protection relay for each pump. Motor protection relays shall be as specified in Section 16305 – Medium Voltage Motor Control Centers.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. Install VFDs to allow complete door swing required for component removal.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. The VFDs specified in this Section shall be witness shop tested and inspected in accordance with the equipment manufacturer's standard procedures and the certified shop testing described below. The testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to such tests and inspection dates.

b. Certified Shop Tests and Reports

c. Submit description of proposed testing methods, procedures, and apparatus.

d. Factory test the complete VFD in accordance with IEEE and NEMA standards.

e. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications referenced in Section 16000 – Basic Electrical Requirements.

b. The Contractor shall field measure actual harmonic distortion with tests performed by an independent testing agency acceptable to the Owner after satisfactory full-load operation. The Contractor shall provide the harmonic distortion reports with the O&M Manual.

1) Unless otherwise indicated on the Drawings, the harmonic distortion measurements shall be made at each load center where VFDs are present.

2) Harmonic distortion measurements shall be made after VFD installation. One set of measurements shall be made with the VFD loads inactive, and one set of measurements shall be made with the VFD loads running at design capacity.

B. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.

C. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.

D. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

3.03 SERVICES OF A MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

B. The manufacturer's technical representative shall perform all startup and field acceptance testing as specified herein.

C. The Contractor shall provide training for the Owner's personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner's personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of four (4) hours each. Training shall not take place until after the VFDs have been installed and tested. Training shall be conducted at times coordinated with the Owner.

D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One (1) trip of one (1) working day during installation of the motor controllers.

2. One (1) trip of two (2) working days to perform startup and field acceptance testing of the motor controllers.

3. One (1) trip of one (1) working day to perform training as specified herein.

4. One (1) trip of one (1) working day two (2) months before the expiration of the warranty to identify any issues to be corrected under warranty.

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

3.04 PAINTING

A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

END OF SECTION

SECTION 16426

LOW VOLTAGE SWITCHBOARDS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation the low voltage switchboards (SWBDs) as specified herein and indicated on the Drawings.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 – Identification for Electrical Systems

3. Section 16902 – Electric Controls and Relays

4. Section 16280 – Surge Protective Devices

C. The SWBD line-ups shall contain circuit breakers, metering equipment, control devices, and all accessories as specified herein, indicated on the Drawings, and as required to result in a complete and operable power distribution equipment assembly.

D. The Contractor shall obtain the SWBDs from one manufacturer who shall also manufacture the structure and major equipment components, which includes, but is not limited to, circuit breakers, power monitoring equipment, meters, relays, instrument transformers, controls, and other components of the equipment assembly. Sub-contracting of wiring is not acceptable.

E. The SWBDs shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

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a. ANSI/IEEE C12.1 – Code for Electricity Metering.

b. ANSI/IEEE C39.1 – Requirements for Electrical Analog Indicating Instruments.

c. ANSI/IEEE C57.13 – Instrument Transformers.

2. National Electrical Manufacturers Association (NEMA):

a. NEMA AB 1 – Molded Case Circuit Breakers and Molded Case Switches.

b. NEMA PB 2 – Deadfront Distribution Switchboards.

3. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

4. Underwriters Laboratories (UL):

a. UL 98 – Enclosed and Dead -Front Switches.

b. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.

c. UL 891 – Switchboards.

d. UL 1066 – Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Proposed Testing Methods

5. Reports of Certified Shop and Field Tests

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submissions will be returned to the Contractor without review for resubmittal.

C. Shop drawings for each SWBD assembly shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations, and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations and exceptions taken to each Drawing related to this Specification Section.

2. Bill of material list for each SWBD assembly including each SWBD compartment.

3. Equipment specifications and product data sheets identifying all electrical ratings. This information shall include all equipment and devices comprising the SWBD.

4. Complete assembly, layout, anchoring, and installation drawings with clearly marked dimensions. Plan, front, and side view drawings, including overall dimensions of the SWBD assembly. Identify shipping splits and show conduit stub-up area locations on the Drawings.

5. Approximate total shipping weight of each shipping split and/or equipment assembly, and total assembled equipment line-up weight.

6. Complete, custom one-line diagram and complete three-line diagram for the SWBD line-up. The diagrams shall indicate the devices comprising the SWBD assembly including, but not limited to, circuit breakers, control power and instrument transformers, meters, relays, control devices, and other equipment comprising the complete assembly. Clearly indicate electrical ratings of all devices.

7. Complete, custom internal wiring diagram of each SWBD compartment/assembly. Each wiring diagram shall include wire identification and terminal numbers.

8. Internal compartment-to-compartment interconnection wiring diagrams including wiring identification and terminal numbers.

9. Example equipment nameplate data sheet.

10. Nameplate schedule for each compartment.

11. Key interlock scheme drawing and sequence of operations.

12. Manufacturer's installation instructions.

13. Manufacturer's written warranty statement.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books and/or leaflets.

2. Spare parts list.

3. Final as-built construction drawings (updated from those included in the shop drawings) incorporating all changes made in the manufacturing and installation process.

4. All other drawings, product information, and other materials originally included in the shop drawings, updated as necessary to reflect as-built conditions.

1.06 SPARE PARTS

A. The SWBDs shall be furnished with all spare parts as recommended by the equipment manufacturer. Spaces in SWBDs shall be furnished with installed spare circuit breakers where indicated on the Drawings.

B. In addition to the spare parts recommended by the manufacturer, the Contractor shall furnish the following minimum spare parts for each SWBD assembly:

Number Required	Description
1 set	Fuses of each size and type provided.

C. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each SWBD line-up shall be identified with the identification name and/or number indicated on the Drawings (e.g., SWBD-TF). A nameplate shall be securely affixed in a conspicuous place on the SWBD.

B. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

1.08 WARRANTY

A. Contractor and Manufacturer shall warrant that the material and workmanship of all components and the operation of the equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty shall include, but not be limited to the following:

1. Replace equipment/components found to be faulty, make changes in equipment arrangement, and/or make adjustments necessary to meet the equipment or functional requirements of this Specification.

2. System rewiring and component substitution/rebuild.

3. All accessories and appurtenances provided by the equipment manufacturer.

C. Warranty for each SWBD line-up shall be in effect for a period of 24 months following final acceptance of the SWBD.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by these specifications is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the SWBDs be manufactured and assembled by a single manufacturer who shall be responsible for matching all components and

providing equipment which functions together as a system. Subcontracting of wiring and/or third-party assembly is not acceptable.

C. The SWBDs shall be Pow-R-Line Xpert (PRLX) as manufactured by Eaton, Spectra Series Switchboard from GE by ABB, or QED-2 LV Series as manufactured by The Square D Company.

2.02 SWITCHBOARDS

A. General

1. Each complete SWBD assembly shall bear a UL Label. Where indicated on the Drawings, SWGR shall be suitable for use as service entrance equipment and bear a service entrance label.

2. The equipment assemblies shall be suitable for operation at the available fault current, 65,000 amperes rms symmetrical (minimum), unless indicated otherwise on the Drawings. The equipment assemblies shall be labeled to indicate the maximum available fault current rating, taking into account the structure, bussing, main/tie circuit breaker(s), and feeder/branch circuit devices. The short circuit current rating shall not be less than that specified herein or indicated on the Drawings. The distribution SWBD feeder/branch circuit devices short circuit current rating shall be fully rated, series rated systems are not acceptable.

3. SWBDs shall dead-front type, completely metal enclosed, with self-supporting sections that are NEMA Type 1 (gasketed) industrial use enclosures. The sections shall be totally accessible from the front and the sides. Equipment assemblies requiring rear access are not acceptable. The framework shall be of UL gauge steel. Ventilation shall be provided as required. Enclosure interior and exterior finish paint color shall be ANSI 49 or 61 grey, using the manufacturer’s standard painting process. The color of the back panels located within the enclosure shall be white.

4. All wire troughs shall have hinged doors.

B. Bus

1. Where 3-wire bus is indicated on the Drawings, the SWBD shall be furnished with 3 phase busses and a ground bus. In addition, if a transformer with a grounded wye secondary is shown on the Drawings to be supplying a 3-wire SWBD, a neutral landing pad shall be furnished within the SWBD for each incoming supply to provide a place to terminate the grounded conductor. Providing a 4-wire bus (3 phases plus neutral) for a 3-wire system is not acceptable.

2. Where a 4-wire bus is indicated on the Drawings, the SWBD shall be furnished with 3 phase busses, a neutral bus of equal ampacity to the phase bus, and a ground bus.

3. All bus shall be tin-plated copper. The bussing shall be of sufficient cross-sectional area to meet UL 891 for temperature rise. The fully rated main bus shall have a maximum ampacity as indicated on the Drawings and extend the full length of the equipment. The main bus shall be 100 percent rated. The ground bus shall be sized per UL 891 and installed in the entire length of the equipment assemblies. The distribution SWBD bus shall be rated as required by the rating of the mounted feeder/branch devices, including spares or spaces. Full height vertical bus shall be provided to accommodate future circuit breakers. Less than full height vertical bus which will only accommodate the circuit breakers included for this project is unacceptable.

4. Where required by the NEC, a bonding jumper, sized in accordance with the NEC, shall be installed between the SWBD ground bus and the neutral bus or neutral landing pad.

C. Main/Tie Circuit Breaker Sections

1. The main/tie circuit breaker(s) shall be drawout or fixed type as indicated on the Drawings, UL 1066 and/or UL 489 Listed, and molded case construction. Circuit breakers shall be rated for 65,000 A (minimum) RMS symmetrical at 480V unless otherwise indicated on the Drawings.

2. The main/tie circuit breaker(s) shall be electrically operated where indicated on the Drawings and 100 percent rated where indicated on the Drawings.

3. The main/tie circuit breaker(s) shall be Eaton Magnum SB Series with Digitrip RMS 1150+ trip unit, Square D Company MasterPact NW Series with MICROLOGIC 5.0/6.0 trip unit, or GE by ABB Power Break II Series with EntelliGuard trip unit. Trip unit rating plug sizes shall be as indicated on the Drawings, and trip unit sensor ratings shall match the frame ratings. The trip units shall be furnished complete with all modules required to facilitate all trip unit functions. Trip units shall have adjustable instantaneous, long-time pick-up and delay, short-time pick-up and delay, ground fault pick-up and delay, and trip indicator, minimum (unless trip functions are indicated otherwise on the Drawings).

4. Main circuit breakers shall be configured for top or bottom conduit entry as required. Unless otherwise noted, the Contractor is responsible for coordinating top or bottom conduit entry requirements with the SWBD Manufacturer.

5. Where indicated on the Drawings, main/tie circuit breakers shall be provided with a shunt trip device to trip the breaker from a remote location by means of a trip coil energized from a separate circuit. A 120 VAC shunt trip shall be capable of

operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage. Provide a minimum of two (2) auxiliary contacts for remote indication of main/tie circuit breaker position.

6. The SWBD manufacturer shall provide all of the proper cable lugs for all cable connections as required to avoid field modifications. Reference the Drawings for the quantity and size of conductors.

7. For circuit breakers rated 1200A and larger, trip units shall be provided with a reduced energy let-thru mode to reduce arc-flash energy. Provide a lockable selector switch, normally open contacts, and an indicator light for control and indication of reduced energy let-thru mode.

8. Provide key interlocks as indicated on the Drawings. Key interlocks shall prevent more than two of the three circuit breakers in a main-tie-main breakers arrangement from being closed simultaneously.

D. Distribution Sections

1. The distribution SWBD shall include group-mounted and/or individually mounted feeder/branch circuit breakers which are to be totally front accessible and front connectable. The circuit breaker connections to the distribution panel bussing shall be of bolt-on design such that the connections grip the bus bars firmly under high-fault conditions.

2. Feeder/branch circuit breakers shall be UL 489 Listed molded case type with trip and frame ratings as indicated on the Drawings. Unless otherwise indicated, circuit breakers shall be manually operable, with automatic trip-free operation, and shall provide inverse-time-limit overload and instantaneous short-circuit protection.

3. Unless indicated otherwise on the Drawings, feeder/branch circuit breakers shall be rated 480 VAC, 3-pole, and shall have 100-ampere or larger frames. The interrupting rating shall match that of the SWBD short circuit rating at 480V.

4. Unless indicated otherwise on the Drawings, feeder/branch circuit breakers with smaller than 225-ampere frames shall be the thermal-magnetic type. Thermal and magnetic trip elements may be fixed or adjustable.

5. Where indicated on the Drawings, circuit breakers of 225-ampere frames and larger, the circuit breakers shall have interchangeable electronic trip units (ETU) and adjustable trip elements and time delays. Provide electronic trip units with the adjustable functions indicated on the Drawings (e.g., Long, Short, Instantaneous, Ground, etc.).

6. Where indicated on the Drawings, feeder/branch circuit breakers shall be 100% rated.

7. The SWBD manufacturer shall provide all of the proper lugs for all cable connections as required to avoid field modifications. Reference the Drawings for the quantity and size of conductors.

8. For circuit breakers rated 1200A and larger, trip units shall be provided with a reduced energy let-thru mode to reduce arc-flash energy. Provide a lockable selector switch, normally open contacts, and an indicator light for control and indication of reduced energy let-thru mode.

E. Current Transformers (CTs)

1. Ring type current transformers (CTs) shall be dry type, for indoor service, insulated for 600 volts, 10 kV BIL. Design shall have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the circuit breaker of the application.

2. Current ratio shall be as indicated on the Drawings.

3. CTs shall be rated in accordance with ANSI Standard C37.20.1, with accuracy of the CTs suitable for BO.5 metering accuracy at rated burden. The CTs shall be sized for the necessary burden for the required devices, minimum.

4. Identify the CTs for polarity with standard marking or symbols. The CTs shall be capable of carrying rated primary current continuously without damage.

5. Run secondary wiring from CTs in suitable wiring trough, or conduit, to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

6. Door mounted test blocks for all CTs in the SWBD shall be provided.

F. Potential Transformers (PTs)

1. Potential transformers (PTs) shall be indoor dry type, single-phase, 60 hertz.

2. PTs shall have a 10kV BIL and an accuracy classification determined according to ANSI Standards. The PTs shall be suitable for 0.3 metering accuracy at the burden to be served for the required devices plus 20 percent. Primary and secondary voltages shall be as indicated on the Drawings.

3. Connect secondaries to potential buses as required. Protect PTs with primary and secondary fuses. Protect primary side with current-limiting fuses.

4. Door mounted test switches for all PTs in the SWBD shall be provided. Test switch wiring shall be plainly marked to indicate the respective circuits to each pole of the switch.

G. Control Wiring and Control Terminal Blocks

1. Wire and factory test SWBD to satisfy the requirements of the operation described or as necessary.

2. All control wiring shall be No. 14 AWG (minimum). Power wiring shall be sized to suit the maximum load rating of unit; No. 12 AWG (minimum). For current transformer (CT) circuits, minimum wire size shall be No. 12 AWG (number 10 AWG or larger wire shall be used to decrease resistance as required). Wiring shall be type MTW rated for 105°C.

3. Route control wires for outgoing or "compartment-to-compartment" interconnecting wiring to master terminal blocks with suitable numbering strips numbered in agreement with the manufacturer's detailed wiring diagrams. Provide a minimum of 10 percent (10%) spare terminal blocks for each circuit breaker and auxiliary compartment.

4. Terminal blocks for control wiring shall be provided in accordance with Section 16902 – Electric Controls and Relays.

5. Number wiring with shrink-type tag devices at both ends consistent with the manufacturer's detailed wiring diagrams. Duplication of wire numbers and terminal block numbers is not acceptable.

H. Power Monitoring, Instruments, and Control Devices

1. Where indicated on the Drawings, provide power monitors with door-mounted graphic display modules. Power monitors shall be Power Xpert Meter (PXM) 4000 Series as manufactured by Eaton, PowerLogic ION7650 as manufactured by Square D Company, or EPM 9000 by General Electric Company (ABB). Power monitor manufacturer shall match the manufacturer of the circuit breakers and other components of the SWBD assembly. All PTs and CTs, power supplies, wiring, and other devices indicated on the Drawings, and as required, shall be provided for a complete monitoring system.

2. Power monitors shall be provided with 1GB of memory, minimum, and a network communications port to communicate with the control system via Ethernet/IP protocol. Provide any necessary hardware gateways to provide this communication capability. The following parameters shall be communicated as a minimum:

   a. Current (all phases).

   b. Voltage (all phases).

   c. KW, KVAR, KVA.

d. Power Factor.

3. Furnish instruments, meters, and control devices complete with devices and associated circuitry necessary to perform the required functions in accordance with these Specifications.

4. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16902 – Electric Controls and Relays:

   a. Pilot devices (e.g., switches, indicating lights, etc.).

   b. Relays and timers, if required.

I. Nameplates and Legend Plates

1. Provide engraved plastic nameplates to identify each SWBD, each compartment, and associated door mounted devices and internal components. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

2. Equipment names and/or numbers and device identification text shown on the Drawings shall be used as the basis to engrave the nameplates and legend plates. Where the equipment identification text would exceed the capacity of the SWBD manufacturer's standard nameplate/legend plate size, the manufacturer shall provide larger nameplates and/or additional nameplates as necessary. Abbreviating equipment names/numbers and device identification text is not acceptable.

3. Provide a master nameplate listing SWBD designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.

4. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked for identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

J. Warning Signs

1. Provide a minimum of two (2) warning signs on the front of the SWBD line-up (and two (2) on the rear, where the rear of the line-up is accessible).

   a. Red laminated plastic engraved with white letters approximately ½-inch high.

   b. Signs shall read "DANGER HIGH VOLTAGE"

K. Source Quality Control

1. Completely assemble, wire, and test SWBDs at the factory. Detailed inspections before and after assembly shall assure correctness of design and workmanship. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.

2. After assembly, provide the SWBDs with lifting channels having eyebolts for attachment of crane slings to facilitate lifting and handling each shipping-assembly unit. These lifting channels shall be removable after equipment is placed on permanent foundations.

L. Accessories

1. SWBD accessories shall be provided as follows:

    a. A 4” infrared inspection port in the front door of each main/tie circuit breaker section. IR ports shall be located to allow IR observation of the cable terminations within the compartment. IR ports shall meet requirements of IEEE C37.20.2, shall maintain NEMA rating of SWBD enclosure when in use.

M. Surge Protective Devices

1. Surge protective devices (SPD) shall be provided either integral to the SWBD enclosure or as a separate unit external to the SWBD enclosure, as indicated on the Drawings. See Section 16280 – Surge Protective Devices for SPD requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The SWBD shall be furnished and installed as shown on the Drawings and in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment. The equipment shall be suitably protected until accepted by the Owner.

B. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:

1. Checking to ensure that the pad location is level to within .125 inches.

2. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations.

3. Assemble all shipping sections, remove all shipping braces, and connect all shipping split mechanical and electrical connections.

4. Secure assemblies to foundation or floor channels.

5. Inspect and install all circuit breakers in their proper places.

3.02 PAINTING

A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

3.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witness Shop Tests

a. Not required.

2. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit notarized and certified copies of all test reports. As a minimum, the entire SWBD assembly shall go through a quality inspection before shipment. This inspection shall include, but is not limited to, the following:

1) Physical inspection of the structure and the electrical conductors including bussing, general wiring, and units.

2) General electrical tests including power circuit phasing, control circuit wiring, instrument transformers, meters, ground fault system, and device electrical operation.

3) AC dielectric tests of the power circuits and control circuits.

4) Markings/labels, including instructional type, Underwriters Laboratory (UL), and inspector's stamps.

c. The manufacturer shall use integral quality control checks throughout the manufacturing process to maintain the correctness of the SWBD.

3. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, NETA Acceptance Testing Specifications, and Section 16000 – Basic Electrical Requirements.

3.04 FIELD ADJUSTMENTS

A. The circuit breaker trip units shall be set in the field by a qualified representative of the manufacturer, or an outside testing company retained by the Contractor, in accordance with the settings designated in the coordination study. See Section 16000 – Basic Electrical Requirements.

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SECTION 16440
ENCLOSED SWITCHES

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation separately mounted, individual disconnect switches as specified herein and indicated on the Drawings.

B. Disconnect switches for process instruments are not included in the scope of this Section and shall be as specified in Section 16141 – Wiring Devices.

C. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Disconnect switches shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. National Electrical Manufacturers Association (NEMA):

a. NEMA 250 – Enclosures for Electrical Equipment.

b. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).

2. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

3. Underwriters Laboratories (UL):

a. UL 98 – Enclosed and Dead-Front Switches.

b. UL 98 – Enclosed and Dead-Front Switches.

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c. UL 1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01330 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

3. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of disconnect switch.

3. Assembled weight of each unit.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. The equipment shall be furnished with all spare parts as recommended by the equipment manufacturer.

B. One (1) complete set of spare fuses for each ampere rating installed shall be furnished and delivered to the Owner at the time of final inspection.

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C. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.06 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the equipment name with which it is associated (e.g., ACU-TFEB-3 DSW). Equipment identification shall be in accordance with Section 16195 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Switches shall be manufactured by the Square D Company, Eaton, the GE by ABB, or Rockwell Automation (Allen-Bradley).

2.02 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty type and/or as specified in these Specifications. Switches shall be furnished and installed as shown on the Drawings and as required by the NEC. Handles shall be lockable.

B. Disconnect switches for non-hazardous areas shall be UL 98 Listed. Disconnect switches for hazardous areas shall be UL 1203 Listed.

C. Switches shall meet NEMA Standard KS 1 type HD requirements, be, single-throw, be externally operated, and be fused or non-fused as indicated on the Drawings. Switches shall have the number of the poles, voltage, and ampere ratings as shown on the Drawings.

D. Enclosure Types and Materials

1. In non-hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. In hazardous locations, disconnect switches shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

3. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs.

4. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.

E. Disconnect switches shall be quick-make, quick-break and with an interlocked cover which cannot be opened when switch is in the "ON" position and capable of being locked in the "OPEN" position.

F. A complete set of fuses for all switches shall be furnished and installed as required. Time-current characteristic curves of fuses serving motors or connected in series with circuit breakers shall be coordinated for proper operation. Fuses shall have voltage rating not less than the circuit voltage.

G. Disconnect switches shall be furnished with a factory installed internal barrier kit that helps prevent accidental contact with live parts and provides “finger-safe” protection when the door of the enclosed switch is open.

H. Disconnect switches shall be furnished with a manufacturer-supplied ground lug kit for termination of equipment grounding conductors. Where a grounded (neutral) conductor is shown on the Drawings in the conduits connected to the disconnect switch, a manufacturer-supplied neutral bar shall be furnished for termination of the grounded conductors. Third party ground lug and neutral lug kits not supplied by the disconnect switch manufacturer are not acceptable.

I. Fused disconnect switches shall be furnished for motor operated valve and gate actuators where shown on the Drawings. The Contractor shall coordinate the supply of these fused switches with the specific requirements of the actuator. Fuses with fast fault clearing times may be required for modulating valve actuators.

J. Disconnect switches for all motors connected to variable frequency drives (VFDs) shall be furnished with a factory installed electrical interlock kit that includes one (1) early-break auxiliary contact rated for 5A (minimum) at 120 VAC to be used to open the control circuit before the main switch blades break.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Disconnect switches shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the operating handle mechanism (and not to exceed 6ft 7in to the center of the operating handle grip when in its highest position), at the equipment height where appropriate and permitted by the NEC, or where shown otherwise.

B. Disconnect switches shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

END OF SECTION

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SECTION 16461
LOW VOLTAGE TRANSFORMERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation transformers for power and lighting distribution systems as specified herein, as indicated on the Drawings, and as required to complete the electrical installations.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 – Identification for Electrical Systems

C. All equipment specified in this Section shall be furnished by the transformer manufacturer who shall be responsible for the suitability and compatibility of all included equipment.

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Transformers shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):

a. ANSI/IEEE C57.12.01 – Standard for General Requirements for Dry -Type Distribution and Power Transformers.

2. National Electrical Manufacturers Association (NEMA):

a. NEMA ST 20 – Dry Type Transformers for General Applications.

3. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

4. Underwriters Laboratories (UL):

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a. UL 1561 – Dry-Type General Purpose and Power Transformers.

5. U.S. Department of Energy 2016 Efficiency Standards

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Operation and Maintenance Manuals.

3. Spare Parts List.

4. Reports of Certified Shop Field Tests.

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein, and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Drawings showing clearly marked dimensions and weight for each transformer.

3. Sample equipment nameplate diagram.

D. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., TX-LP-TF-1).

E. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

A. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each transformer shall be identified with the equipment item number indicated on the Contract Drawings and the accepted Shop Drawings. A nameplate shall be securely affixed in a conspicuous place on each transformer. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Dry type distribution transformers shall be Energy Star compliant and manufactured by the Square D Company, GE by ABB, or Eaton.

2.02 DRY TYPE TRANSFORMERS

A. Furnish and install single-phase and three-phase general purpose, dry-type transformers, as specified herein and indicated on the Drawings. The transformers shall be 60 Hz, self-cooled, quiet-design insulated of the two-winding type.

B. The transformers shall be UL 1561 Listed.

C. The primary windings shall be rated 480 VAC for use on 3-phase systems and connected delta unless indicated otherwise on the Drawings. KVA ratings shall be as shown on the Drawings. Furnish transformers with two 2-1/2% primary taps above, and four 2-1/2% primary taps below rated voltage for transformers 15 KVA and above, and two 2-1/2% primary taps above, and two 2-1/2% primary taps below rated voltage for transformers less than 15 kVA. All taps shall be full capacity rated.

D. The ratings of the secondary windings shall be as indicated on the Drawings.

E. Transformers shall be designed for continuous operation at rated KVA, 24 hours a day, 365 days a year, with normal life expectancy as defined in ANSI/IEEE C57.96. This performance shall be obtainable without exceeding 150 degrees Celsius average temperature rise by resistance or 180 degrees Celsius hot spot temperature rise in a 40 degrees Celsius maximum ambient and 30 degrees Celsius average ambient. The maximum coil hot spot temperature shall not exceed 220 degrees Celsius. All insulating materials shall be flame retardant and shall not support combustion as defined in ASTM Standard Test Method D 635. All insulating materials shall be in accordance with NEMA ST 20 Standard for a 220 degrees Celsius UL component recognized insulation system.

F. Transformer coils shall be of the continuous wound copper construction and shall be impregnated with non-hygroscopic, thermosetting varnish.

G. All cores are to be constructed of high grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current loses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be tightly clamped and compressed with structural steel angles. The completed core and coil shall then be bolted to the base by means of vibration-absorbing mounts to minimize sound transmission. There shall be no metal-to-metal contact between the core and coil assembly and the enclosure.

H. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees Celsius. Transformers shall be furnished with lugs of the size and quantity required and suitable for termination of the field wiring.

I. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE, and ANSI standards.

J. Transformers shall have core and coil assemblies mounted on rubber isolation pads to minimize the sound levels. Transformers shall not exceed the sound levels listed in NEMA ST-20.

K. Transformers shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 3R, Painted Steel
Indoor Dry Process Area	NEMA 2, Painted Steel

Area Designation	Enclosure Type and Material
Indoor Dry Non-Process Area	NEMA 2, Painted Steel
All Outdoor Areas	NEMA 3R, Painted Steel

L. The enclosure shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with a baked weather-resistant enamel using the manufacturer's standard painting process. Color shall be ANSI 49 or 61 grey.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The transformers shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer.

B. Conduit routed to and from the transformer shall be arranged for easy removal of the transformer access covers.

C. Where transformers 50 kVA and smaller are shown to be wall mounted, a transformer manufacturer supplied wall mounting kit shall be used. The lowest point of the wall mounting bracket shall be no lower than 7'-0" above the finished floor. Field fabricated mounting hardware is not acceptable unless reviewed and approved in writing by the Engineer.

D. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 01. The following tests are required:

1. Certified Shop Tests

a. The transformers shall be given routine factory tests in accordance with the requirements of the ANSI and NEMA standards. Temperature rises may be certified from basic design.

b. As a minimum, the following tests shall be made on all transformers:

1) Ratio tests on the rated voltage connection and on all tap connections.

2) Polarity and phase-relation tests on the rated voltage connection.

3) Applied potential tests.

4) Induced potential tests.

5) No-load and excitation current at rated voltage on the rated voltage connection.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 01, and NETA Acceptance Testing Specifications, latest edition.

b. Insulation between windings shall be tested by 1000 VDC Megohmmeter for one (1) minute. Resistance value shall be no less than 100 Megaohms.

END OF SECTION

SECTION 16470
PANELBOARDS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation panelboards as specified herein and indicated on the Drawings. Panelboards shall be furnished with circuit breaker ratings, number of breakers, number of poles, and arrangements/locations conforming to the panelboard schedules shown on the Drawings.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 –Identification for Electrical Systems

3. Section 16280 – Surge Protective Devices

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. National Electrical Contractors Association (NECA):

   a. NECA 407 – Standards for Installing and Maintaining Panelboards.

2. National Electrical Manufacturers Association (NEMA):

   a. NEMA PB 1 – Panelboards.

3. National Fire Protection Association (NFPA):

   a. NFPA 70 – National Electrical Code (NEC).

4. Underwriters Laboratories (UL):

   a. UL 50 – Enclosures for Electrical Equipment, Non-environmental Considerations.

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b. UL 67 – Standard for Panelboards.

c. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.

d. UL 943 – Ground Fault Circuit Interrupters.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

3. Operation and Maintenance Manuals.

4. Reports of Field Tests.

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions for each panelboard.

3. Complete panelboard schedules indicating circuit designations as shown on the Drawings for each panelboard.

4. The submittal information shall reflect the specific equipment identification number as indicated on the Drawings (e.g., LP-TF-1, PP-PAC, etc.).

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books and/or leaflets.

2. Recommended spare parts list.

3. Final as-built construction drawings included in the shop drawings incorporating all changes made in the manufacturing process and during field installation.

1.06 SPARE PARTS

A. For each panelboard, the Contractor shall furnish to the Owner all spare parts as recommended by the equipment manufacturer. All spaces in the panelboards shall be furnished with a spare breaker as indicated in the panelboard schedules shown on the Drawings.

A. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each panelboard shall be identified with the identification name/number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each panelboard. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the panelboards be produced by a single manufacturer who shall be responsible for matching all components and providing equipment which functions together as a system.

C. Distribution panelboards, those identified with a prefix “DP” on the Drawings, shall be the PRL4X Series by Eaton, I-Line Series by Square D, or GE by ABB equivalent.

D. Power panelboards, those identified with prefix “PP” on the Drawings, shall be the PRL3X Series by Eaton, NF Series by Square D, or GE by ABB equivalent.

E. Lighting and instrument panelboards, those identified with prefix “LP” and “IP” respectively on the Drawings, shall be the PRL1X or PRL2X Series by Eaton, NQ Series by Square D, or GE by ABB equivalent.

2.02 PANELBOARDS

A. General

1. Panelboards shall be dead-front type and shall be of the configuration and rating as specified herein and indicated on the Drawings. Panelboards shall be UL 67 Listed and shall be constructed to NEMA PB1 standards.

2. Where specified herein, indicated on the Drawings, or required, panelboards shall be rated for service entrance and bear a service entrance label.

3. Panelboards shall be equipped with a main circuit breaker or main lugs complete with branch circuit breakers, as indicated on the Drawings. The panelboards shall be suitable for flush or surface mounting as indicated on the Drawings.

4. Panelboards shall be fully rated and shall have a minimum short circuit rating of 22,000 amperes symmetrical for units rated 240VAC and below, and 42,000 amperes symmetrical for units rated above 240VAC, unless otherwise indicated on the Drawings.

B. Enclosures

1. Enclosures shall be UL 50 Listed and have a NEMA rating as indicated on the Drawings. An Underwriter's Laboratories, Inc. inspection label shall appear on the interior of the cabinet. Enclosures designated as NEMA 4X shall be constructed of 304 stainless steel. Enclosures with all other NEMA ratings shall be constructed of No. 12 U.S.S. code gauge galvanized steel, painted ANSI 49 or 61 gray. The enclosure shall have wiring gutters on sides and shall be at least 5-3/4 inches deep.

2. The door shall be fastened to the enclosure with concealed hinges and shall be equipped with flush-type catches and locks. Enclosure doors exceeding 40 inches in height shall be equipped with a vertical bolt three-point locking mechanism. All locks shall be keyed alike. The panelboard trim shall have a removable hinge assembly, in addition to the door hinge, that allows work inside the enclosure without the need to remove the trim.

3. The panelboard shall be provided with an information label. The information label shall include the panelboard designation, voltage, phase, wires, and bus rating.

C. Bus Work

1. Main bus bars shall be of ample size so that a current density of not more than 1000 amperes per square inch of cross section will be attained. This current density shall be based on the application of the full load connected to the panel plus approximately 25% of the full load for spare capacity. The main bus shall be full capacity as based on the preceding for the entire length of the panel so as to provide full flexibility of circuit arrangement. Bus shall be sized in accordance with UL standards to limit the temperature rise on any current carrying part to a maximum of 50 degrees C above a maximum ambient temperature of 40 degrees C.

2. Where neutral bus bars are required, neutral bus ampacity shall be the same as the main bus bars unless otherwise noted. Ratings shall be in accordance with applicable standards.

3. A separate ground bus shall be provided with lugs for termination of equipment grounding conductors.

4. Branch bus work shall be rated to match the maximum branch circuit breaker which may be installed in the standard space.

5. All bus shall be tin-plated copper and shall extend the entire useable length of the panelboard, including spaces.

D. Circuit Breakers

1. Main and branch circuit breakers shall be bolt-on, UL 489 Listed molded-case type with trip ratings as indicated on the Drawings. Unless otherwise indicated, circuit breakers shall be manually operable, with automatic trip-free operation, and shall provide inverse-time-limit overload and instantaneous short-circuit protection. All circuit breakers shall have quick-make, quick-break, toggle mechanisms for manual as well as automatic operation.

2. Main circuit breakers shall be individually mounted. Branch-mounted main circuit breakers are not acceptable unless specifically indicated on the Drawings. Coordinate top or bottom mounting of main circuit breaker with incoming conduit location(s).

3. Tandem or half-size circuit breakers are not acceptable.

4. Circuit breaker voltage ratings shall meet or exceed the panelboard voltage indicated on the Drawings. The number of poles and trip ratings shall be as indicated on the Drawings. Where a trip rating is not indicated on the Drawings, provide a 20A circuit breaker.

5. Circuit breakers for panelboards rated 240VAC and below shall have an interrupting rating at 240 VAC that matches the panelboard short circuit rating. Circuit breakers for panelboards rated above 240VAC shall have an interrupting rating at 480 VAC that matches the panelboard short circuit rating.

6. Unless indicated otherwise on the Drawings, circuit breakers with smaller than 225-ampere frames shall be the thermal-magnetic type. Thermal and magnetic trip elements may be fixed or adjustable.

7. Where indicated on the Drawings, and for circuit breakers of 225-ampere frames and larger, circuit breakers shall have interchangeable electronic trip units (ETU) and adjustable trip elements and time delays. Provide electronic trip units with the adjustable functions indicated on the Drawings (e.g., Long, Short, Instantaneous, Ground, etc.).

8. Where indicated on the Drawings, or where required by Code, circuit breakers shall be equipped with integrally mounted ground fault circuit interrupters (i.e., GFI/GFCI) complete with "TEST" push button, and shall be of a type which fit standard panelboard spaces for the breaker continuous current rating required. Ground fault circuit interrupter style circuit breakers shall be UL 943 Listed. Circuit breakers used for lighting circuit switching shall be approved for the purpose and shall be marked "SWD". Where required by Article 440 of the NEC, circuit breakers installed for air conditioning units shall be HACR type.

9. Where indicated on the Drawings, circuit breakers shall be 100% rated.

10. Where indicated on the Drawings, main circuit breakers shall be provided with a shunt trip device to trip the breaker from a remote location by means of a trip coil energized from a separate circuit. A 120 VAC shunt trip shall be capable of operating 55% or more of rated voltage. All other shunt trips shall be capable of operating at 75% or more of rated voltage.

11. Where indicated on the Drawings, or as required, circuit breakers shall be provided with a padlockable hasp or handle padlock attachment (lock-off device) for padlocking in the “OFF” position as required to meet the NEC requirement for disconnecting means and/or OSHA lock-out/tagout standard. Locking hardware shall remain in place even when the padlock is removed. Where indicated on the Drawings, or as required, branch circuit breakers shall be provided with a similar attachment (lock-on device) for padlocking in the “ON” position for critical circuits (e.g., fire alarm control panel circuits) which must remain energized.

E. Directories

1. Approved directories with noncombustible plastic cover, and with typewritten designations of each branch circuit, shall be furnished and installed in each panelboard (including both new panelboards and existing panelboards modified

under this project). The Contractor shall maintain in each panelboard, during the duration of the Contract, a handwritten directory clearly indicating the circuit breakers in service. This directory shall be updated as work progresses, and final, typewritten directories, as specified above, shall be installed at the end of the project. Designations and circuit locations shall conform to the panelboard schedules on the Drawings, except as otherwise authorized by the Engineer.

2.03 SURGE PROTECTIVE DEVICES

A. Surge protective devices (SPD) shall be provided either integral to the panelboard or as a separate unit external to the panelboard enclosure, as indicated on the Drawings. See Section 16280 – Surge Protective Devices for SPD requirements.

B. Integral SPDs shall be installed within the panelboard enclosure in a location that allows the required quantity and rating of branch circuit breakers to be installed. Reducing the quantity of branch circuit breakers to less than that required by the panel schedules is not acceptable.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Panelboards shall be furnished and installed as shown on the Drawings and as recommended by the equipment manufacturer, and as required by NECA 407.

B. Panelboards shall be set true and plumb in locations as shown on the Drawings. The top of panelboard enclosure shall not exceed six (6) feet above finished floor elevation.

C. Enclosures shall not be fastened to concrete or masonry surfaces with wooden plugs. Appropriate cadmium plated or galvanized steel bolts shall be used with expansion shields or other metallic type concrete insert for mounting on concrete or solid masonry walls. Cadmium plated or galvanized steel toggle bolts shall be used for mounting on concrete block or other hollow masonry walls. Bolt diameter shall be as required considering the size and weight of the completed panelboard and enclosure to provide adequate structural support.

D. The Contractor shall not use factory furnished knockouts with surface mounted back boxes. The Contractor shall punch or drill required openings during installation and shall equip flush mounted back boxes with manufacturer's standard pattern of knockouts.

E. The Contractor shall install cabinets (and other enclosure products) in plumb with the building construction. Flush mounted enclosures shall be installed so that the trim will rest against the surrounding surface material and around the entire perimeter of the enclosure.

F. Bus loads in all panelboards shall be balanced between phases to within a tolerance of one (1) KVA. Convenience receptacles shall be distributed evenly among all phase buses as much as practical.

G. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same lacquer as used for shop finishing coats.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Field Tests

a. Prior to termination of any conductors to the circuit breakers, all bus work and circuit breakers shall be tested from phase to phase and phase to ground with a 1000 VDC megohmmeter for 1 minute in accordance with NECA 407. Resistance values shall be recorded and shall not be less than 100 megohms.

b. Prior to terminating any wires to the circuit breakers, the resistance of the connection between the bus work and each circuit breaker shall be tested through the use of a low-resistance ohmmeter. Record the resistance values for each circuit breaker.

END OF SECTION

SECTION 16481

LOW-VOLTAGE ENCLOSED MOTOR CONTROLLERS – FULL VOLTAGE

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation separately mounted, full voltage individual motor controllers as specified herein and indicated on the Drawings. Individual motor controllers specified in this Section include magnetic motor starters and manual motor starters.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16123 – Low Voltage Conductors and Cables

3. Section 16195 – Identification for Electrical Systems

4. Section 16902 – Electric Controls and Relays

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. Enclosed motor controllers shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. National Electrical Manufacturers Association (NEMA):

a. NEMA 250 – Enclosures for Electrical Equipment.

b. NEMA ICS 2 – Controllers, Contactors and Overload Relays Rated 600 Volts.

2. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

3. Underwriters Laboratories (UL):

a. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breakers.

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b. UL 508A – Standard for Industrial Control Panels.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts.

3. Reports of Certified Shop and Field Tests.

4. Operation and Maintenance Manuals.

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete layout and installation drawings with clearly marked dimensions for each type/size/rating of individual motor controller.

3. Custom wiring diagrams for each individual motor controller. Standard wiring diagrams that are not custom created by the manufacturer for the individual motor controllers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. mixer) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

4. Bill of material list for each individual motor controller.

5. Nameplate schedule for each individual motor controller.

6. Manufacturer’s installation instructions.

7. Table listing all motor loads connected to the motor controller. Table shall include the full load amps of the APPROVED motors. Final approval of motor controller shop drawings cannot be given until all motor loads associated with each motor controller have been reviewed, approved, and shown in this table.

8. Time-current curves for each type and size protective device if requested by the Engineer.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for individual motor controller. These final drawings shall be plastic laminated and securely placed inside each individual motor controller unit door and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The Contractor shall furnish the following additional spare parts:

1. Two (2) spare fuses for each size and type used.

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved with the equipment name and/or number with which it is associated. Equipment identification shall be in accordance with Section 16195 – Identification for Electrical Systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 INDIVIDUAL MAGNETIC MOTOR STARTERS

A. **The Contractor** is fully responsible for the review of the full Contract Documents to determine specified motor speed, horsepower and full load ampere requirements for each motor-driven load.

B. Individual magnetic motor starters shall be combination type complete with motor circuit protectors (MCPs). Starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be furnished with a minimum of two (2) spare auxiliary contacts.

C. Motor branch circuits shall be protected by a motor circuit protector (MCP). MCP sizes shall be selected by the manufacturer based on the motor nameplate information gathered and listed in the table required herein. MCP shall have an adjustment range that allows for between 800% and 1200% of motor nameplate FLA.

D. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.

E. The motor controller manufacturer is advised to review the total Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings. Control power transformers shall be fused on both the primary and secondary sides. The minimum control power transformer VA requirements are as shown below. Control power transformers shall be sized as required for the connected loads, plus 25% spare capacity.

1. Size 1-150 VA

2. Size 2-150 VA

3. Size 3-200 VA

4. Size 4-300 VA

5. Size 5-500 VA

F. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy and bi-metallic type overload relays are not acceptable.

G. Enclosures

1. In non-hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	**Enclosure Type and Material**
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

2. In hazardous locations, motor starters shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	**Enclosure Type and Material**
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

3. Each motor controller enclosure in non-hazardous areas shall be supplied with an industrial, heavy-duty flange-mount handle mechanism for the operation of the motor controller disconnecting means as follows:

    a. The mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position.

    b. The operator handle shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator.

    c. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8-inch diameter shackle padlock.

    d. The operator handle shall be mechanically interlocked such that the disconnecting means cannot be closed with the enclosure door open, nor can the enclosure door be opened when the disconnecting means is closed. A defeater mechanism shall be provided so that qualified personnel can bypass these interlocks for maintenance and testing purposes. The defeater mechanism shall allow the enclosure door to be opened without interrupting the operation of the motor controller.

4. Each motor controller enclosure in hazardous areas shall be supplied with an industrial, heavy-duty door-mounted handle mechanism for the operation of the motor controller disconnecting means as follows:

    a. The operator handle shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator or door.

    b. It shall be possible to lock the handle in the "OFF" position with up to one (1) 3/8-inch diameter shackle padlock and in the "ON" position with one (1) 3/8-inch diameter shackle padlock.

    c. The operator handle shall be mechanically interlocked such that the disconnecting means cannot be closed with the enclosure door open, nor can the enclosure door be opened when the disconnecting means is closed. No defeater mechanisms shall be permitted.

H. Control Devices

1. Furnish and install control devices as required and/or shown on the Drawings. The following control devices shall be provided as specified in Section 16902 – Electric Controls and Relays:

a. Pilot devices (switches, indicating lights, etc.)

b. Relays and timers

c. Control terminal blocks

I. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105ºC. Wire color coding shall be as specified in Section 16123 – Low Voltage Conductors and Cables.

J. Each motor starter coil shall be equipped with a surge-suppression device, where applicable, for protection of solid-state equipment (e.g., programmable logic controller) wired as part of the control circuit.

K. Individual magnetic motor starters shall be as manufactured by Eaton using NEMA rated Freedom Series starters and contactors, GE by ABB equivalent, the Square D Company equivalent, Rockwell Automation (Allen-Bradley) equivalent, or Siemens Energy & Automation, Inc. equivalent.

2.03 INDIVIDUAL MANUAL MOTOR STARTERS

A. Individual manual motor starters in enclosures as specified above shall be furnished and installed for outdoor and indoor exposed work. Furnish and install manual motor starters in outlet boxes with flush wall plates as required for concealed work.

B. Furnish and install manual motor starters with pilot lights and overload heater elements of correct rating based on motor nameplate data.

C. Manual motor starters shall be equipped with either a push button or toggle operator with reset device or mechanism accessible without opening the enclosure.

D. Individual manual motor starters for motors one (1) horsepower and less shall be Eaton Type MS, GE by ABB equivalent, the Square D Company equivalent, Rockwell Automation (Allen-Bradley) equivalent, or Siemens Energy & Automation, Inc. equivalent.

E. Individual manual motor starters for integral horsepower motors shall be Eaton Type B100 or B101, GE by ABB equivalents, the Square D Company equivalents, Rockwell Automation (Allen-Bradley) equivalent, or Siemens Energy and Automation, Inc. equivalents.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All individual motor starters shall be installed as indicated on the Drawings and as recommended by the equipment manufacturer.

B. Individual motor starters shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

3.03 FIELD ADJUSTMENTS

A. The settings of the motor circuit protectors and overload relays shall be set based on the motor nameplate data of the motors installed.

END OF SECTION

SECTION 16495

LOW VOLTAGE VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFDs) as specified herein and indicated on the Drawings.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 – Identification for Electrical Systems

3. Section 16902 – Electric Controls and Relays

C. The Contractor is responsible for coordinating with the driven equipment manufacturer and the VFD manufacturer to ensure that the VFD is sized properly to meet all of the requirements herein. This includes, but is not limited to, accounting for motor RPM and variable or constant torque applications. The Contractor is responsible for including any costs related to equipment upsizing, conduit and wire upsizing, etc. that results from selecting equipment with a higher full load amp rating than was specified or used as the basis for design.

D. The variable frequency drives shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

1.02 CODES AND STANDARDS

A. VFDs shall be designed, manufactured, and/or listed to the following standards as applicable:

1. NEMA 250 – Enclosure for Electrical Equipment

2. IEEE 519 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

3. NEMA ICS 7 – Adjustable-Speed Drives

041322

4. NEMA ICS 61800-2 – Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems

5. UL 489 – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

6. UL 508A – Standard for Industrial Control Panels

7. UL 508C – Standard for Power Conversion Equipment

1.03 DEFINITIONS

A. The following definitions are provided for clarity with regard to the language used in this Specification:

1. Variable Frequency Drive (VFD) – The complete custom-engineered VFD as packaged within an overall enclosure, including the VFD unit and all other components within that enclosure as specified herein.

2. VFD Unit – The solid-state power electronic device or devices within the VFD.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Reports of Certified Shop and Field Tests

5. Manufacturer’s Field Start-up Report

6. Manufacturer’s Representative’s Installation Certification

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings **for each VFD** shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this Specification Section. In the left margin beside each and every paragraph/item, a letter "C", "D", or "E" shall be typed or written in. The letter "C" shall be for full compliance with the requirement. The letter "D" shall be for a deviation from the requirement. The letter "E" shall be for taking exception to a requirement. Any requirements with the letter "D" or "E" beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this Specification Section.

2. Complete bill of material and catalog data sheets for all equipment and devices comprising the VFD.

3. Heat loss data for each VFD.

4. Manufacturer’s warranty information.

5. Product data sheets for **all** system components, including but not limited to:

    a. VFD units

    b. Harmonic correction devices and/or equipment, e.g. line reactors, passive filters, and 18-pulse phase-shifting transformers

    c. Output reactors and/or output filters

    d. Pilot lights and pilot devices

    e. Control and timing relays

    f. Enclosure fans

    g. Contactors

    h. Power supplies

    i. Control power transformers

    j. Current transformers

    k. Potential transformers

l. Circuit breakers and/or motor circuit protectors

m. Fuses

n. Terminal blocks (power, control, and shorting)

6. Layout drawings of the VFD that include:

a. All cabinet or enclosure dimensions, access details, and weights.

b. Required clearances around the enclosure, e.g. ventilation.

c. Conduit entry areas and/or stub-up locations.

d. Nameplate sizes, colors, and locations.

e. Physical arrangement of door mounted devices located on the variable frequency drive enclosure.

f. Physical arrangement of **all** interior components, including DIN-rail-mounted devices.

General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

7. Custom schematic and interconnection wiring diagrams of all electrical work, including but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, terminal blocks and identification numbers, wire numbers, and other equipment comprising the complete system.

a. These drawings shall be circuit specific for each motor-load combination (e.g. Carbon Slurry Tank Mixer No.1, etc.). Specific equipment names consistent with the Drawings shall appear on each respective diagram.

b. Indicate all devices, regardless of their physical location, on the schematic diagrams.

c. Electrical ratings of all equipment and devices shall be clearly indicated on the schematic diagrams.

Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable.

8. Confirmation of spare parts requirements as specified herein.

9. Table listing all motor loads connected to the VFD. Table shall include the full load amps of the APPROVED motors. Final approval of VFD shop drawings cannot be given until all motor loads for each VFD have been reviewed, approved, and shown in this table.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01300 – Submittals and Section 11000 – Equipment General Provisions.

B. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD. These final drawings shall be included in the O&M manuals and an additional copy that is plastic laminated shall be securely placed inside each VFD.

C. The O&M manual shall include the “as-commissioned” parameters of each VFD in both print and digital formats.

D. If the VFDs require computer software or configuration, the O&M manual shall include copies of all programming guides/manuals.

1.07 SPARE PARTS

A. The VFDs and accessories shall be furnished with all spare parts as recommended by the equipment manufacturer. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following spare parts:

1. Two (2) sets of fuses for each size and type of fuse provided.

2. One (1) HMI per type of HMI provided.

3. One (1) set of enclosure air filters for each VFD.

4. For each VFD unit **without** field-replaceable internals, furnish one (1) spare VFD unit per size provided.

5. For each VFD unit **with** field-replaceable internals, furnish one (1) fully functional main control circuit board per VFD unit size provided.

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.08 WARRANTY

A. Contractor shall warrant that the material and workmanship of all components and the operation of the VFDs and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty shall include, but not be limited to the following:

1. Replace components found to be faulty and make changes in equipment arrangement or make adjustments necessary to meet the equipment or functional requirements or this Specification.

2. System rewiring and component substitution/rebuild.

3. All accessories and appurtenances provided by the VFD manufacturer.

C. Warranty shall be in effect for a period of 24 months following final acceptance of each VFD.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The Contractor shall obtain the VFDs from one manufacturer who shall also manufacture and assemble the enclosure and major equipment components including, but not limited to the VFD unit and bypass starters. The manufacturer shall have five years minimum of experience in the manufacture of similar units and shall have a general distribution to the electrical trade. **Subcontracting of wiring and/or third-party assembly is not acceptable.**

C. The VFDs shall be manufactured by Eaton, the Square D Company, Rockwell Automation (Allen-Bradley), ABB, or Toshiba.

D. The Contractor shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all load, torque, speed and performance requirements from the appropriate sources and integrating these into a VFD that fulfills the requirements of this Specification.

2.02 VFD SYSTEMS

A. Operating Conditions

1. The following operating conditions are applicable for all equipment of this Specification.

a. Humidity: 0-95%.

b. Ambient Temperature: 0 degrees Celsius to plus 40 degrees Celsius.

c. Altitude: up to 3,300 feet

B. Basic Design and Performance

1. Each VFD shall be a complete alternating current electric drive system including all hardware and software necessary to accomplish variable speed operation of a motor and load combination. VFDs shall be provided in accordance with the requirements indicated on the Drawings and as described in these Specifications.

2. Each VFD shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete VFD system shall have a minimum short circuit current rating of 65,000 amperes symmetrical at rated voltage.

3. **The Contractor** is fully responsible for the review of the full Contract Documents to determine specified motor speed, horsepower and full load ampere requirements for each motor-driven load. In addition, the Contractor shall size and select the VFD and components as follows:

a. Each VFD shall provide, continuously, motor load current equal to 100% of the direct on-line motor nameplate full load current.

b. Each VFD shall be selected for Variable Torque (Normal Duty) or Constant Torque (Heavy Duty) based on its respective load type served as shown in the Load Type tables below.

Variable Torque (Normal Duty) Load Types	**Constant Torque (Heavy Duty) Load Types**
Vertical Turbine Mixers	No Constant Torque Load in this Contract

c. The Load Type tables above are intended to exhaustively cover all possible equipment controlled by VFDs to be provided under Division 16 for this Contract. If a piece of equipment is found that is not explicitly listed in these tables, this discrepancy shall be brought to the attention of the Engineer (in

writing) immediately for resolution **prior to submitting the Bid for this Contract.**

4. Each VFD shall be suitable to operate, at times, on a limited power source engine-generator set. The VFD shall be provided with equipment and devices to prevent waveform distortion as specified herein.

5. Each VFD shall be provided with control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks. Each VFD shall be designed such that specific control and protection functions can be attained through simple programming by either factory engineers or Owner's trained operating personnel.

6. Unless otherwise accepted in writing by the Engineer, VFDs shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals that exceed the ratings of the inverter duty rated motor winding insulation.

    a. **The Contractor** is responsible for providing the VFD manufacturer with estimated and field-verified cable lengths between each VFD and its respective motor. The VFD manufacturer shall select and size the output reactors or filters based on the cable lengths provided by the Contractor. Any change in output filter or reactor selection and/or size from the Bid shall be immediately brought to the attention of the Engineer in writing for resolution.

    b. The output filters or reactors shall be as manufactured by TCI, MTE Corporation, Mirus International, or engineer approved equal.

7. Motor control circuits shall be wired in accordance with the requirements specified herein and/or indicated on the Drawings.

C. Components

1. Each VFD shall contain the number of VFD units as shown on the Drawings and required for the applications.

2. Each VFD shall contain and/or be furnished with the harmonic correction equipment as shown on the Drawings and required for the applications. Harmonic correction equipment shall be as specified elsewhere in this Specification.

3. Each VFD shall contain the number of auxiliary contacts, control power transformer(s), pilot devices and indicating lights, control relays, elapsed time meters, and other devices as specified herein, shown on the Drawings and required for the applications. The following components shall meet the requirements of Section 16902 – Electrical Controls and Relays:

a. Pilot devices (switches, indicating lights, etc.)

b. Relays and timers

c. Terminal blocks

4. Power terminal blocks for VFD output to the motor shall be fixed-mounted to a backplane or the enclosure. Mounting the terminal blocks on DIN rails is not acceptable.

5. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.

6. Each VFD shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

7. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100% redundant. New and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be provided in lieu of 100% redundant auxiliaries if accepted in writing by the Engineer.

8. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished.

9. Motor Circuit Protectors

a. Each VFD shall be protected by a motor circuit protector (MCP) that is UL 489 recognized.

b. Motor circuit protectors shall be completely enclosed molded case devices with a current sensing coil in each of the 3 poles and have a magnetic trip adjustment located on the front. The motor circuit protector shall be manually operable. The protector shall be designed to meet the NEC requirement concerning motor full load and locked-rotor current. Ampere ratings shall be clearly visible. Contacts shall be of non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes, consisting of metal grids mounted in an insulating support.

c. The motor circuit protector shall be operated by a toggle type handle and shall have a quick make, quick break overcenter switching mechanism that

is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. All poles shall be so constructed that they open, close, and trip simultaneously.

d. Each pole of these motor circuit protectors shall provide instantaneous short circuit protection by means of an adjustable magnetic only element.

e. Motor circuit protector ratings, modifications, etc., shall be as specified herein and as required for the VFD and motor load combination.

D. Controls

1. Each VFD shall be provided with automatic and manual controls as shown on the Drawings and as required to comply with all Specifications. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings.

2. The Elementary Control Schematics shown on the Drawings are **representative of design intent only.** The manufacturer shall be responsible for providing all additional components, controls, and internal wiring necessary to meet the design intent.

3. VFD circuitry shall be designed such that the enclosure cooling fans only run when the VFD unit is producing output power. Designs that allow the enclosure cooling fans to run continuously when the VFD unit is energized but not producing output power are not acceptable. Fans that are used exclusively to provide cooling for the VFD unit (and not the overall enclosure) are permitted to run continuously if required by the VFD manufacturer’s design standards/practices.

E. Enclosures

1. Equipment within the VFD enclosure shall be arranged so that it does not interfere with the entry of conduits and cables into the enclosure.

2. All pilot devices (selector switches, pushbuttons, indicating lights, etc.) and the human machine interface (HMI, specified elsewhere herein) shall be door mounted on the exterior of each VFD enclosure. Manipulation of the pilot devices or HMI, viewing of the information on the HMI, or viewing that status of pilot devices shall not require the VFD enclosure door to be opened.

3. Unless otherwise indicated on the Drawings, VFDs in non-hazardous locations, shall be furnished with the following enclosure type and material of construction,

dependent upon the designation of the area in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-Process Area	NEMA 1, Painted Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

4. VFDs shall not be installed in hazardous locations.

5. NEMA 1 and NEMA 12 VFD enclosures shall be force ventilated with front accessibility and the following:

    a. Enclosures shall be provided with washable enclosure air intake filters that can be replaced while the enclosure door remains closed.

    b. Enclosures shall be designed for bottom or top entry of conduits and cables as required.

    c. Enclosures shall be finished in ANSI-61 gray enamel or in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

6. NEMA 4X VFD enclosures shall be air conditioned, dead-front, with front accessibility and the following:

    a. The air conditioning system shall utilize a heat-exchange method that allows for cooling of the enclosure interior without circulating outside air through the enclosure.

    b. Enclosures shall be furnished with tubular type enclosure space heaters. Space heaters shall be rated at 500V or 250V and operated at 240V or 120V, respectively.

    c. VFDs shall be furnished with an additional control power transformer sized to provide power exclusively for the air conditioning system and enclosure space heater.

    d. VFDs shall be furnished with a tamper-resistant hinged cover with a clear polycarbonate viewing window over the door-mounted pilot devices.

e. VFDs shall be designed for bottom entry of cables/conduits only.

7. Each VFD shall be designed such that rear access to the enclosure is not required for operations, maintenance, or repair tasks.

8. The Contractor shall reference the Drawings for maximum dimensions of the VFDs. The Engineer shall be notified prior to the initial shop drawing submittal if exceptions to the dimensions indicated on the Drawings are to be requested.

9. Integrating VFDs into a motor control center assembly is not permitted unless specifically shown as integrated on the Drawings.

10. Enclosure doors shall have full length piano type hinges and shall be braced to prevent sag when fully open.

11. Each VFD enclosure shall be supplied with an industrial, heavy-duty flange-mount handle mechanism for the operation of the VFDs disconnecting means as follows:

    a. The mechanism shall be engaged with the disconnect device at all times as an integral part of the unit regardless of the unit door position.

    b. The operator handle shall have an up-down motion with the down position as off. The ON-OFF condition of the disconnecting means shall be permanently marked on the handle operator.

    c. It shall be possible to lock the handle in the "OFF" position with up to three (3) 3/8-inch diameter shackle padlocks and in the "ON" position with one (1) 3/8-inch diameter shackle padlock.

    d. The operator handle shall be mechanically interlocked such that the disconnecting means cannot be closed with the enclosure door open, nor can the enclosure door be opened when the disconnecting means is closed. A defeater mechanism shall be provided so that qualified personnel can bypass these interlocks for maintenance and testing purposes. The defeater mechanism shall allow the enclosure door to be opened without interrupting the operation of the VFD.

F. Nameplates and Legend Plates

1. Provide engraved plastic nameplates and legend plates to identify each VFD and associated door mounted devices and internal components. Nameplates shall be as specified in Section 16195 – Identification for Electrical Systems.

2. Equipment names and/or numbers and device identification text shown on the Drawings shall be used as the basis to engrave the nameplates and legend plates. Where the equipment identification text would exceed the capacity of the VFD

manufacturer’s standard nameplate/legend plate size, the manufacturer shall provide larger nameplates and/or additional nameplates as necessary. Abbreviating equipment names/numbers and device identification text is not acceptable.

3. Control components mounted as part of the assembly, such as fuse blocks, control relays, pushbuttons, switches, and similar devices, shall be suitably marked with identification corresponding to appropriate designations on the manufacturer's wiring diagrams.

2.03 VFD UNITS

A. The VFD unit shall be the Eaton PowerXL DG1 series, Square D Altivar 600 series, Rockwell Automation (Allen-Bradley) PowerFlex 750 series, ABB ACQ 580 series, or Toshiba AS3 series.

B. Basic Design and Performance

1. Each VFD unit shall be of adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 VAC NEMA Design A or B induction motors. Units for other than NEMA Design A or B induction motors (e.g., NEMA Design C) shall be coordinated with the requirements of that respective load.

2. Each VFD unit shall consist of a semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the motor at the desired speed.

3. Each VFD unit shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

4. The overall efficiency of each VFD unit shall be a minimum of 95% when operating the specified motor-load combination at rated voltage, frequency, and current.

5. Each VFD unit shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed. The VFD unit shall be provided with adjustable maximum and minimum frequency limits.

6. Each VFD unit shall maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5% of rated frequency of 60 Hertz for a 24-hour period and a repeatability of 0.1% of rated frequency of 60 Hertz.

7. Each VFD unit shall be capable of operating the specified load continuously at any speed within the operating speed range of 10% to 100% of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

8. Each VFD unit shall be capable of controlled linear acceleration and deceleration. Each VFD unit shall be capable of ramping the speed of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Each VFD unit shall have two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.

9. Voltage or current unbalance between phases of the VFD unit output voltage shall not exceed 3% of the instantaneous values. The VFD unit shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3%. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

10. Each VFD unit shall operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10% for a duration of 15 cycles. VFD unit output voltage regulation shall be plus or minus 2%.

C. Features and Characteristics

1. Each VFD unit shall be furnished with a Human Machine Interface (HMI) to provide controls and indication to accomplish maintenance and operational functions as specified herein and shown on the Drawings. The HMI shall be password protected after startup to prevent unauthorized personnel from making changes. The HMI shall at minimum provide indication of the following:

    a. Input Voltage

    b. Output Voltage

    c. Output Current

    d. Output Frequency

e. Output Speed from 0-100%

f. Alarm Read-out

2. Each VFD unit shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback/speed indication to external equipment.

3. Each VFD unit shall accept a 4-20 mADC speed input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed equal to or less than 0.1% of rated speed.

4. Input Voltage Loss Handling

   a. The VFD unit shall shut down upon a loss of one or more input phases, a 3-phase complete input power loss, or a sustained input undervoltage event. A sustained input undervoltage event is defined as voltage that is less 75% of nominal, for more than 0.5 seconds.

   b. Upon restoration of 3-phase power that is at an acceptable voltage level, the VFD unit shall automatically reset (after an adjustable time delay, 0-2 minutes) and be capable of being restarted and ramping up to speed when remotely commanded through the control system or locally commanded at any local controls. Personnel shall not be required to reset the VFD unit manually after a shutdown caused by any input voltage loss event.

   c. Automatic reset of the VFD unit shall be achieved through programming/parameter setpoints, time delay relays, or a combination of both.

5. Each VFD unit shall have a multiple attempt restart feature.

6. Each VFD unit shall have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The VFD unit shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

7. Each VFD unit shall be furnished with programmable electronic overload and torque limits.

8. Each VFD unit shall have an automatic trip feature which will remove the drive output from the motor and allow it to decelerate safely. This automatic system shall lock-out the VFD unit and indicate the fault only upon the following conditions:

a. Output voltage unbalance (trip threshold field set).

b. Loss of phase on output.

c. Motor overload.

d. Motor stator winding fault (phase-to-ground, phase-to-phase).

e. Unacceptable voltage variation.

f. High variable frequency drive equipment temperature.

g. VFD failure as determined by the manufacturer.

h. Component failure.

i. Overcurrent.

9. Provide each VFD unit with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the VFD unit, this feature shall be capable of being disabled.

10. Each VFD unit shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure.

    a. Diagnostics shall operate a visual alarm indicator on the HMI.

    b. Diagnostics shall provide an easily readable output that can be used to isolate a failure.

    c. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.

    d. Provide normally open and/or normally closed dry contacts as indicated on the Drawings for VFD failure conditions .

11. Each VFD unit shall communicate the following parameters to the control system via Ethernet/IP protocol. Provide any necessary hardware gateways to provide this communication capability. The following parameters, at a minimum, shall be communicated:

    a. Motor current (all phases)

    b. Motor voltage (all phases)

c. Motor KW

12. Each VFD unit shall be provided with input/output (I/O) cards including expansion cards as necessary to facilitate connection of all I/O specified herein and shown on the Drawings.

2.04 HARMONIC CORRECTION

A. Harmonic correction devices for each VFD shall be as specified herein and located as shown on the Drawings.

B. Input Line Reactors

1. 6-pulse VFD units shall be provided with input line reactor and/or integral DC link reactor. Total reactor impedance shall be a minimum of 3% and shall not exceed 5%.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The VFDs shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. Install VFDs to allow complete door swing required for component removal.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Factory test the complete VFD in accordance with IEEE and NEMA standards.

c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

3. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications referenced in Section 16000 – Basic Electrical Requirements.

b. The Contractor shall field measure actual harmonic distortion with tests performed by an independent testing agency acceptable to the Owner after satisfactory full-load operation. The Contractor shall provide the harmonic distortion reports with the O&M Manual.

c. Unless otherwise indicated on the Drawings, the harmonic distortion measurements shall be made at each load center where VFDs are present.

d. Harmonic distortion measurements shall be made after VFD installation. One set of measurements shall be made with the VFD loads inactive, and one set of measurements shall be made with the VFD loads running at design capacity.

B. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.

C. Certification on materials and records of shop tests necessary for the inspector to verify that the requirements of the Specifications are met, shall be made available to the inspector.

D. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

3.03 SERVICES OF A MANUFACTURER’S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and startup of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

B. The manufacturer’s technical representative shall perform all startup and field acceptance testing as specified herein.

C. The Contractor shall provide training for the Owner’s personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner’s personnel in operation and maintenance of all equipment provided under this

Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall not take place until after the VFDs have been installed and tested. Training shall be conducted at times coordinated with the Owner.

D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One (1) trip of one (1) working day during installation of the motor controllers.

2. One (1) trip of one (1) working day to perform startup and field acceptance testing of the motor controllers.

3. One (1) trip of one (1) working day to perform training as specified herein.

4. One (1) trip of one (1) working day two (2) months before the expiration of the warranty to identify any issues to be corrected under warranty.

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

3.04 PAINTING

A. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

END OF SECTION

SECTION 16496

AUTOMATIC TRANSFER SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operation automatic transfer switches as specified herein and indicated in Drawings. It is the intent that these transfer switches be used to transfer between two (2) sources. Transfer switches are not for transferring loads to the standby generator.

B. All devices and components of the automatic transfer switch shall be NEMA rated. IEC rated devices are unacceptable and shall be cause for rejection of the submittals/equipment.

1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts Lists

4. Special Tools List

5. Reports of certified shop tests shall be submitted which indicates a closing and withstand ampere rating as required based on short circuit study requirements. Rating shall be symmetrical, 3 cycles at 480 VAC.

6. Guarantee/Warranty Program

B. Each submittal shall be identified by the applicable specification section.

1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor for resubmittal without review.

C. Shop drawings for each automatic transfer switch shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions and conduit entrance locations.

3. Example equipment nameplate data sheet.

4. Complete internal schematic and interconnecting wiring diagrams. Standard wiring diagrams that are not custom created by the manufacturer for the automatic transfer switch for this project are not acceptable.

5. Nameplate schedule.

6. Manufacturer's standard installation instructions.

7. Manufacturer's standard warranty.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each automatic transfer switch. These final drawings shall be plastic laminated and securely placed inside each transfer switch and included in the O&M manuals.

1.04 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.05 TOOLS, SUPPLIES AND SPARE PARTS

A. The automatic transfer switches shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.06 IDENTIFICATION

A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each switch. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.07 WARRANTY

A. The manufacturer shall warrant each automatic transfer switch for a minimum of five (5) years from date of shipment. In addition, the manufacturer shall repair or replace equipment found faulty under the terms of the warranty. The manufacturer shall submit data outlining the guarantee/warranty program.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The equipment described herein, as a minimum, shall meet all of the requirements specified in this Section and shall be a product of a manufacturer who has produced automatic transfer switches for a period of at least five (5) years. The equipment shall be compatible with the loads to be served. Assembly of the switches by a fabricator is not acceptable.

C. The manufacturer of the automatic transfer switch shall verify that the switches are listed by Underwriters Laboratories, Inc., standard UL-1008, with 3-cycle withstand and close-in values as indicated on the Drawings or specified herein.

D. The automatic transfer switches shall be manufactured by Eaton, GE/Zenith, or ASCO/Square D.

2.02 AUTOMATIC TRANSFER SWITCH

A. General

1. Switches shall have ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation.

2. For three phase, four-wire systems where a neutral is required, a true four-pole switch shall be supplied with all four electrically and mechanically identical poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

3. The transfer switch shall have both top and bottom mounted cable access.

4. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.

5. The three-cycle closing and withstand current rating of the switch shall be 65,000 amperes RMS (minimum). This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.

6. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.

7. All bolted bus connections shall have Belleville compression type washers. Switches for four-wire systems shall be furnished with a fully rated solid neutral bus.

8. The switch shall be equipped with 90 degree C rated copper/aluminum solderless mechanical type lugs of the proper quantity and size to accommodate the termination of field wiring.

9. Switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

B. Design Requirements

1. The switch shall be double throw, activated by an electrical operator momentarily energized and connected to the transfer mechanism by a simple over-center linkage. A center-off-position shall be provided as a neutral position during switching. Minimum transfer time shall 400 milliseconds.

2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.

3. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current. Switches using in-phase monitors are not acceptable.

4. Normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts to be of silver-tungsten alloy, mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets. Provide separate arcing contacts, with magnetic blowouts on each pole. Interlocked molded case circuit breaker switches or contactors are not acceptable.

5. Equip the transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts.

C. Sequence of Operation

1. Should the voltage on any phase of the normal source drop below 80 percent or increase to 120 percent, or frequency drops below 90 percent, or increase to 110 percent, or 20 percent voltage differential between phases occur, after a programmable time delay period of 0-9999 seconds factory set at three (3) seconds to allow for momentary dips, the engine starting contact(s) shall close to connect to the standby source.

2. Transfer to the standby power source shall occur when 90 percent of rated voltage and frequency has been reached by the standby power source.

3. After restoration of normal power on all phases to a preset value of 90 percent to 110 percent of rated voltage, at least 95 percent to 105 percent of rated frequency, and voltage differential is below 20 percent between phases, an adjustable time delay period of 0-9999 seconds factory set at 300 seconds shall delay the transfer to allow stabilization of the normal source. Should the standby source fail during this time delay period, the switch shall automatically retransfer to the normal source.

4. After retransfer to the normal power source, the standby plant shall operate at no load for a programmable period of 0-9999 seconds factory set at 300 seconds. Should the normal power source fail during this time delay period, the transfer switch shall automatically return to the standby source.

D. Controls

1. The transfer switch shall be equipped with a microprocessor-based control system to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with battery back-up.

2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory, I/O, and communication circuits with a watchdog power fail circuit.

3. The serial communication port shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control system.

4. The controller shall have password protection to limit access to authorized personnel.

5. The controller shall include a 20 character LCD display with a keypad, which allows access to the system.

6. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both normal and standby sources.

7. The controller shall be capable of storing the following records in memory for access either locally or remotely:

   a. Number of hours the transfer switch is in the standby position (total since record reset).

   b. Number of hours standby power source is available (total since record reset).

   c. Total transfer in either direction (total since record reset).

   d. Date, time, and description of the last four source failures.

   e. Date of the last exercise period.

   f. Date of record reset.

8. Controller shall indicate:

   a. Switch is in normal position

   b. Switch is in standby position.

   c. Controller is running.

9. An LCD readout shall display both normal source and standby source availability.

10. The microprocessor controller shall meet the following requirements:

   - Storage conditions - 25□C to 85□C
   - Operation conditions - 20□C to 70□C ambient
   - Humidity 0 to 99% relative humidity, non-condensing
   - Capable of withstanding infinite power interruptions
   - Surge withstand per ANSI/IEEE C-37.90A-1978

11. All control wiring shall be 18 gauge (minimum), 600 VAC, SIS switchboard type. All control wiring shall be identified at each termination (both ends) using tubular, sleeve-type wire markers.

12. The automatic transfer switch controller shall be programmed by the manufacturer at the factory, and shall be made by the same manufacturer as the transfer equipment.

E. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

2. Programmable three phase sensing of the standby source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds.

4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.

5. Time delay on transfer to standby, programmable 0-9999 seconds, factory set at 3 seconds.

6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.

7. A time delay bypass on retransfer to normal shall be included. Keypad initiated.

8. Contact, rated 10 A at 30VDC, to close on failure of normal source to initiate engine starting.

9. Relay contacts which close when normal source fails wired to a terminal strip.

10. Relay contacts which open when normal source fails wired to a terminal strip.

11. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on normal and wired to a terminal strip.

12. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on standby and wired to a terminal strip.

13. Provide a preferred source selector switch to permit the selection of either source as the "preferred" source which the ATS will always seek if that source is available. The two-position selector switch shall have a legend plate which reads "Source A/Source B."

2.03 ENCLOSURES

A. The transfer switches shown to be installed indoors shall be housed in a NEMA 1 (gasketed) enclosure fabricated from 12-gauge steel. The enclosure shall exceed the UL-1008 minimum wire bending space requirements. The enclosure shall be equipped with an internal, welded steel, door-mounted print pocket.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Each automatic transfer switch shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. The automatic transfer switch shall be provided with adequate lifting means for installation of wall or floor mounted enclosures.

C. The Contractor shall tighten all assembled bolted connections to the manufacturer's torque recommendations prior to energizing.

D. Install each switch to allow complete door swing required for component removal. This is specifically required where a switch is set next to a wall to the left of the switch enclosure.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required

2. Certified Shop Tests and Reports

a. Automatic transfer switches shall be given routine factory tests. The factory tests shall demonstrate that the completed switches function correctly and that the required timing has been set. Certification of these settings shall be submitted to the Engineer upon request.

b. Test procedures shall be in accordance with UL-1008. During the 3-cycle withstand tests, there shall be no contact welding or damage.

c. The three cycle tests shall be performed without the use of current limiting fuses.

d. Oscillograph traces across the main contacts shall verify that contact separation has not occurred and there is contact continuity across all phases after completion of the test.

e. When conducting temperature rise tests in accordance with UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

f. Manufacturer shall submit test reports upon request.

3. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications referenced in Section 16000, Basic Electrical Requirements.

b. Prior to acceptance of the installation, load test the equipment under load. Correct defects which become evident during this test.

3.03 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified, factory-trained manufacturer's technical representative who shall adequately supervise the testing of all equipment furnished under this Contract. The manufacturer's representative shall certify in writing that the equipment has been installed in accordance with the manufacturer's recommendations. No further testing or equipment startup may take place until this certification is accepted by the Owner.

B. The manufacturer’s technical representative shall perform startup and functional testing of the equipment as specified herein.

C. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory-trained representative who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be provided for two (2) sessions of two (2) hours each. Training shall be at times coordinated with the Owner.

D. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One (1) trip of one (1) working day during the installation and startup of the equipment.

2. One (1) trip of one (1) working day two (2) months before the warranty expiration date to identify any issues to be corrected under warranty.

3. One (1) trip of one (1) working day to perform training as specified herein.

E. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

- END OF SECTION –

SECTION 16500
LIGHTING

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all lighting fixtures, labor, and material, in accordance with the preceding Specifications, the requirements of this Section, and as shown on the Drawings.

B. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16170 – Grounding and Bonding for Electrical Systems

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. The equipment shall be designed, manufactured, and/or Listed to the following standards as applicable.

1. American National Standards Institute (ANSI)

   a. ANSI C62.41 – Guide for Surge Voltages in Low-Voltage AC Power Circuits

   b. ANSI C82.11 – High Frequency Fluorescent Lamp Ballasts

2. Illuminating Engineering Society (IES)

3. National Fire Protection Association (NFPA)

   a. NFPA 70 – National Electric Code (NEC).

4. Underwriters Laboratories (UL)

   a. UL 924 – Emergency Lighting and Power Equipment

   b. UL 844 – Luminaires for Use in Hazardous (Classified) Locations

   c. UL 916 – Standard for Energy Management Equipment

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1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts Lists

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor for resubmittal without review.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Catalog cuts for each fixture type showing performance and construction details of standard fixtures, and complete working drawings showing all proposed construction details of special or modified standard fixtures.

3. Photometric curves.

4. LED data including efficiency (Efficacy lumens/watt) information.

5. LED Driver information

6. Catalog data including applicable coefficients of utilization tables, isolux chart of illumination on a horizontal plane, beam efficiency, horizontal and vertical beam spread, and beam lumens.

7. Manufacturer’s warranty information.

8. Custom wiring diagrams for each individual lighting contactor application. Standard wiring diagrams that are not custom created by the manufacturer for the individual lighting contactors for this project are not acceptable. One wiring diagram which is typical for all lighting contactors is not acceptable. Each wiring diagram shall

include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

9. System (entire fixture assembly) efficiency data.

10. Pole and foundation calculations.

D. Shop drawings shall be submitted to the Engineer for review and acceptance for all fixtures before fixtures and poles are manufactured. Substitutions will be permitted only if acceptable to the Engineer.

E. Manufacturer's model/series and description in the fixture schedule on the Contract Documents establishes a level of quality, style, finish, etc. The use of a model/series describing the various types of fixtures shall be used as a guide only and does not exclude all the required accessories or hardware that may be required for a complete installation.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit Operation and Maintenance Manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor. The following additional spare parts shall be furnished:

1. A minimum of one (1) LED driver for every ten (10) drivers (of the same type) installed.

A. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

1.07 LIGHTING CONTROLS

A. The lighting systems shall be controlled as specified herein and indicated on the Drawings.

B. Lighting contactors shall be furnished and installed for specific lighting control applications as specified herein and indicated on the Drawings.

1.08 WARRANTY

A. The manufacturer's warranty shall in no event be for a period of less than five (5) years from date of delivery of fixtures to the project site and shall include repair labor, travel

expense necessary for repairs at the jobsite, shipping costs, expendables used during the course of repair, or complete replacement of the failed lighting unit.

B. Warranty for LED fixtures shall be provided for the entire fixture and shall include all parts and accessories. Submittals received without written warranties as specified shall be rejected in their entirety.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The fixture schedule indicates the basis-of-design manufacturer(s) for each fixture type. The Contractor shall submit photometric calculations for each space and/or area where the Contractor wishes to use an equivalent fixture in accordance with Section 16000 – Basic Electrical Requirements. Fixtures will be approved or denied as equivalent on a per-fixture and/or per-space/area basis.

2.02 FIXTURES

A. All lighting fixtures shall be furnished complete with all fittings and hardware necessary for a complete installation. Lighting fixtures shall have all accessories, characteristics, and functionality as specified.

B. Fixture leads shall be as required by NEC. Fixtures shall be grounded by the equipment grounding conductor in the conduit.

C. All glassware shall be high quality, homogeneous in texture, uniform in quality, free from defects, of uniform thickness throughout, and properly annealed. Edges shall be well rounded and free from chips or rough edges.

D. Emergency and exit fixtures shall be UL 924 Listed and have a minimum 90 minutes battery back-up.

E. Fixtures for use in hazardous locations shall be UL 844 Listed.

F. Fixtures specified to be damp or wet locations rated shall be UL 1598 Listed.

G. Fixtures shall be as specified in the fixture schedule on the Drawings

2.03 LED DRIVERS

A. Drivers shall have a voltage range of 347-480V or 120-277 (as required) +/- 10% at a frequency 60Hz.

B. All drivers shall be designed to a power factor >90% with a total harmonic distortion THD <20% at full load.

C. Case temperature shall be rated for -40°C through +80°C.

D. Drivers shall have overheat protection, self-limited short circuit protection and overload protected.

E. Drivers shall be furnished with a fused primary.

F. Drivers shall have an output current ripple <30%

G. Drivers shall be manufactured by Advance, Universal or equal.

H. Drivers shall be UL Listed for damp location, UL1012, UL935, ROHS.

I. Drivers shall meet FCC 47 Sub Part 15.

J. All drivers shall be provided with ANSI/IEEE C62.41 Category C (10kV/5kA) surge protection.

2.04 LEDS

A. Luminaires provided with LED technology shall utilize high brightness LEDs with a group binning code of P and/or Q.

B. Color Temperature: as specified in fixture schedule.

C. Junction point shall be designed and manufactured to allow adequate heat dissipation.

D. LEDs shall be rated for 50,000 hours of life, minimum (based on IESNA L70).

2.05 POLES AND FOUNDATIONS

A. Poles shall be designed to withstand calculated wind force based on wind velocity in accordance with the provisions of the Building Code for the State or Commonwealth in which the project is located.

B. Pole mounted fixtures shall be mounted on poles as designated in the fixture schedule or as indicated on the Drawings. Poles shall have adequate handholes. Furnish and install weatherproof receptacles where indicated. All anchor bolts and nuts shall be hot-dipped galvanized steel.

C. The Contractor shall furnish and install a concrete foundation for freestanding pole mounted fixtures as indicated on the Drawings and as required (e.g., site/roadway lighting). The Contractor shall furnish and install structural anchorage/attachment, including mounting brackets where applicable, for pole mounted fixtures that are attached to a structure (e.g., clarifiers, aeration basins, etc.).

1. Foundation shall be designed and approved by a Professional Structural Engineer currently registered in the State or Commonwealth in which the project is located. The wind design shall be in accordance with ASCE 7 and the Building Code for the State or Commonwealth in which the project is located.

D. Poles shall be as specified in the pole schedule below and shall be furnished with fixture types where specified in the fixture schedule:

Pole Type	Description	Mfr. and Model
A	Round, gray color, base-mounted, straight, 10 ft, painted aluminum pole.	As selected by fixture manufacturer

2.06 LIGHTING CONTROLS

A. Lighting Contactor and Astronomical Time Clock

1. Furnish and install a lighting contactor with integral astronomical time clock to control lighting as indicated on the Drawings.

2. Lighting contactors shall be Model ET2845C as manufactured by Intermatic, or Engineer approved equal. Lighting contactors shall be heavy duty type and shall include four (4) SPST contacts rated for 30A at 120-277VAC, minimum (per contact). The SPST contacts shall be capable of being operated in pairs for 2-pole DPST operation. The four (4) integral contacts shall allow for direct control of up to four (4) lighting circuits as indicated on the Drawings. Lighting contactors shall include an integral electronic controller as specified herein. In addition, any auxiliary relays or other devices required for proper operation shall be included.

3. Integral programmable electronic astronomic controller shall be 365/7-day type, capable of permitting up to 48 ON and 48 OFF events. Controllers shall include selectable astronomic (dusk/dawn) settings for each day and each circuit to allow load switching at sunset and/or sunrise without a photo control device. Controllers shall provide a minimum ON or OFF time of 1 minute. Controllers shall operate on a 120 VAC, 60 Hz control power supply. The electronic controller shall be UL 916 Listed.

B. In non-hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area

in which they are to be installed. Area designations are indicated on the Drawings.

AREA DESIGNATION	ENCLOSURE TYPE AND MATERIAL
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Painted Steel
Indoor Dry Non-process Area	NEMA 1, Painted Steel
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

C. In hazardous locations, lighting contactors shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

AREA CLASSIFICATION	ENCLOSURE TYPE AND MATERIAL
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 7, Die Cast Aluminum
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

PART 3 – EXECUTION

3.01 INSTALLATION

A. Lighting fixtures shall be located symmetrically with building lines as shown on the Drawings. The Contractor shall furnish and install the lighting fixtures to allow "convenient" access for maintenance. The Contractor shall install fixtures at mounting heights indicated on the Drawings or as instructed by the Engineer. In areas with exposed ducts and/or piping, installation of lighting fixtures shall be adapted to field conditions as determined by the Engineer. Where fixtures are shown in locations on the Drawings where maintenance would be difficult, the Contractor shall notify the Engineer for direction.

B. The Contractor shall provide and install all inserts, conduit, structural supports as required, lamps, ballasts, poles, wiring, and any other items required for a complete system. Contractor shall properly adjust and test, to the satisfaction of the Engineer, the entire lighting system. The Contractor shall provide pigtails and flexible conduit

connected to an outlet box where necessary or required resulting in a neat and complete installation.

C. The Contractor shall protect all fixtures at all times from damage, dirt, dust, and the like. Upon completion of work, and after the building area is broom clean, all fixtures shall be made clean and free of dust and all other foreign matter both on visible surfaces, and on surfaces that affect the lighting performance of the fixture including diffusers, lenses, louvers, reflectors, and lamps.

D. The Contractor shall furnish and install all pendant trapezes and pendant stem hangers with durable swivel or equivalent trapeze hanger permitting normal fixture motion and self-alignment. Fixture pendants shall be Appleton Type UNJ ball type flexible hanger at the fixture and supports from an Appleton JBLX junction box with JBLX hub cover, or equal. Pendant lengths shall be adequate and adjusted to provide uniformity of installation heights above the reference datum. Stems shall be one-piece, with matching canopies and fittings.

E. All wiring/cables associated with lighting equipment shall be installed in conduits or other raceways as specified. Installing wiring/cables exposed is not acceptable, unless specifically shown otherwise on the Drawings.

F. The Contractor shall furnish and install recessed fixtures with a separate junction box concealed and located as to be accessible when fixture is removed.

G. The Contractor shall furnish and install all boxes for lighting fixtures such that the box is not the sole support of the fixture. The boxes shall be offset to allow maintenance such that access to wiring within the box can be attained without having to consider supporting (holding) the fixture.

H. All lighting fixtures, when installed, shall be set true and be free of light leaks, warps, dents, and other irregularities. All hangers, cables, supports, channels, and brackets of all kinds for safely erecting this equipment in place, shall be furnished and erected in place by the Contractor.

I. The Contractor shall support each fixture securely. The Contractor shall not secure fixtures to the work of other trades, unless specified or noted otherwise, and shall not support fixtures from plaster. The Contractor shall furnish and install all members and supports as required to fasten and suspend fixtures from the structure.

J. In all mechanical equipment areas, the Contractor shall install lighting fixtures after all piping and equipment therein has been installed. Exact locations for such fixtures may be determined by the Engineer on the site during the course of the work.

K. All fixtures that require physical adjustment shall be so adjusted in accordance with the directions of the Engineer. The Contractor shall also adjust angular direction of fixtures and/or lamps, as directed.

L. No special tools shall be required for re-lamping of fixtures. All optical control surfaces such as lenses and reflectors shall be safely and securely attached to fixtures and shall be easily and quickly removed and replaced for cleaning without the use of special tools.

M. Lighting contactors shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Certified Shop Tests

a. The lighting fixtures shall be given routine factory tests in accordance with the requirement of ANSI, NEMA and Underwriters Laboratories standards.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA Acceptance Testing Specifications, latest edition.

END OF SECTION

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SECTION 16670
FACILITY LIGHTNING PROTECTION

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation a complete lightning protection system as specified herein. This is a performance specification. The Drawings do not show a complete lightning protection system design. The Contractor shall retain the services of a firm specializing in the design, installation, and testing of lightning protection systems.

1.02 CODES AND STANDARDS

A. All equipment shall be Listed by and shall bear the Label of Underwriter's Laboratories, Incorporated (UL).

B. The system shall comply with the following codes and standards:

1. Underwriters Laboratories (UL):

   a. UL 96 – Lightning Protection Components.

   b. UL 96A – Installation Requirements for Lightning Protection Systems.

   c. UL 467 – Safety Grounding and Bonding Equipment.

2. National Fire Protection Association (NFPA):

   a. NFPA 70 – National Electrical Code (NEC).

   b. NFPA 780 – Standard for the Installation of Lightning Protection Systems.

3. Lightning Protection Institute (LPI):

   a. LPI-175 – Standard for the Design – Installation – Inspection of Lightning Protection Systems.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01330 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

072623

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts List

4. Test Reports

5. UL Master Label Certification

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings for each lightning protection system shall include, but not be limited to:

1. Product data sheets.

2. Complete U.L. approved, full size layout and installation drawings/details with clearly marked dimensions. Drawings shall indicate the exact location of all system components. Drawings shall be signed by a full-time employee of the lightning protection system manufacturer who is in responsible charge of this project and has been engaged in the business for at least ten (10) years.

3. Weights of major all components.

4. Bill of material list for each lightning protection system.

5. Manufacturer's installation instructions.

6. Manufacturer's and installer's warranty information.

7. Evidence of the designer/installers UL listing.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1. The manuals shall include:

1. Instruction books and/or leaflets.

2. Recommended spare parts list.

3. Final as-built construction drawings included in the shop drawings incorporating all changes made during the installation.

4. All other information that was included in the shop drawing submittal.

1.06 SPARE PARTS

A. The lightning protection system shall be furnished with all spare parts as recommended by the equipment manufacturer. In addition to the manufacturer recommended spare parts, the Contractor shall furnish the following minimum spare parts for each structure provided with a lightning protection system under this Contract:

Number Required	Descriptions
2	Air Terminals
2	Point Tip Protectors

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The lightning protection systems covered by this Specification shall be furnished using standard components of proven performance as manufactured by reputable concerns. The systems shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed.

B. System designer/supplier/installer qualifications shall be as follows:

1. System components shall be manufactured by a company specializing in lightning protection equipment with a minimum of 5 years documented experience. Company shall be Listed in the section entitled "Lightning Conductor, Air Terminals

and Fittings" of the U.L. "Electrical Construction Materials Directory" for at least 5 years prior to this Contract's bid opening date.

2. The system designer/installer shall be an authorized installer of manufacturer with a minimum of 5 years of documented experience. Designer/Installer shall be Listed in the section entitled "Lightning Protection Installation" of the U.L. "Electrical Construction Materials Directory" for at least 5 years prior to this Contract's bid opening date.

2.02 LIGHTNING PROTECTION SYSTEMS

A. General

1. All components and parts of the lightning protection system shall be as specified herein. The materials used shall meet or exceed the material specification requirements of the Underwriters Laboratories, Inc. All materials shall be marked with a UL label or stamp.

2. The complete lightning protection system shall be inspected and included in the Master Label certification.

B. Conductors

1. Conductors shall be aluminum cable, consisting of a minimum of 24 strands of No. 14 AWG aluminum wire. Copper conductors shall be furnished and installed only where required and when in contact with the earth. Where termination of copper conductors is required to aluminum parts, suitable bi-metallic connectors approved for the purpose shall be furnished and installed.

C. Fittings

1. Fittings shall be the bolted type with stainless steel bolts, nuts, and washers. Fittings shall be of cast metal construction specifically designed for the application. Crimp-type fittings are not acceptable. Bi-metallic type fittings shall be furnished where required.

D. Fasteners

1. Fasteners shall be manufactured from non-corrosive material of ample strength and rigidity for the application.

E. Bases

1. Bases shall be bolted style provided with the model to suit the application (i.e., parapet, standing seam, etc.). Bolts, nuts, and washers shall be made of stainless steel. Bases shall be of aluminum or bronze construction, compatible with the

material of the surface to which it is attached. Crimp-type bases are not acceptable.

F. Ground Rods

1. Ground rods shall be 3/4-inch by 10-foot 0-inch sectional type copper-clad steel rods; as specified in Section 16170 – Grounding and Bonding for Electrical Systems; quantity as required. Ground rods and all associated hardware shall be UL 467 Listed.

G. Air Terminals

1. Air terminals shall be solid aluminum. Air terminals shall be tapered or blunt tip type to suit the application and furnished with air terminal bases and safety tips (ball or bullet type) for impalement protection.

H. Thru-Roof Hardware

1. Thru-roof penetrations shall have stainless steel nuts, bolts, and washers. Sealing washers and sealing boots shall be provided as required and shall be compatible with the roofing material. Conductor connections to this roof hardware shall be by bolted connection. Crimp type connections are not acceptable.

PART 3 – EXECUTION

3.01 INSTALLATION

A. The lightning protection system shall be furnished and installed in accordance with the manufacturer's installation instructions. One (1) copy of these instructions shall be included with the system components at time of shipment. The system components shall be suitably protected until accepted by the Owner.

B. The equipment shall be installed in accordance with the manufacturer's recommendations. This shall include, but not be limited to the following:

1. Course all main down conductors to maintain a downward or horizontal run free of pockets or sags. Maintain an eight-inch (8") minimum radius and make no bend greater than 90 degrees. Follow the most direct route with inductance bonding conductors maintaining the horizontal or downward course of the main conductor. Interconnect roof conductors to provide at least two paths to ground from each terminal and to form closed loops. Follow the most direct path possible with down conductors between roof conductors and ground terminals. All down conductors for new occupiable buildings shall be placed in a concealed manner. Down conductors for existing occupiable structures, tanks, basins, and other non-occupiable structures may be installed exposed.

2. Install ground connections at no less than 60-foot intervals and at each down conductor on perimeter. If the structure has a ground grid, the ground rods from that grid may be used for connection to the down conductors. At each ground connection, determine the extent of the grounding arrangement according to the volume and type of soil encountered and the lowest expected moisture content. Have the Owner's representative observe each ground connection. Bond together all electrical service, telephone service, and lightning protection grounds to all underground metallic piping systems as required by Article 250 of the NEC.

3. The structural steel frame (where provided) may substitute for main down conductors provided the frame is electrically continuous and of adequate cross-section. Where the steel frame is utilized, connect the roof conductor to steel at least as often and at the same column as the ground connections. Make connections to steel with exothermic welds wherever possible. Provide bonding as required to make the entire metal frame continuous.

4. Bond all sizable metal objects within 6-feet of down, roof, or grounding conductors to the system. Use only approved fittings and conductors.

5. Wherever possible problems with corrosion are encountered, use substitute approved materials and/or provide corrosion protection. Use bimetallic or other specially designed and approved connectors where dissimilar metals are to be joined.

6. Install air terminals within 2-feet of the edge of structure and at intervals not greater than 20-feet along perimeter and peak. Provide additional terminals to limit spacing across roof to 50-feet maximum. Bond any exposed metallic object or surface to the roof conductor. Flash all terminal or conductor penetrations in the roof to conform to the roofer's requirements.

7. Record each ground connection location and mark up a reproducible copy of the approved shop drawings with their location. Also, indicate any substantial field modifications on these drawings. These drawings shall be included in the O&M manual.

8. Log all continuity tests of metal framing, ground grid connections, bonding, and similar connections. Indicate the location of tests or plans. Include test results in the O&M manual.

9. Retain U.L. to inspect the completed installation and issue a Master Label Certification. Furnish a copy of the Certification to the Owner upon receipt.

3.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Certified Shop Tests and Reports

a. None Required.

2. Field Tests

a. After installation, the lightning protection system shall be tested for continuity to the ground grid. The tests shall be made by the lightning protection system installer. Test shall be as follows:

1) Record the resistance between each down conductor and the ground grid to ensure a suitable low-resistance connection. All resistance values shall be 1 ohm or less. Test shall be made after the ground grid has been installed and tested per the requirements of Section 16170 – Grounding and Bonding for Electrical Systems.

END OF SECTION

SECTION 16902

ELECTRIC CONTROLS AND RELAYS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test, and place in satisfactory operation all electric controls and relays as specified herein and indicated on the Drawings.

B. Electrical control and relay systems shall be assembled using NEMA rated components. Components designed and built to International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and Labeled in compliance with IEC standards is not acceptable.

C. Reference the following Specification Sections:

1. Section 16000 – Basic Electrical Requirements

2. Section 16195 – Identification for Electrical Systems

1.02 CODES AND STANDARDS

A. Products specified herein shall be designed, manufactured, and/or Listed to the following standards as applicable:

1. American National Standards Institute (ANSI)/International Society of Automation (ISA):

a. ANSI/ISA 12.12.01 – Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.

2. National Electrical Manufacturers Association (NEMA):

a. NEMA 250 – Enclosures for Electrical Equipment.

3. National Fire Protection Association (NFPA):

a. NFPA 70 – National Electrical Code (NEC).

4. Underwriters Laboratories (UL):

a. UL 508A – Standard for Industrial Control Panels.

b. UL-1203 – Standard for Explosion-proof and Dust-ignition-proof Electrical Equipment for use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300 – Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

B. Each submittal shall be identified by the applicable Specification Section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

1.05 SPARE PARTS

A. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. Reference Section 16000 – Basic Electrical Requirements for spare parts delivery and handling requirements.

PART 2 – PRODUCTS

2.01 CONTROL COMPONENTS

A. Manufacturers

1. Control components shall be manufactured by Eaton, The Square D Company, GE by ABB, Allen-Bradley, Siemens Energy and Automation, or Engineer approved equal.

B. Pilot Devices

1. General

a. All pilot devices shall be provided with a legend plate. Legend plates shall have a white background and black lettering and indicate the function of the respective pilot device. The text shown on the Drawings or indicated in the specifications shall be used as the basis for legend plate engraving (e.g., HAND-OFF-AUTO, RUN, EMERGENCY STOP, etc.).

b. All pilot devices shall be selected and properly installed to maintain the NEMA 250 rating of the enclosure in which they are installed. All pilot devices shall be UL 508 Listed.

c. All pilot devices shall be 30.5mm in diameter, unless otherwise indicated. 22mm devices are not acceptable.

d. Pilot devices for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

e. In Class 1 Division 2 hazardous locations, pilot devices shall be the hermetically-sealed type, constructed in accordance with ANSI/ISA 12.12.01.

2. Pushbuttons

a. Pushbuttons shall be non-illuminated, black in color, and have momentary style operation unless otherwise indicated on the Drawings.

b. Pushbuttons shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each pushbutton. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

c. Pushbuttons shall be provided with a full guard around the perimeter of the button. Where a lockout style pushbutton is specified or indicated on the Drawings, provide a padlockable guard.

3. Selector Switches

a. Selector switches shall be non-illuminated, black in color, and have the number of maintained positions as indicated on the Drawings and as required. Handles shall be the extended type that provide a greater surface area for operation.

b. Selector switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each selector switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

c. Where indicated in the Drawings or Specifications, provide spring return positions.

d. Selector switches shall be provided with an indexing component that fits into the keyed portion of the cutout for the device and prevents the switch from spinning when operated.

4. Indicating Lights

a. Indicating lights shall be LED type, with the proper voltage rating to suit the application, and push-to-test feature.

b. Indicating light lens colors shall be as required in equipment specifications and/or as indicated on the Drawings. If lens colors are not indicated, the following colors shall be used:

Color	Designation
Red	"Run", "On", “Open”
Green	"Off", “Closed”
Amber	"Alarm", "Fail"
White	“Control Power On”

5. Emergency Stop and Tagline Switches

a. Emergency stop switches shall be non-illuminated, red in color, with a minimum 35mm diameter mushroom head. Once activated, switch shall maintain its position and require a manual pull to release/reset.

b. Tagline switches shall have a plunger that activates upon tension from the associated safety cable. Once activated, switch shall maintain its position and require a manual release/reset.

c. Emergency stop and tagline switches shall have the quantity of normally closed and/or normally open contacts as indicated on the Drawings and as required. In addition to the required contacts, one (1) spare normally open and one (1) spare normally closed contact shall be installed at each switch. Contacts shall be rated for 5A at 250VAC/DC (minimum), but no less than required for the application.

C. Relays and Timers

1. General

a. Relays and timers shall be furnished with an integral pilot light for positive indication of coil energization.

b. Relays and timers shall have tubular pin style terminals with matching 11-pin DIN rail mount socket. Spade or blade style terminals are not acceptable.

c. Relays and timers for all electrical equipment under this Contract shall be of the same type and manufacturer unless otherwise specified herein or indicated on the Drawings.

2. Control and Pilot Relays

a. Relays shall have a clear or translucent housing that allows the contacts to be visually inspected without disassembly.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have 3-pole, double-throw (3PDT) contact arrangement.

3. Time Delay Relays

a. Timers delay relays shall utilize electronic timing technology. Mechanical timing devices are not acceptable.

b. Relays shall have coil voltage as required to suit the application and/or as indicated on the Drawings.

c. Relays shall be provided with contacts rated for 10A (resistive), minimum, at 120/240 VAC and 28 VDC. Relays shall have double-pole double-throw (DPDT) contact arrangement.

d. Time delay ranges shall be as indicated on the Drawings and/or as required to suit the application. Timing range shall be adjustable from the front of the relay. On delay and off delay timer configurations shall be provided as indicated on the Drawings and/or as required to suit the application.

4. Elapsed Time Meters

a. Elapsed time meters shall be non-resettable type with no less than a four (4) digit display. Coil voltage shall be as required to suit the application and/or as indicated on the Drawings.

D. Control Terminal Blocks

1. Control terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the enclosure or subpanel. Terminals shall be tubular screw type with pressure plate that will accommodate wire size range of #22 – #8 AWG.

2. Control terminal blocks shall be single tier with a minimum rating of 600 volts and 20A. Separate terminal strips shall be provided for each type of control used (e.g., 120VAC vs. 24VDC). Quantity of terminals shall be provided as required to suit the application. In addition, there shall be a sufficient quantity of terminals for the termination of all spare conductors.

3. Terminals shall be marked with a permanent, continuous marking strip, with each terminal numbered. One side of each terminal shall be reserved exclusively for incoming field conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

2.02 LOCAL CONTROL STATIONS

A. Local control stations shall be furnished and installed complete with pushbuttons, selector switches, indicating lights, and other devices as indicated on the Drawings.

B. Specific devices installed in local control stations shall be provided in accordance with the requirements specified elsewhere in this Section.

C. In non-hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the designation of the area

in which they are to be installed. Area designations are indicated on the Drawings.

Area Designation	Enclosure Type and Material
Indoor Wet Process Area	NEMA 4X, Type 304 Stainless Steel
Indoor Dry Process Area	NEMA 12, Die Cast Zinc
Indoor Dry Non-process Area	NEMA 12, Die Cast Zinc
Indoor Type 1 Chemical Storage/Transfer Area	NEMA 4X, Fiberglass or Thermoplastic Polyester
Indoor Type 2 Chemical Storage/Transfer Area	NEMA 4X, Type 304 Stainless Steel
All Outdoor Areas	NEMA 4X, Type 304 Stainless Steel

D. In hazardous locations, local control stations shall be furnished with the following enclosure type and material of construction, dependent upon the classification of the area in which they are to be installed. Area classifications are indicated on the Drawings.

Area Classification	Enclosure Type and Material
Class I, Division 1, Group D	NEMA 7, Die Cast Aluminum
Class I, Division 2, Group D	NEMA 4X, Type 304 Stainless Steel
Class II, Division 1, Group F	NEMA 9, Die Cast Aluminum
Class II, Division 2, Group F	NEMA 9, Die Cast Aluminum

E. Non-metallic enclosures, NEMA 7 enclosures, and NEMA 9 enclosures shall be provided with threaded integral conduit hubs. Conduit hubs shall be external to the enclosure. Where located outdoors or in indoor wet process areas, NEMA 7 and NEMA 9 enclosures shall also carry a NEMA 4X rating.

F. Local control stations for use in non-hazardous locations shall be UL-508 Listed. Local control stations for use in Class I, Division 1 and Class II, Divisions 1/2 hazardous locations shall be UL-1203 Listed. Local control stations for use in Class I, Division 2 hazardous locations shall be in accordance with ANSI/ISA 12.12.01-2013.

G. Provide a nameplate on each local control station in accordance with Section 16195 – Identification for Electrical Systems. The name and/or number of the equipment associated with each control station shall be engraved on the nameplate, followed by the words “LOCAL CONTROL STATION”.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Local control stations shall be provided in the enclosure type and material of construction required for the area in which it is installed. Reference the requirements in Part 2 herein, and the area designations indicated on the Drawings.

B. Local control stations shall be mounted, nominally, at 4ft 6in above finished floor or finished grade to the centerline of the enclosure, at the equipment height where appropriate and permitted by the NEC, or as shown otherwise on the Drawings.

C. All control components shall be mounted in a manner that will permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable

unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component's mounting shall be oriented in accordance with the component manufacturer's and industries' standard practices.

D. Pilot devices shall be properly bonded to the equipment enclosure door where they are installed. If proper bonding cannot be achieved through the locknuts that affix the device in place, a green colored bonding screw shall be provided on the pilot device. The device shall be bonded to the equipment enclosure with an insulated green bonding conductor.

E. Local control station covers shall be bonded to the local control station enclosure with an insulated green bonding conductor.

F. Wiring to devices at each local control station shall be provided with enough slack to permit the local control station cover to be removed and pulled at least 6 inches away from the enclosure.

G. Terminal strips, relays, timers, and similar devices shall not be installed on the rear of the panel/cabinet doors. Terminal strips, relays, timers, and similar devices shall not be installed on the side walls of panel/cabinet interiors without written permission from the Engineer.

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SECTION 17000

CONTROL AND INFORMATION SYSTEM
SCOPE AND GENERAL REQUIREMENTS

PART 1 -- GENERAL

1.01 SCOPE

A. The Contractor shall provide, through the services of an instrumentation and control system subcontractor, all components, system installation services, as well as all required and specified ancillary services in connection with the modification of the existing Instrumentation, Control and Information System. This shall include all materials, labor, tools, fees, charges and documentation required to modify, furnish, install, test and place in operation the instrumentation as well as the modifications to the existing control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, digital hardware and software (as required) and updating the existing operator workstations, updating the existing interconnecting wiring diagrams for the modified existing programmable logic controllers (PLCs) and such accessories as shown, specified, and/or required to provide the functions indicated.

B. The scope of the work to be performed under this Division includes but is not limited to the following:

1. The Contractor shall retain overall responsibility for the instrumentation and control system as specified herein.

2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

3. Furnish and install local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.

4. Final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17.

5. Furnish, install and terminate all special cables (instruments, etc.).

6. Furnish and install surge protection devices for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.

7. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.

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8. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.

C. Specific modifications to the Owner's existing PLC-based plant control system at the **Glenville Lake WTP** to be provided under this Division shall be as follows:

1. All new PLC installations under this project shall be Allen-Bradley CompactLogix Controller with 1769 Compact IO Modules. PLC hardware selection and design shall be as specified in Section 17120 – Programmable Logic Controllers.

2. Existing RTU's:

a) Ammonia Building RTU-3: Replace existing Modicon PLC with Allen Bradley CompactLogix. Existing RTU-3 enclosure shall be re-used.

b) Chemical Building RTU-2: Replace existing Modicon PLC with Allen Bradley CompactLogix. Existing RTU-2 enclosure shall be re-used.

c) RTU-1 in Control Room (Administration Building): Replace existing Modicon PLC with Allen Bradley CompactLogix. New designation for this PLC shall be RTU-1. RTU-1 enclosure shall be free-standing, painted steel, NEMA 12 rated. RTU-1 shall be located in the Electrical Room adjacent to the Control Room as shown on Contract Drawings.

3. Furnish and install three (3) new Filter RTU panels, RTU-4, 5, and 6. Each Filter RTU shall operate four (4) filters.

4. Furnish new flow switches for ten (10) existing safety shower/eyewash stations. The Glenville Lake WTF SCADA system shall be configured to receive the flow alarm of the emergency shower/eyewashes.

5. All existing filter consoles at the filter gallery shall be removed and replaced with a SCADA HMI Operator Workstation located in the Filter Mezzanine. The new SCADA OWS at this location shall be an industrial PC with industrial touch-screen monitor, panel mounted in a NEMA 4X, 316 SST enclosure.

6. Furnish new SCADA redundant servers and SCADA HMI Operator workstations in the plant control room (Administration Building). New SCADA OWS's at this location shall be thin-client workstations with dual monitor support.

7. Further specific requirements for programming/configuration of SCADA HMI software are specified in Sections 17200 and 17950.

8. Furnish and install a wireless communication network (WLAN) covering the Glenville Lake Water Treatment Plant. The wireless devices shall include wireless access points as shown on Drawings and one operator interface tablet PC.

9. Provide SCADA HMI configuration services. Existing iFIX SCADA HMI software shall be replaced with VTScada by Trihedral, Inc. HMI software configuration

performed under this Contract shall be coordinated with the Owner and shall comply to the requirements specified in Section 17240.

10. Contractor shall provide equipment and services for new SCADA system related components listed below through an allowance. Contractor shall obtain quotes for each item listed within six months of Notice-to-Proceed from three suppliers, unless an individual supplier is identified in the Table below. Quotes shall be submitted to the Owner for review. Owner shall approve equipment/supplier to be used. Contractor shall include any overhead cost for allowance equipment and services in the Bid. Equipment and service suppliers shall be paid in accordance with the General Conditions.

Hardware Allowance Items:

Equipment / Service	**Manufacturer / Supplier**
Control Room equipment:	
• 65" wall-mounted security system camera monitor with wall-mounted bracket (Quantity: 1)	Samsung, LG, Sony
• 32" high-definition SCADA HMI monitors (Quantity: 4)	DELL, HP, Lenovo
• Wireless Tablet with Docking Station and accessories (Quantity: 2)	Microsoft (see Section 17141)
• Thin-Client Workstations (Quantity: 2) Industrial Fanless Computer, 0 - 50°C, 0 – 95% RH non-condensing, UL508A Certification, Panel-Mount, dual monitor output	Arista, Advantech, Wyse, or equal
SCADA HMI equipment:	
• 19" communication and server cabinet (42U): Wheeled; Top-mounted ventilation fan; Front-opening access door; UL508A Listed	Hoffman
• SCADA Server	HP (Preferred), or equivalent by DELL
• Redundant SCADA server	HP (Preferred), or equivalent by DELL
• Historian Server	HP (Preferred), or equivalent by DELL
• Ethernet network switches and accessory modules (24-Port, Quantity: 2)	Cisco (see Section 17180)
• UPS (Quantity: 1)	Liebert, Toshiba
• Power distribution unit	Hoffman
• KVM switch, allows sharing of monitor, keyboard and mouse	Hoffman
• Ethernet patch panel	
• Rack-mounted monitor and keyboard	
• Wireless LAN controller (Quantity: 2)	Cisco Catalyst 9800-L

Chemical Building (on RTU-2) and at Filter Gallery (Mezzanine):	
• Panel-Mount Industrial Monitor & Touch Screen (Quantity: 2): 15.6”, HD1080P/16:9 Native Resolution, 0 - 50°C, 20% - 90% RH non-condensing, NEMA 4/4X, UL508A Certification	Hope Industrial Systems, Inc., or equal
• Thin-Client Workstations (Quantity: 2): Industrial Fanless Computer, 0 - 50°C, 10 – 95% RH non-condensing, UL508A Certification, Panel-Mount	Arista, Advantech, Wyse, or equal
Wireless Access Points (see Section 17186)	
• Indoor (Quantity: 9)	Cisco Catalyst 9166
• Outdoors (Quantity: 2)	Cisco Catalyst IW9167

D. Specific modifications to the Owner’s existing PLC-based plant control system at **the P.O. Hoffer WTP** to be provided under this Division shall be as follows:

1. Furnish and install new RTU panel, RTU – 15 Powder Activated Carbon System.

2. Furnish and install new RTU panel, RTU – 17 High Service Pump Station, located in the Treatment Facility Electrical Building.

3. Provide additional I/O and PLC programming modifications for existing RTU-10 (Ammonia Building). RTU-10 currently contains an Allen-Bradley CompactLogix 5370 1769-L33 CPU.

4. Integration of 9 motor protection relays into new plant SCADA control system for monitoring purposes of the High Service Pumps and the Filter Backwash Pump.

E. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.

B. Additional and related work performed under Division 16 includes the following:

1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17.

2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables and communication network cables.

3. Instrumentation and control system signal wiring.

4. Install control system communication network cables.

5. Furnish and install grounding systems for all digital equipment, local control panels, remote telemetry units, and instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.

6. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

C. The Contractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Contractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component.

E. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the functional control descriptions and electrical control

schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various human-machine interface (HMI) and data reporting functions as specified in the software sections of this Specification.

F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Contractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. The instrumentation subcontractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.

H. The Contractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.

I. The Contractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water treatment facilities. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers and/or models of major hardware or software products (PLC, HMI software, LAN, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and

control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

B. Acceptable instrumentation and control system subcontractors shall be CITI, LLC; Custom Controls Unlimited, Inc.; Revere Control Systems; Rovisys; Piedmont Automation, Inc.; Lord and Company.

1.05 DEFINITIONS

A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.

B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.

E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.

F. Availability: The availability of a non-redundant device or system shall be related to its MTBF and MTTR by the following formula:

$$A = 100 \times (MTBF/(MTBF + MTTR)) \text{ Percent}$$

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

$$A = A2 + 1 - ((1-A1) \times (1-A1))$$

where:

A1 = availability of non-redundant device or system

A2 = availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

A	-	Availability
ADC	-	Analog to Digital Converter
AI	-	Analog Input
AO	-	Analog Output
AVAIL	-	Available
BCD	-	Binary Coded Decimal
CSMA/CD	-	Carrier Sense Multiple Access/Collision Detect
CPU	-	Central Processing Unit
CRC	-	Cyclic Redundancy Check
CRT	-	Cathode Ray Tube
CS	-	Control Strategy
DAC	-	Digital to Analog Converter
DBMS	-	Data Base Management System
DI	-	Discrete Input
DMA	-	Direct Memory Access
DO	-	Discrete Output
DPDT	-	Double Pole, Double Throw
DVE	-	Digital to Video Electronics
EPROM	-	Erasable, Programmable Read Only Memory
FDM	-	Frequency Division Multiplexing
FSK	-	Frequency Shift Keyed
HMI	-	Human Machine Interface (Software)
I/O	-	Input/Output
LAN	-	Local Area Network
LDFW	-	Lead-Follow
MCC	-	Motor Control Center
MTBF	-	Mean Time Between Failures
MTTR	-	Mean Time To Repair
OS	-	Operating System
PAC	-	Programmable Automation Controller
PCB	-	Printed Circuit Board

PID	-	Proportional Integral and Derivative Control
PLC	-	Programmable Logic Controller
PROM	-	Programmable Read Only Memory
RAM	-	Random Access Memory
RDY	-	Ready
RMSS	-	Root Mean Square Summation
RNG	-	Running
ROM	-	Read Only Memory
RTU	-	Remote Telemetry Unit
SPDT	-	Single Pole, Double Throw
ST/SP	-	Start/Stop
TDM	-	Time Division Multiplexing
UPS	-	Uninterruptible Power Supply

H. To minimize the number of characters in words used in textual descriptions on CRT displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.

D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets, interconnecting hardware, and fasteners shall be aluminum, type 316 stainless steel, or metal alloy as otherwise suitable for chemical resistance within chemical feed/storage areas shown on the installation detail drawings.

PART 2 -- PRODUCTS

2.01 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.

B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

PART 3 -- EXECUTION

3.01 SCHEDULE OF PAYMENT

A. Payment to the Contractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System.

B. The following payment schedule defines project milestones that will be used for establishing maximum partial payment amounts for the Control and Information System. Payment for field instruments, field wiring, fiber optic network cable and similar items will be made in addition to the payment for the scopes of services incorporated into the schedule below.

1.. Task Completed - Maximum Cumulative % Request for Payment

a) Mobilization - 3%

b) Preliminary Design Review - 5%

c) Approved Submittals - 20%

d) Hardware Purchase (excludes field instruments) - 40%

e) Factory Acceptance Test - 60%

f) Loop Checkout - 70%

g) Control System Start-up and Test - 80%

h) Plant Start-up - 90%

i) Final System Acceptance Test - 95%

j) Final Acceptance - 100%

C. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory acceptance test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.

D. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

3.02 CLEANING

A. The Contractor shall thoroughly clean all soiled surfaces of installed equipment and materials.

B. Upon completion of the instrumentation and control work, the Contractor shall remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:

1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.

2. Completion of the Availability Demonstration.

3. Completion of all specified control system training requirements.

4. Completion of all punch-list items that are significant in the opinion of the Engineer.

B. Final acceptance of the System shall mark the beginning of the extended warranty period.

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SECTION 17030

CONTROL AND INFORMATION SYSTEM SUBMITTALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall submit for review complete Shop Drawings for all equipment in accordance with the General Conditions and Division 1 of the Specifications. All submittal material shall be complete, legible, and reproducible, and shall apply specifically to this project.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittals

B. Section 17000 – Control and Information System Scope and General Requirements

1.03 EXISTING CONDITIONS / AS-BUILT DOCUMENTATION SUBMITTAL

A. Prior to modifying, demolishing, removing, or decommissioning equipment, thoroughly investigate and document the existing conditions. Please note that Owner's record drawings alone are not sufficient for documentation. The record drawings, if present, shall be verified in the field prior to submitting. Submit drawings, markup, sketches, information, or other materials for documenting the following existing conditions:

1. All I/O on PLC modules that have its wiring modified or new I/O terminated or for any PLC that is being decommissioned/removed/demolished. Document module number, point number, wire numbers, terminal numbers, destination, and function.

2. All wiring entering or leaving a PLC that is being decommissioned, removed, or demolished that is not otherwise accounted for.

B. When all information has been gathered, it shall be submitted to Engineer along with a clear and unequivocal statement that the existing conditions have been documented and understood. Contractor shall be held responsible for all issues that arise due to Contractor's modifications, demolition, removal, or decommissioning of existing equipment, including necessary reversion back to previous conditions.

1.04 DIGITAL HARDWARE SUBMITTALS

A. Submit system block diagram(s) showing:

1. All equipment to be provided.

2. All interconnecting cable.

3. Equipment names, manufacturer, and model numbers.

4. Equipment locations.

B. Submit information for all digital equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.

2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.

4. Assembly drawings.

5. Mounting requirements.

6. Color samples.

7. Nameplates.

8. Environmental requirements during storage and operation.

1.05 SOFTWARE SUBMITTALS

A. Software submittals shall include the following as a minimum:

1. Bill of materials with software names, vendors, and complete listings of included software modules.

2. Standard manufacturer's literature describing the products.

3. Description of function of software in Control and Information System.

4. Limitations or constraints of software.

5. Minimum system (processor and memory) requirements.

6. Operation and maintenance requirements.

B. Submit information on the following software:

1. Third-party software, including:

a. Operating system.

b. Operator workstation (SCADA or HMI) software, including all add-in software provided to perform specific functions (alarm dialers, schedulers, backup creation software, etc.).

c. Office-type products, such as spreadsheets, word processors, etc.

d. Database management software.

e. Communication software, including all applicable local and wide area network software.

f. Programmable controller programming software (where applicable).

2. Software configuration, including:

a. Graphic display organization.

b. Database configuration for operator workstations and database management system.

c. Trends.

d. System security.

e. Formats for all reports, including all required calculations.

f. Intercommunications between software products required to implement system functions.

g. Equipment backup configuration and requirements.

C. Programming Methodology Submittal

1. Standard PLC programming logic, with comments, for

a. “Across-the-line” motor

b. Variable speed motor

c. Open/close valve

d. Modulating valve

e. Lead/lag sequencing

f. Operator mode/stage selection with auto alternate

2. Internal PLC task/routine layout, per PLC if not standardized

3. Standard PLC tag name structure

D. Control Strategies

1. Description of automatic logic and all non-standard manual logic using plain English, for non-technical persons, and written in Contractor’s own words. The write-up shall include references to associated I/O, tag/loop numbers, alarming/interlocks.

2. Submitting language verbatim to Section 17950, Functional Control Descriptions, shall not be acceptable.

E. Application Software

1. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

2. Application software includes all custom routines developed specifically for this project, or pre-written routines used for accomplishing specified functions for this project. This shall include any add-in custom software.

F. Graphic Displays

1. Submit all graphic displays required to perform the control and operator interface functions specified herein. Submitted graphic displays shall be for both new and modified graphics.

2. Submit the complete set of graphic displays for review by the Owner and the Engineer at least 60 days prior to commencement of factory testing.

3. Where a large number of graphic displays are required, submit an initial set of example displays for review before the complete set of displays is submitted. This initial set shall include examples of all basic graphic display design features and parameters, and is intended to allow the Contractor to obtain preliminary approval of these features and parameters prior to beginning main graphic display production.

4. The Contractor shall allow for one major cycle of revisions to the displays prior to factory testing and one minor cycle of revisions following factory test. A cycle of revisions shall be defined as all revisions necessary to complete a single set of changes marked by the Engineer and the Owner. Additional corrections shall be performed during start-up as required to accommodate changes required by actual field conditions, at no additional cost to the Owner.

5. The required submittals in each revision cycle shall be full color prints of the entire set of displays.

6. Displays shall be printouts of actual process graphics implemented in the system.

1.06 CONTROL PANEL SUBMITTALS

A. Submittals shall be provided for all control panels, and shall include:

1. Exterior panel drawings with front and side views, to scale.

2. Interior layout drawings showing the locations and sizes of all equipment and wiring mounted within the cabinet, to scale.

3. Panel area reserved for cable access and conduit entry.

4. Location plans showing each panel in its assigned location.

B. Submit information for all exterior and interior panel mounted equipment including, but not limited to, the following:

1. Bill of materials with equipment names, manufacturers, complete model numbers and locations.

2. Catalog cuts, including complete part number breakdown information.

3. Complete technical, material and environmental specifications.

4. Assembly drawings.

5. Mounting requirements.

6. Color samples.

7. Nameplates.

8. Environmental requirements during storage and operation.

C. Submit panel wiring diagrams showing power, signal, and control wiring, including surge protection, relays, courtesy receptacles, lighting, wire size and color coding, etc.

1.06 INSTRUMENT SUBMITTALS

A. Submit information on all field instruments, including but not limited to the following:

1. Product (item) name and tag number used herein and on the Contract Drawings.

2. Catalog cuts, including complete part number breakdown information.

3. Manufacturer's complete model number.

4. Location of the device.

5. Input - output characteristics.

6. Range, size, and graduations.

7. Physical size with dimensions, NEMA enclosure classification and mounting details.

8. Materials of construction of all enclosures, wetted parts and major components.

9. Instrument or control device sizing calculations where applicable.

10. Certified calibration data on all flow metering devices.

11. Environmental requirements during storage and operation.

12. Associated surge protection devices.

1.07 WIRING DIAGRAMS

A. Submit interconnection wiring diagrams for all panels and signals in the Control and Information System.

B. Electrical interconnection diagrams shall show all terminations of equipment, including terminations to equipment and controls furnished under other Divisions, complete with equipment and cable designations. Where applicable, interconnection wiring diagrams shall be organized by input/output card. Interconnecting diagrams shall be prepared in a neat and legible manner on 11 X 17-inch reproducible prints.

1.09 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall deliver equipment operation and maintenance manuals in compliance with Section 01300 - Submittals. Operation and maintenance (O&M) manuals shall consist of two basic parts:

1. Manufacturer standard O&M manuals for all equipment and software furnished under this Division.

2. Custom O&M information describing the specific configuration of equipment and software, and the operation and maintenance requirements for this particular project.

B. The manuals shall contain all illustrations, detailed drawings, wiring diagrams, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All modifications to manufacturer standard equipment and/or components shall be clearly identified and shown on the drawings and schematics. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

C. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operation and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data and full preventive maintenance schedules. The instructions shall be bound in locking 3-D-ring binders with bindings no larger than 3.5 inches. The manuals shall include 15% spare space for the addition of future material. The instructions shall include drawings reduced or folded and shall provide the following as a minimum.

1. A comprehensive index.

2. A functional description of the entire system, with references to drawings and instructions.

3. A complete "as-built" set of all approved shop drawings, which shall reflect all work required to achieve final system acceptance.

4. A complete list of the equipment supplied, including serial numbers, ranges, and pertinent data.

5. Full specifications on each item.

6. Detailed service, maintenance, and operation instructions for each item supplied.

7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.

8. Complete parts lists with stock numbers and name, address, and telephone number of the local supplier.

9. References to manufacturers' standard literature where applicable.

10. Warning notes shall be located throughout the manual where such notes are required to prevent accidents or inadvertent misuse of equipment.

D. The operating instructions shall clearly describe the step-by-step procedures that must be followed to implement all phases of all operating modes. The instructions shall be in terms understandable and usable by operating personnel and maintenance crews and shall be useful in the training of such personnel.

E. The maintenance instructions shall describe the detailed preventive and corrective procedures required, including environmental requirements during equipment storage and system operation, to keep the System in good operating condition. All hardware maintenance documentation shall make reference to appropriate diagnostics, where applicable, and all necessary wiring diagrams, component drawings and PCB schematic drawings shall be included.

F. The hardware maintenance documentation shall include, as a minimum, the following information:

1. Operation Information - This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment.

2. Preventive-Maintenance Instructions - These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the System.

3. Corrective-Maintenance Instructions - These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an

equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction.

4. Parts Information - This information shall include the identification of each replaceable or field-repairable component. All parts shall be identified on a list in a drawing; the identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between equipment numbers and manufacturer's part numbers shall be provided.

G. Software documentation shall conform to a standard format and shall include, but not be limited to, the following:

1. A program abstract that includes:

a. Program Name - The symbolic alphanumeric program name.

b. Program Title - English text identification.

c. Program Synopsis - A brief text shall be provided that specifies the need for the program, states when it shall be used and functionally describes all inputs, outputs and functions performed. This descriptive text shall be written in a language that is understandable by nonsoftware oriented readers.

2. A program description that shall include, but not be limited to, the following:

a. Applicable Documents - List all documents (standard manufacturer's literature, other program descriptions, etc.) by section, if practical, that apply to the program. One complete copy of all applicable reference material shall be provided.

b. Input-Output - Identify each input and output parameter, variable, and software element used by the program. State the purpose of all inputs, outputs, and variables.

c. Processing - This section shall contain a description of the overall structure and function of the program. Describe the program run stream and present a detailed description of how the program operates. Describe the timing and sequencing of operations of the program relative to other programs. Describe all interactions with other programs. Processing logic that is not readily described without considerable background information shall be handled as a special topic with references to an appendix or to control strategy document that details the necessary information. Reference shall also be made to an appendix or control strategy document for equation and program algorithm derivations.

d. System Configuration - Describe in detail the system configuration or status required for program implementation, if appropriate.

e. Limitations and Constraints - Summarize all known or anticipated limitations of the program, if appropriate.

f. Storage - Define program storage requirements in terms of disk or RAM memory allocation.

g. Verification - Describe, as a minimum, a test that can be used by the operator to assure proper program operation. Define the required system configuration, input requirements and criteria for successful test completion.

h. Diagnostics - Describe all program diagnostics, where applicable. Descriptions shall list each error statement, indicate clearly what it means, and specify what appropriate actions should be taken.

i. Malfunction Procedures - Specify procedures to follow for recovering from a malfunction due to either operator error or other sources.

1.10 FINAL SYSTEM DOCUMENTATION

A. All documentation shall be delivered to the Owner prior to final system acceptance in accordance with the Contract Documents. As a minimum, final documentation shall contain all information originally part of the control system submittals.

B. Provide a complete set of detailed electrical interconnection diagrams required to define the complete instrumentation and control system. All diagrams shall be 11 X 17-inch original reproducible prints. All diagrams shall be corrected to describe final "as built" hardware configurations and to reflect the system configuration and control methodology adopted to achieve final system acceptance.

C. Provide system software documentation for the operation and maintenance of all system software programs provided as a part of the digital system. All system software documentation shall be amended as required to delineate all modifications and to accurately reflect the final as built software configurations.

D. Provide application software documentation that contains program descriptions for the operation, modification, and maintenance of all application programs provided for the digital system.

E. Provide control strategy documentation which shall include control strategy (block oriented or ladder logic) diagrams to describe the control of all processes. Control strategy documentation shall reflect the system configuration and control methodology adopted to achieve final system acceptance. Control strategy documentation shall conform to the submittal requirements listed hereinabove.

F. O&M documentation shall be amended with all final, adjusted values for all setpoints and other operating parameters for Owner reference.

G. The Owner recognizes the fact that not all possible problems related to real time events, software interlocks, and hardware maintenance and utilization can be discovered during

the Acceptance Tests. Therefore, the instrumentation subcontractor through the Contractor shall investigate, diagnose, repair, update, and distribute all pertaining documentation of the deficiencies that become evident during the warranty period. All such documentation shall be submitted in writing to the Owner within 30 days of identifying and solving the problem.

1.11 PROGRAMS AND SOURCE LISTINGS

A. Provide one copy of all standard, of-the-shelf system and application software (exclusive of firmware resident software) on original media furnished by the software manufacturer.

B. Provide one copy of source listings on DVD media for all custom software written specifically for this facility, all database files configured for this facility, and all control strategies. All source listings shall include a program abstract, program linkage and input/output data. Comments describing the program flow shall be frequently interspersed throughout each listing.

C. All software/logic shall be in both its native format and in Adobe Portable Document Format.

1.12 SUBMITTAL/DOCUMENTATION FORMAT

A. All drawing-type submittals and documentation shall be rendered and submitted in the latest version of AutoCAD.

B. All textual-type submittals and documentation shall be rendered and submitted in the latest version of Microsoft Word or in Searchable Adobe Portable Document Format (.pdf).

1.13 ELECTRONIC O&M MANUALS

A. Subject to acceptance by the Owner and Engineer, the O&M information may be submitted in part or in whole in an electronic format on optical media.

B. Electronic O&M manuals shall contain information in standard formats (Searchable Adobe PDF, Word, AutoCAD, HTML, etc.) and shall be easily accessible through the use of standard, “off-the-shelf” software such as an Internet browser.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

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SECTION 17040

CONTROL AND INFORMATION SYSTEM TRAINING REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. To familiarize the Owner's personnel with the process control system and field instrumentation, training shall be provided as detailed hereunder.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

1.03 SUBMITTALS

A. A minimum of 60 days prior to beginning training, submit a detailed training plan describing the following:

1. A listing of all courses to be conducted.

2. Course content.

3. Applicability of each course to management, operations, maintenance, laboratory, etc., personnel.

4. Course schedules.

5. Qualifications and experience of individual(s) providing training.

B. A minimum of 14 days prior to beginning each training course, submit documentation for use by the Owner's personnel during training. The training documentation shall be specific to the particular course, and shall include the following:

1. A listing of all subjects to be covered.

2. Course schedule.

3. Documentation/lesson plans covering all subjects to be covered during the course instruction. Information shall be in a "how to" format, with sufficient background documentation and references to manufacturer literature to provide a thorough and clear understanding of the materials to be covered.

1.04 GENERAL REQUIREMENTS

A. All costs of providing the training courses shall be borne by the Contractor.

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B. As used herein, the term "day" shall mean an eight-hour day, and the term "week" shall mean a five-day, 40-hour week.

C. Training courses, especially those for operator training, may be required to be scheduled during non-standard business hours (i.e., not between the hours of 8:00 am and 5:00 pm) to accommodate the working schedule of the Owner's personnel. No additional compensation will be awarded to the Contractor for training at non-standard hours.

D. All training courses shall complement the experience and skill levels of the Owner's personnel.

E. Training courses shall be structured in order of increasing capability or security levels. The purpose of this requirement is to allow personnel with lesser training requirements or security password levels to drop out of the training at certain times while the training continues for personnel with greater requirements or higher security levels.

F. All training courses shall include lecture as well as "hands on" experience for each of the attending personnel. The Contractor shall provide sufficient equipment for this to be accomplished. For example, training in which the instructor uses the computer and the Owner's personnel passively observe as the instructor demonstrates system functions shall not be acceptable.

G. Unless otherwise specified, all training courses shall be conducted in the Owner's facilities.

H. All training shall be completed prior to system acceptance.

I. Standard manufacturer training courses are acceptable pending approval by the Engineer and Owner.

1.05 SYSTEM SUPERVISOR/ENGINEER TRAINING

A. Provide manufacturer standard training in the use and configuration of the specified operator workstation (HMI or SCADA) software.

B. System supervisor/engineer training shall be performed a minimum of 30 days prior to system startup.

C. Training shall be provided in the following subjects:

1. System overview and capabilities.

2. Database configuration.

3. Graphic display configuration, including linking of data to displays.

4. Historical data configuration (collection, manipulation, and display).

5. Real-time and historical trending.

6. Report configuration, generation, printing, and customization.

7. Alarm configuration and management.

8. System security.

9. I/O driver use and configuration.

10. System backup and recovery.

11. DDE linking, where applicable.

12. System command language.

13. Troubleshooting.

14. System optimization.

15. System startup and shutdown procedures.

16. LAN and WAN communications, as appropriate.

D. The course shall be structured as follows:

1. Fundamentals:

a. Standard VTScada fundamental course conducted by certified training instructor from Trihedral Engineering Limited.

b. Training shall be provided for two persons which shall serve as a digital control system familiarization course for project management personnel, engineers, and key operating/maintenance personnel. This course shall be a prerequisite for the advanced course described below in Item 2.

2. Advanced:

a. VTScada advanced class conducted by Trihedral such as digital system configuration and operating course shall be provided.

b. Training shall be provided for two persons. The level of training shall be sufficient to familiarize the Owner's personnel with the configuration and application of all system programs. All essential system operating procedures shall be described as required to enable the Owner's personnel to operate the system via the various workstations and local control panels.

3. Historical:

a. VTScada Historical course conducted by Trihedral to instruct two persons in the use and configuration of the historical data archival system. Training shall include creation, viewing, and printing of trends, charts, and reports. Training

shall include all database maintenance and archival functions necessary to maintain the facility's data on both short and long term basis, including periodic archival to optical media.

1.06 OPERATOR TRAINING

A. Five one-day courses comprised of daily half-day (four-hour) sessions for up to ten persons each shall be conducted to provide instruction in the use of the Control and Information System to monitor and control the facility.

B. Operator training shall include familiarization training covering the Control and Information System. Operators shall be instructed in the names, locations, functions, and basic operation of all items of digital equipment and associated software.

C. Operator training shall cover process and equipment operation both individually and collectively as an operating system. Normal as well as abnormal operating conditions shall be covered, including the response to failure occurrences and system alarms. All operator/system interactions shall be described.

D. Operators shall be trained to instruct other operators and shall be provided with all course materials.

1.07 MAINTENANCE TRAINING

A. Two one-day courses shall be conducted for at least ten persons prior to the start-up of digital equipment at the Owner's plant. Instruction shall be provided in the following:

1. Operating all digital equipment, including system start-up and shutdown procedures.

2. The use of hardware diagnostic routines, test equipment and test procedures as required to enable the Owner's personnel to detect and isolate system faults to the circuit board or module level and to implement repairs by replacing failed circuit boards or modules.

3. Calibration and routine maintenance procedures for all analog and digital equipment.

B. Step by step written procedures shall be provided for all preventive maintenance tasks and for identifying hardware faults to the circuit board or module level for all items of digital equipment.

C. All digital equipment preventive and corrective maintenance training activities shall be limited to the use of commercially available off-the-shelf test equipment and to the use of diagnostic routines and hardware items which are the same as those to be provided as part of the system.

1.08 INSTRUMENT TRAINING

A. A one-day course shall be provided at the Owner's facilities no more than three months prior to system start-up to instruct a minimum of five persons each in the calibration and preventive maintenance of the field instruments provided under this Contract.

1.09 PLC TRAINING

A. One minimum three-day manufacturer standard training course up to four persons shall be provided in the programming and use of PLC's to implement monitoring and control functions such as those provided for this project. Training shall cover all aspects of the PLC hardware and PLC programming software. This training shall be provided by the PLC manufacturer or, as directed by the manufacturer, by the authorized distributor engaged by the manufacturer to perform this training.

B. One three-day course of specific training shall be provided for up to four persons by the instrumentation subcontractor in the use and modification of all control strategies provided under this Division.

1.10 GENERAL REFRESHER TRAINING

A. A one-week general refresher training course shall be provided for up to ten persons 3-6 months after final system acceptance. Instruction shall be given in all aspects of the complete instrumentation and control system. Instructor(s) shall be capable of answering questions related to all aspects and details of the complete system.

PART 2 -- PRODUCTS

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PART 3 -- EXECUTION

(NOT USED)

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SECTION 17060

SIGNAL COORDINATION REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall conform to the signal coordination requirements specified herein.

B. The Contractor shall be responsible for coordinating signal types and transmission requirements between the various parties providing equipment under this Contract. This shall include, but not be limited to, distribution of appropriate shop drawings among the equipment suppliers, the electrical subcontractor, and the instrumentation subcontractor.

C. Analog signals shall be signals for transmitting process variables, etc. from instruments and to and from panels, equipment PLC's and Control System PLC's.

D. Discrete signals shall consist of contact closures or powered signals for transmitting status/alarm information and control commands between starters, panels, equipment PLC's, the Control System, etc.

1.02 ANALOG SIGNAL TRANSMISSION

A. Signal transmission between electric or electronic instruments, controllers, and all equipment and control devices shall be individually isolated, linear 4-20 milliamperes and shall operate at 24 volts D.C.

B. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

C. All cable shields shall be grounded at one end only, at the control panel, with terminals bonded to the panel ground bus.

D. Analog signal isolation and/or conversion shall be provided where necessary to interface with instrumentation, equipment controls, panels, and appurtenances.

E. Non-standard transmission systems such as pulse duration, pulse rate, and voltage regulated shall not be permitted except where specifically noted in the Contract Documents. Where transmitters with nonstandard outputs do occur, their outputs shall be converted to an isolated, linear, 4-20 milliampere signal.

F. The Contractor shall provide 24 V power supplies for analog signals and instruments where applicable and as required inside panels, controls, etc.

G. Where two-wire instruments transmit directly to the Control and Information System, the instrumentation subcontractor shall provide power supplies at the PLC-equipped control panels for those instruments.

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H. Where four-wire instruments with on-board loop power supplies transmit directly to the Control and Information System, the instrumentation subcontractor shall provide necessary signal isolators or shall otherwise isolate the input from the Control and Information System loop power supply. Similar provisions shall be made when a third element such as a recorder, indicator, or single loop controller with integral loop power supply is included in the loop.

1.03 DISCRETE INPUTS

A. All discrete inputs to equipment and Control and Information System PLC's, from field devices, starters, panels, etc., shall be unpowered (dry) contacts in the field device or equipment, powered from the PLC's, unless specified otherwise.

B. Sensing power (wetting voltage) supplied by the PLC shall be 120 VAC.

1.04 DISCRETE OUTPUTS

A. All discrete outputs from local control panels and Control and Information System PLC's to field devices, starters, panels, etc., shall be 120 VAC powered (sourced) from PLC's.

B. PLC powered discrete outputs shall energize 120 VAC pilot relay coils in the field devices, starters, panels, etc. which in turn open or close contacts in the associated control circuit. The AC relay coil, contacts, and associated control circuitry shall be furnished integral with the field device, starter, panel, etc. by the supplier and contractor furnishing the field device, starter, or panel.

C. Where required or specified herein, discrete outputs from equipment and Control and Information System PLC's to motor operated valves shall be dry contact outputs.

D. Outputs to solenoid valves shall be 120 VAC, powered from the PLC or control panel unless specified or shown otherwise.

1.05 OTHER DISCRETE SIGNALS

A. Discrete signals between starters, panels, etc. where no 24 VDC power supply is available may be 120 VAC, as long as such contacts are clearly identified in the starter, panel, etc. as being powered from a different power supply than other starter/panel components.

B. Where applicable, warning signs shall be affixed inside the starter, panel, etc. stating that the panel is energized from multiple sources.

C. Output contacts in the starter, panel, etc., that are powered from other locations shall be provided with special tags and/or color-coding. Disconnecting terminal strips shall be provided for such contacts.

D. The above requirements shall apply to all starters and panels, regardless of supplier.

PART 2 -- PRODUCTS

2.01 PILOT RELAYS

A. Pilot relays shall be supplied with the following:

1. 24 VDC or 120 VAC coils, as required.

2. At a minimum, DPDT contacts rated at 5 A, 120 VAC or 28 VDC.

3. Sockets for 24 VDC and 120 VAC relays shall be of different configurations.

4. Clips for attachment to sockets.

5. Indicator lights that glow when the relay coil is powered.

B. Pilot relays shall be as manufactured by Square D, Allen Bradley, Potter & Brumfield, or equal.

PART 3 -- EXECUTION

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SECTION 17070

CONTROL AND INFORMATION SYSTEM TESTING - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall test the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17072 – Field Testing

C. Section 17073 – Final Acceptance Test

1.03 SUBMITTALS

A. For each of the specified tests, submit a test plan to the Engineer at least one month in advance of commencement of the tests. The test plan shall contain the following at a minimum:

1. A schedule of all testing to be conducted.

2. A brief description of the testing to be performed

3. Test objectives.

4. Testing criteria per the Specifications.

5. Check lists and procedures for performing each of the specified tests.

6. Sample test result documentation.

7. Requirements for other parties.

1.04 GENERAL REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures; check lists, etc., previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of any system tests and reserves the right to have his and/or the Owner's representatives in attendance.

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B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor (or designee) shall maintain master logbooks for each phase of installation, startup and testing activities specified herein. Each logbook shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified hereinabove.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a certified copy of all test results shall be furnished to the Engineer together with a clear and unequivocal statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

E. The Engineer will review test documentation in accordance with the Contract Documents and will give written notice of the acceptability of the tests within 10 days of receipt of the test results.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17071

FACTORY ACCEPTANCE TEST

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform a Factory Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17070 – Control and Information System Testing, General

C. Section 17072 – Field Testing

D. Section 17073 – Final Acceptance Test

1.03 FACTORY ACCEPTANCE TEST

A. The Control and Information System equipment shall not be shipped until the Contractor receives notice of acceptability of the factory tests.

B. Each item of equipment shall be fully factory inspected, calibrated and tested for function, operation and continuity of circuits. Exceptions shall be approved in writing by the Engineer.

C. Each subsystem shall be fully factory tested for function and operation.

D. System performance shall be tested using a fully integrated system, including all software and hardware. To achieve this, the entire control system, including all peripheral devices and all interconnecting cables (field instruments are not included in this requirement), shall be assembled on the factory test floor and the complete operational program loaded and simulated inputs applied.

E. All hardware and software required to perform the specified testing shall be furnished by the Contractor at no additional cost to the Owner.

F. The instrumentation subcontractor shall perform a 100-hour full system test, during which the entire system shall operate continuously without failure in accordance with the requirements of the Contract Documents. If a system component fails during the test, the 100-hour test period shall be restarted after its operation is restored.

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G. The factory testing shall demonstrate all aspects of system sizing and timing including:

1. Monitoring and control scan times at the PLC level.

2. Response times at the operator workstation level.

H. The overall system as well as individual component hardware shall be tested under conditions of power failure to ensure proper response as specified herein.

I. Operator Workstation Operation - This demonstration shall provide proof of system operation on an individual subsystem basis first, and then in the expected operating environment. Both normal and abnormal operating modes shall be demonstrated. Operator workstation testing shall include the following:

1. Demonstrate proper operation, under both normal and abnormal conditions of the operator workstation application software (SCADA, remote alarm dial-up, etc.). This shall include demonstration of system on-line diagnostics, fail-over features, reconfiguration operations, system initialization and restart, software fault tolerance, error detection and recovery, communications, and all additional features necessary to assure the successful operation of the system.

2. Demonstrate the standard features of the system. This shall include proof of operation of the process control database generator, the display generator, data storage and retrieval functions, data acquisition and control, trending functions, and reporting functions.

3. Demonstrate the configuration of the system to verify conformance with the Contract Documents. This shall include graphic displays and vectoring, operator interface functions, trending, reports, alarm management, security system configuration, etc.

4. The system shall be operated with data input/output with the PLC's and associated panels to prove operation of all workstation functions.

5. The testing in Items 2 and 3 above may be performed concurrently (i.e., the standard and configured features of the system may be demonstrated simultaneously).

J. PLC Operation - All functions comparable to those demonstrated for the operator workstations shall be demonstrated on the PLC's. This shall include the following:

1. On-line and off-line diagnostics.

2. For redundant units, fail-over operation and reconfiguration.

3. System initialization and restart.

4. Network communications, including fieldbus communications where required.

5. Non-volatility of memory.

6. Operation of all control logic shall be demonstrated as described herein.

K. Process I/O Simulation - Process input/output simulation for PLC's shall be performed with a manual simulation control panel, a separate programmable logic controller, network-based simulation software, analog signal generators, and/or jumpering of discrete signals between outputs and associated inputs, or some combination of these. Alternate process I/O systems such as plug-in circuit cards or I/O test modules may be utilized subject to approval by the Engineer to provide the specified simulation functions. The simulation system shall provide analog and discrete I/O hardware devices in sufficient quantity to allow complete and thorough testing of the control strategies and functions of the system. The process I/O simulation system shall be used in several ways as follows:

1. To provide a means of communications checkout from the operator workstations through the various levels of software in the PLC's and to the process, i.e., the simulation panel. Likewise, a discrete or analog input shall be initiated from the simulation panel and the result monitored at the workstations.

2. Alarm response to discrete status changes or analog value limits shall be verified. Database entries or attributes such as engineering units and conversion equations shall be verified by varying analog inputs.

3. To provide data for use at all levels of the control system at the time of system integration.

L. Control Strategy Testing - Provision shall be made to test all control strategies to prove the integrity of each strategy and the process control language in which it is implemented. For each control strategy, all functions shall be tested individually (where possible) and collectively to verify that the control strategy performs as described herein and as required for overall functionality within the control system.

PART 2 -- PRODUCTS

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PART 3 -- EXECUTION

(NOT USED)

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SECTION 17072

FIELD TESTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform field testing on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17070 – Control and Information System Testing, General

C. Section 17073 – Final Acceptance Test

1.03 GENERAL REQUIREMENTS

A. Control system start-up and testing shall be performed to ensure that all plant processes shall be systematically and safely placed under digital control in the following order:

1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified in Sections 17600.

2. Each final control element shall be individually tested as specified hereinafter.

3. Each control loop shall be tested as specified hereinafter.

4. Each control strategy shall be tested under automatic digital control as specified hereinafter.

5. The entire control system shall be tested for overall monitoring, control, communication, and information management functions, and demonstrated for system availability as specified hereinafter.

B. System start-up and test activities shall include the use of water, if necessary, to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

C. Each phase of testing shall be fully and successfully completed and all associated documentation submitted and approved prior to the next phase being started. Specific exceptions are allowed if written approval has been obtained in advance from the Engineer.

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1.04 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall ensure that all mechanical equipment, equipment control panels, local control panels, field instrumentation, control system equipment and related equipment and/or systems are tested for proper installation, adjusted and calibrated on a loop-by-loop basis prior to control system startup to verify that each is ready to function as specified. Each test shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

B. The Contractor shall be responsible for coordination of meetings with all affected trades. A meeting shall be held each morning to review the day's test schedule with all affected trades. Similarly, a meeting shall be held each evening to review the day's test results and to review or revise the next day's test schedule as appropriate.

C. The Contractor shall ensure that the electrical subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function and coordination of all motor control center control and interlock circuitry and the transmission of all discrete and/or analog signals between equipment furnished by the electrical subcontractor and the control system specified herein.

D. The Contractor shall ensure that the HVAC subcontractor conforms to the start-up, test and sign-off procedures specified herein to assure proper function of all HVAC system control and interlock circuitry and the transmission of all discrete and/or analog signals between HVAC equipment and controls and the control system specified herein.

1.05 FINAL CONTROL ELEMENT TESTING

A. The proper control of all final control elements shall be verified by tests conducted in accordance with the requirements specified herein.

B. All modulating final control elements shall be tested for appropriate speed or position response by applying power and input demand signals, and observing the equipment for proper direction and level of reaction. Each final control element shall be tested at 0, 25, 50, 75, and 100 percent of signal input level and the results checked against specified accuracy tolerances. Final control elements, such as VFD’s, that require turndown limits shall be initially set during this test.

C. All non-modulating final control elements shall be tested for appropriate position response by applying and simulating control signals, and observing the equipment for proper reaction.

1.06 LOOP CHECKOUT

A. Prior to control system startup and testing, each monitoring and control loop shall be tested on an individual basis from the primary element to the final element, including the operator workstation or loop controller level, for continuity and for proper operation and calibration.

B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

C. The accuracy of all DAC's shall be verified by manually entering engineering unit data values at the operator workstation and then reading and recording the resulting analog output data.

D. The accuracy of all ADC's shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the operator workstation.

E. Each loop tested shall be witnessed, dated and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.07 CONTROL SYSTEM STARTUP AND TESTING

A. Control system startup and testing shall be performed to demonstrate complete compliance with all specified functional and operational requirements. Testing activities shall include the simulation of both normal and abnormal operating conditions.

B. All digital hardware shall be fully inspected and tested for function, operation and continuity of circuits. All diagnostic programs shall be run to verify the proper operation of all digital equipment.

C. Final control elements and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits.

D. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses for final control elements. Simulated input data signals may be used subject to prior written approval by the Engineer.

E. Each control strategy shall be tested to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

F. The control system start-up and test activities shall include running tests to prove that the Instrumentation, Control and Information System is capable of continuously, safely and reliably regulating processes, as required by the Contract, under service conditions that simulate, to the greatest extent possible, normal plant operating ranges and environmental conditions.

G. A witnessed functional acceptance test shall be performed to demonstrate satisfactory performance of individual monitoring and control loops and control strategies. At least one test shall be performed to verify that the control and instrumentation system is capable of simultaneously implementing all specified operations.

H. Each loop and control strategy test shall be witnessed and signed off by both the Contractor (or designee) and the Engineer upon satisfactory completion.

1.08 FACILITY STARTUP COORDINATION

A. Facility start-up shall comply with requirements specified in the Contract Documents and those requirements specified herein. Facility start-up shall commence after all previously described start-up and test activities have been successfully completed and shall demonstrate that the Instrumentation, Control and Information System can meet all Contract requirements with equipment operating over full operating ranges under actual operating conditions.

B. The control system start-up period shall be coordinated with process startup activities and shall be extended as required until all plant processes are fully operational and to satisfy the Engineer that all control system Contract requirements have been fulfilled in accordance with the Contract Documents.

C. The instrumentation subcontractor's personnel shall be resident at the facility to provide both full time (eight hours/day, five days/week) and 24 hours on call (seven days/week) support of operating and maintenance activities for the duration of the start-up period.

D. At least one qualified control systems technician shall be provided for control system startup and test activities (at least two when loop checkout is being performed).

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17073

FINAL ACCEPTANCE TEST

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall perform the Final Acceptance Test on the Control and Information System as specified herein to demonstrate compliance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17070 – Control and Information System Testing, General

C. Section 17072 – Field Testing

1.03 AVAILABILITY DEMONSTRATION AND FINAL SYSTEM ACCEPTANCE

A. Upon completion of all control system startup activities and prior to final system acceptance, the Contractor shall demonstrate that the availability of the entire control system, including operation under conditions of digital equipment fail-over, initiated either automatically or manually, shall be not less than 99.8 percent during a 30-day availability test period. The Owner shall be given two (2) weeks notice of the starting date of the 30-day availability test.

B. For purposes of determining availability figures, downtime of each system or portions of each system resulting from the causes specified hereunder will not be considered system failures.

1. Downtime of any network-connected device that is automatically backed-up upon failure shall not be considered a system failure provided that the downtime of the failed component does not exceed 24 hours.

2. Downtime of a PLC that is not automatically backed-up shall be considered a system failure if the downtime of the failed controller exceeds one (1) hour.

3. Downtime of a portion of the system resulting from failure of any field sensor shall not be considered a system failure provided that the system operates as specified under this condition.

4. Downtime of the following devices shall not be considered a system failure provided the failed device is repaired within the specified time:

a. Communication interfaces (eight hours)
b. Workstations (one day)

c. Process control system networks (eight hours)
d. Off-line (optical, etc.) storage units (one day)
e. UPS unit (one day)

5. Total shutdown of a single PLC resulting from a software fault shall be considered a system failure.

6. An erroneous command to the process that can be specifically related to a software fault shall be considered as one (1) hour of downtime.

7. The inoperability of any subsystem resulting from a software fault shall be considered a system failure.

8. The failure of the same component more than one time during the 30-day test shall be considered a system failure.

C. If the system fails the 30-day availability test, the 30-day test period shall be restarted after the failed component or software is repaired/replaced and full operation is restored. The system shall be demonstrated for the full 30-day period following the restart.

D. The Contractor shall submit an availability demonstration report that shall state that all system availability requirements have been met.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 17080

QUALITY ASSURANCE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. It is the intent of these Specifications and Drawings to secure high quality in all materials, equipment and workmanship in order to facilitate operations and maintenance of the facility. The Contractor shall provide equipment and services to meet this intent.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. All work shall be installed in accordance with the National Electric Code, National Electric Safety Code, OSHA, State, local and other applicable codes.

1.03 QUALITY ASSURANCE - GENERAL

A. All equipment and materials shall be new and the products of reputable recognized suppliers having adequate experience in the manufacture of these particular items.

B. For uniformity, only one manufacturer will be accepted for each type of product.

C. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses that may occur during fabrication, transportation, and erection as well as during continuous or intermittent operation. They shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.

D. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, which shall be of sturdy and durable construction and be suitable for long, trouble-free service.

E. Electronic components shall be de-rated to assure dependability and long-term stability.

F. Printed circuit boards in field mounted equipment shall be suitable for the specified environmental conditions.

G. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers.

H. Components of specially selected values shall not be inserted into standard electronic assemblies in order to meet the performance requirements of this specification.

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1.05 OPTIONAL EQUIPMENT

A. Optional or substituted equipment or both requiring changes in details or dimensions required to maintain all structural, mechanical, electrical, control, operating, maintenance or design features incorporated in these Specifications and Drawings shall be made at no additional cost to the Owner. In the event that the changes are necessary, calculations and drawings showing the proposed revisions shall be submitted for approval. The Contractor shall coordinate all changes with other affected trades and contracts and pay all additional charges incurred.

1.06 GUARANTEE

A. The instrumentation subcontractor through the Contractor shall install, maintain and guarantee the Instrumentation, Control and Information System as specified under the General Conditions and Division 1 of the Specifications. Maintenance personnel provided by the instrumentation subcontractor shall instruct the Owner's personnel in the operation, adjustment, calibration and repair of the equipment being serviced. All preventive and corrective activities shall be documented with service reports, which shall identify the equipment being serviced, state the condition of the equipment, describe all work performed and list materials used. A copy of all service reports shall be delivered to the Owner on the day the work is performed.

B. The instrumentation subcontractor shall provide the services of factory-trained service technician(s) at least twice during the guarantee period, for the purpose of performing preventive hardware maintenance.

C. Corrective hardware and software maintenance during the guarantee period shall be performed in accordance with the requirements of Division 1 and, in addition, shall meet the following requirements:

1. Corrective hardware maintenance shall be performed by factory-trained service technician(s) specifically trained to service the digital equipment provided. Technicians possessing suitable training and experience shall be provided to perform corrective maintenance on all other equipment. The hardware service technician(s) shall be available on-site within 24 working hours after notification by the Owner.

2. Corrective software maintenance shall be performed for software provided by the instrumentation subcontractor and incorporated into the system prior to the completion of system commissioning. Software service programmer(s) shall be available for consultation within four business hours and, if required, on-site within 16 business hours after notification by the Owner. Corrective software maintenance shall include the supply, installation and startup of all application software upgrades released during the guarantee period.

3. Corrective hardware and software maintenance performed during the guarantee period shall be performed at no cost to the Owner.

4. As used herein, the term "working hours" shall be defined as those of the treatment facility (seven days per week, 24 hours per day). The term "business hours" shall be defined as the hours between 8:00 a.m. and 5:00 p.m., local time, Monday through Friday; excluding holidays.

5. The guarantee period shall commence upon final acceptance of the completed treatment facility in accordance with the provisions of the Contract Documents.

D. The instrumentation subcontractor shall submit to the Owner a proposed maintenance agreement incorporating the following features:

1. Extension of preventive hardware maintenance services as described above for a period of up to five years from the expiration of the warranty period.

2. Provisions for corrective hardware and/or software maintenance work on a will-call basis for a period of up to five years from the expiration of the warranty period. Corrective maintenance work shall be performed by properly trained personnel as described above.

E. The proposed agreement shall include provisions for payment based upon an annual fee for preventive maintenance and cost plus expenses for corrective maintenance work. The portion dealing with corrective maintenance shall be written to include corrective maintenance caused by actions of the Owner during the warranty period and shall contain clauses for re-negotiation of contract prices based upon changes in recognized economic indicators published by the United States Department of Commerce.

1.07 SHIPPING HANDLING AND STORAGE

A. In addition to shipping, handling and storage requirements specified elsewhere in the Contract Documents, air conditioning/heating shall be provided for storage of all field instrumentation, panels, digital equipment and ancillary devices to maintain temperatures between 20 and 25 degrees C and relative humidity 40 to 60 percent without condensation. The air shall be filtered and free of corrosive contaminants and moisture.

1.08 FABRICATION

A. Fabrication of all equipment shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. The Contractor shall provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.

C. Equipment approval at the factory only allows the equipment to be shipped to the project site. The Contractor shall provide for the proper storage, installation and satisfactory start-up and operation of the equipment to the satisfaction of the equipment manufacturer, the instrumentation subcontractor, and the Engineer.

1.09 INSTALLATION

A. All instrumentation and control system installation work, whether new construction or modifications to existing equipment/panels/structures, shall conform to the codes and standards outlined in this Section, and other portions of the Contract Documents.

B. The instrumentation subcontractor shall assign a competent representative who shall provide full time coordination and supervision of all on-site instrumentation and control system construction work from commencement of construction through completion and final acceptance.

C. All labor shall be performed by qualified craftsmen in accordance with the standards of workmanship in their profession and shall have had a minimum of three years of documented experience on similar projects.

D. All equipment and materials shall fit properly in their installations. Any required work to correct improperly fit installations shall be performed at no additional expense to the Owner.

E. All work shall be performed in a neat and workmanlike manner. All hardware and instrumentation shall be installed in accordance with requirements specified herein, in accordance with industry best practices, in accordance with manufacturers' recommendations, and in a manner suitable for ease of operation, inspection, and maintenance. All wiring shall be neatly bundled, run in wireway, and terminated. All spare wiring shall be neatly coiled and clearly labeled at both ends for future use by the Owner. Any work not meeting these requirements shall be corrected at no expense to the Owner.

F. Sufficient common-mode and differential-mode noise rejection shall be provided to insure operation of the plant process control system to meet all specification requirements. General practice shall include:

1. Maintaining crossings between noisy wires and signal wires at right angles.

2. Maintaining separation between noisy wires and signal wires as wide as practical.

3. Grounding all signals, shields and power supplies at the process control unit or local control panel.

4. Providing passive filters on signals with time constant compatible with scan intervals and overvoltage protection.

5. Eliminating cable splices. All splices in instrumentation and control system signal and network cables shall be approved in advance by the Engineer.

6. Providing a floating output for transmitters that have their own power sources.

G. DC and AC power grounding shall be performed in accordance with the digital hardware manufacturer's recommendations as well as all applicable code requirements.

H. The case of each field instrument and control panel shall be grounded in compliance with the National Electric Code.

I. Power wires shall be separated from parallel-running signal wires by the following minimum spacing:

CIRCUIT VOLTAGE (VAC)	MINIMUM SPACING (IN.)
120	12
240	18
480	18
2000 and above	24

J. The Contractor shall provide all required cutting, drilling, inserts, supports, bolts, and anchors, and shall securely attach all equipment and materials to their supports. Embedded supports for equipment furnished under this Division shall be provided and installed as shown specified herein and shown on the Drawings.

K. Following acceptance of the factory tests by the Engineer, and in accordance with the construction schedule, the Contractor shall commence installation of the digital control system hardware. Digital system equipment items shall not be installed, however, until all architectural, mechanical, HVAC and electrical work has been completed in the equipment rooms, MCC's, control rooms and all structural and/or mechanical work has been completed within 50 feet of equipment locations.

L. Upon completion of the above construction work, the Contractor shall request an inspection of the above-named areas. The Engineer will issue a written approval to proceed with delivery and installation only after being satisfied that all work described above has been properly performed. Digital equipment shall remain at the factory site or storage prior to approval for delivery to the project site. Partial shipments may be required to meet construction schedule requirements.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

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SECTION 17100

CONTROL AND INFORMATION SYSTEM HARDWARE, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The process control system is physically and functionally distributed between PLC equipped control panels, motor control panels, field panels, operator workstations and appurtenances.

B. Although manual control facilities shall be provided adjacent to each final control element or in local control panels, such facilities are for testing, maintenance and local monitoring purposes only and shall not be regarded as backup to the PLC-based control system.

C. PLCs may be categorized as either “process PLCs” that are provided by the instrumentation subcontractor or “equipment control PLCs” provided by equipment manufacturers for the operation of their equipment (blowers, centrifuges, chemical systems, filters, etc.). Unless otherwise specified, all PLCs provided under this Contract shall conform to the requirements specified in this Division.

D. Major plant control system digital equipment items are described in the Specifications and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17120 – Programmable Logic Controllers

B. Section 17180 – Process Control System Networks

1.03 DIGITAL HARDWARE CONFIGURATIONS

A. The digital hardware configuration shown on the Control System Architecture Drawing depicts overall system configuration requirements. System design shall be based upon this concept and shall provide an overall digital system availability of 99.8 percent under the conditions specified in Section 17073. Unless otherwise specified, designs that vary from this concept will be rejected.

B. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. Run time and flow accumulations shall be performed at the PLC level. Except for minimal calculations related to report-specific functions such as minimum, maximum, average, etc., operator workstations shall not be used to perform calculation for the process control system. Operator workstations shall be fully independent devices, individually connected to the plant control system networks.

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C. No other exceptions will be considered.

PART 2 -- PRODUCTS

2.01 GENERAL SYSTEM HARDWARE REQUIREMENTS

A. Unless otherwise specified, all hardware shall be rated for industrial use, resistant to shock, vibration, electromagnetic interference, static discharge, and suitable for the environmental conditions described elsewhere in this Division. Commercial or office grade equipment shall not be accepted.

B. Unless otherwise specified, modular construction shall be employed to simplify maintenance and to provide for future hardware expansion. Plug-in, modular PCB's or modules shall be employed for easy removal to permit exposure of circuit wiring, components and test points. Extender boards shall be provided if necessary to permit PCB's to be completely exposed for testing purposes.

C. Keying schemes shall be used to prevent PCB misplacement.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature.

2.02 DIGITAL SYSTEM FAILURE DETECTION AND FAIL-OVER REQUIREMENTS

A. No degradation in control system performance shall occur when the system is operating in a partial failure or an equipment fail-over mode. Likewise, no degradation of system performance shall occur while a backed up system component is undergoing preventive or corrective maintenance.

B. All devices connected to the plant control system network shall be self-checking and shall report their operational status to the operator workstations as either "normal" or "failed". A graphic display based on the system architecture drawing shall be furnished with the control and information system showing this information along with current communication status of each device.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000, Part 3.

- END OF SECTION -

SECTION 17120

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all programmable logic controllers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17060 – Signal Coordination Requirements

C. Section 17180 – Process Control System Networks

D. Section 17190 – Uninterruptible Power Systems

E. Section 17500 – Enclosures, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. One of each type of CPU and co-processor module for PLC equipment furnished under this Contract.

2. Two of each type of input/output module for PLC equipment furnished under this Contract.

3. One of each type and size of PLC and equipment power supply furnished under this Contract.

4. One of each type of network interface module for PLC equipment furnished under this Contract.

PART 2 -- PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLERS - GENERAL

A. The instrumentation subcontractor shall furnish programmable controllers (PLC's) as specified herein and as shown on the Drawings. PLC's shall be provided complete with rack, power supply, I/O cards, special function cards, instructions, memory, input/output capacity, and appurtenances to provide all features and functions as described herein.

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PLC I/O cards may be supplied by third party vendors if approved by the PLC manufacturer and the Engineer. No substitutions will be permitted.

B. All components of the PLC system shall be of the same manufacturer; who shall have fully tested units similar to those being furnished in an industrial environment with associated electrical noise. The PLC system shall have been tested to meet the requirements of NEMA Standard ICS 2-230 (Arc Test) and IEEE C37.90.1 (SWC). The processing unit shall perform the operations functionally described herein based on the program stored in memory and the status of the inputs and outputs.

C. Programmable controllers shall be designed to operate in an industrial environment. The PLC shall operate in an ambient temperature range of 0°-60°C and a relative humidity of 5-95 percent, non-condensing. The PLC shall operate on supply voltages of 90-132 VAC at 47-63 Hz or 24 VDC if provided with a battery backup system. An integral fuse shall be provided on the power supply for short circuit protection and shall be front panel accessible. Integral overcurrent and undervoltage protection shall be provided on the power supply.

D. PLC system shall be Allen-Bradley CompactLogix 1769-L36ERM. Memory and processor shall be adequate for all control and monitoring functions specified.

2.02 PROCESSORS

A. The processor and its associated memory shall be enclosed in a modular enclosure. A multiple-position selector switch or equivalent shall be used to select processor operating mode. LED-type indicating lights shall be provided to indicate processor, memory, and battery status. Errors in memory shall be recognized and shall activate the memory error indicating lights. The PLC processor shall monitor the internal operation of the PLC for failure and provide an alarm output. Nonvolatile memory in the form of a manufacturer supplied industrial CompactFlash card or equivalent technology shall be required to maintain the entire user application program and firmware of the controller in the event of power loss. The program shall be updated onto the flash memory each time a program change such as an online edit or tag value is changed. When nonvolatile memory (flash memory) is not available for certain controller models as offered by the PLC manufacturer, lithium batteries shall be used to maintain process RAM memory for at least one year in the event of power loss. The lithium battery unit shall be an externally mounted battery assembly with the highest available capacity. The PLC shall send an alarm to the plant control system if battery level is low.

B. The instruction set for the PLC shall conform to the requirements of IEC 61131-3. Each PLC shall have the capability to run all five of the standard IEC 61131-3 programming languages simultaneously. These languages shall be:

1. Ladder Diagram
2. Instruction List
3. Structured Text
4. Function Block Diagram
5. Sequential Function Chart

C. **Additional co-processors or modules may be necessary and shall be furnished as required to meet the functions specified herein and in Section 17950 – Functional Control Descriptions.**

D. PLC processors shall be provided with substantial user program, data and logic memory to allow for future expansion of the overall system. The total memory used on each processor shall be less than 60% of available memory at project completion.

2.03 COMMUNICATIONS

A. PLC to remote I/O communication networks shall be Ethernet/IP.

B. In addition to Ethernet/IP network communications ports, serial communication ports shall be provided for any other devices required plus an additional communication port for connection to a laptop programmer.

2.04 INPUT/OUTPUT SUBSYSTEMS

A. Input/output hardware shall be plug-in modules in associated I/O rack or DIN-rail mounting assemblies. Each unit shall handle the required number of process inputs and outputs plus a minimum of 10 percent active pre-wired spares for each I/O type furnished, plus a minimum of 20 percent spare I/O module space for the addition of future circuit cards or modules.

B. Discrete inputs shall be 120 VAC (integral to the PLC) from dry field contacts. Discrete outputs shall be dry relay contacts (2A minimum) as required. Refer to Section 17060 – Signal Coordination Requirements for further details of discrete signal type and voltage requirements. The PLC shall provide momentary and latched outputs as required to interface with motor controls and external devices. Interposing relays shall be provided where required to interface with field equipment. Interposing relays shall be as specified in Section 17550. Electrical isolation shall be provided where required. Maximum density for discrete I/O modules shall be 16 per input module and 16 per output module.

C. Analog input circuits shall be isolated, minimum 12-bit resolution type. Analog input hardware shall be provided as required for all types of analog inputs being transmitted to the PLC. In general, analog input modules shall be capable of receiving 4-20 mA signals. Where required, RTD input modules shall have a minimum resolution of 0.15°C and be capable of accepting signals from 100-ohm Platinum RTD's. Analog outputs shall be coordinated with the receivers but shall generally be isolated 24 VDC 4-20 mA outputs powered from the PLC. Each input/output circuit shall have optical isolation to protect the equipment against high voltage transients. Optical isolation shall be rated at not less than 1500 V RMS. Lightning/surge protection shall be provided as specified in Section 17560 - Transient Voltage Surge Suppression Devices. Maximum density for analog I/O modules shall be 8 per module.

D. Input/output modules shall be configured for ease of wiring and maintenance. The modules shall be connected to wiring arms that can be disconnected to permit removal of a module without disturbing field wiring. Covers shall be provided to prevent operator personnel from inadvertently touching the terminals. The process interface modules shall be provided with screw-type terminal blocks with barriers between adjacent

terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All DC output circuits to the field shall include fuses, either integral or at the terminal strip. Output failure mode shall be selectable so that upon station or communication system failure all outputs shall be placed either in the non-conducting mode, or remain as were prior to failure. Light-emitting diodes shall be provided for status indication for each input and output point.

E. External power supplies shall be provided with the PLC as required to meet specified installed I/O power requirements plus spares. Power supplies shall be modular units, shall be fully redundant and shall alarm the PLC upon failure. Power supplies shall have a line regulation of 0.05% and meet the environmental and power requirements specified herein for the PLC.

F. I/O modules shall be 1769 Compact Series I/O modules.

2.05 REMOTE I/O SUBSYSTEMS

A. Remote I/O shall be provided as designated on the Control System Architecture Drawing. Remote I/O shall be either PLC backplane type I/O or field modules as manufactured by the PLC manufacturer. Field modules shall meet the requirements of Subsection 2.04, Input/Output Subsystems. Remote I/O processor or communication modules shall be modular and individually replaceable.

B. Remote I/O racks shall communicate with the PLC using the PLC manufacturer's standard protocol Ethernet/IP.

2.06 INPUT/OUTPUT CIRCUIT ARRANGEMENT

A. Signal and control circuitry to individual input/output boards shall be arranged such that board failure shall not disable more than one half of the control loops within any group of controlled equipment (e.g., one pump out of a group of three pumps, two pumps out of four, etc.). Where possible, individual control loops and equipment shall be assigned to individual boards such that failure of the board will disable only one loop or piece of equipment.

2.07 PROGRAMMING SOFTWARE

A. The PLC programming and configuration software shall be the manufacturer's latest, full-featured version, Windows-based, and shall be fully compliant with IEC 61131-3 standards. The software package shall consist of all programming, configuration, and documentation software needed to place the control and information system in satisfactory operation. The software shall allow on-line and off-line program development and documentation. PLC programming software shall include documentation on optical media.

B. A new license of Studio 5000 Engineering and Design software package shall be provided under this Contract for the Owner to develop all of the elements of their control system. CompactLogix system software shall include: Studio 5000 Logix Designer application and RSLinx software.

C. One copy of the PLC programming software shall be purchased by the instrumentation subcontractor and registered to the Owner.

D. PLC logic shall not use structured text. No exceptions will be permitted.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. PLC programming shall be furnished to perform all functions described in Section 17950 – Functional Control Descriptions, including global functions. In addition, PLCs shall be programmed to provide additional functions described in other sections of this Division.

B. PLC programming shall make use of the various IEC languages as appropriate to the specific task and shall be performed in a modular style making extensive use of program blocks (subroutines) and program variables to be passed to the program blocks for specific equipment. It is the intent of this requirement to allow for enhanced readability and ease of modification of the program code through the elimination of multiple instances of repeated code for the same function in a “hard-coded” style.

C. Extensive comments shall be placed in the program code to describe the functions of all elements of the program code. PLC code that does not contain comments shall be rejected.

D. Refer to Section 17000, Part 3 for additional requirements.

3.02 REQUIREMENTS FOR MANUFACTURER-SUPPLIED PLCs

A. PLCs that are supplied for equipment local control panels by individual equipment manufacturers or suppliers shall, where so indicated on the Control System Architecture Drawing, be integrated into the plant control system. The manufacturer-supplied PLC shall be furnished, installed and programmed by the manufacturer. The PLC shall continuously monitor and control the associated system and at the same time shall provide all the required alarms, indications of system parameters, equipment status, etc. to the main control system at the plant.

B. Where required as described above, each manufacturer-supplied PLC shall be connected to the Ethernet process control network for access from the plant control system HMI servers, as specified in Section 17180, and shall contain a fiber optic Ethernet switch identical to those provided for the rest of the network-connected PLCs.

C. Each equipment manufacturer shall provide all monitoring and control data to be transferred between the PLC and the plant control system in contiguous blocks of PLC registers to facilitate block read and write commands for efficient scanning by the control system SCADA servers. These contiguous registers shall be arranged in a single data transfer area, which shall be divided into eight distinct areas with an emphasis on flexibility and future expansion. The distinct areas shall be arranged by data type (analog or discrete), transfer direction (server to PLC or PLC to server), and, where applicable,

implementation schedule (current or future). Where required, peer-to-peer communication between PLCs shall likewise be accomplished using separate blocks of contiguous registers. Where individual equipment PLCs are not required to be connected to the plant control system via the data highway network, they shall provide the individual hardwired signals as specified in the Contract Documents. Data and commands for connection to the control system are described in the Drawings, the Input/Output Schedule, the individual equipment specification sections, and in Section 17950 – Functional Control Descriptions.

D. The operator interface for control of each individual system shall be performed by local operator interface units as specified in Section 17125 or individual pilot devices on the equipment local control panel, as specified in the associated equipment specification section. Additional operator interface functions shall be provided through the plant control system as specified in the respective equipment specifications and in Section 17950.

E. Where operator interface and control functions are required to be provided through the plant control system, the individual system supplier shall be responsible for coordination with the instrumentation subcontractor to provide a complete and working equipment control system. The individual equipment supplier shall also be responsible for limiting the access of the plant control system to the equipment PLC code so as to prevent malfunctions of the equipment and any failure to continuously perform its intended functions. The equipment supplier shall be responsible for ensuring that no actions by the plant control system can damage or otherwise adversely affect the operation of the associated equipment or the safety of personnel working on or near that equipment. The equipment supplier shall also provide direction in the configuration of the SCADA software's security system by the instrumentation subcontractor to limit access to the control functions of the equipment control system to authorized personnel only. The equipment supplier shall coordinate testing of the completed system with the instrumentation subcontractor, which shall conform to the requirements of Section 17072 – Field Testing.

F. The Contractor, equipment supplier and instrumentation subcontractor shall coordinate testing and startup of the equipment provided by the equipment supplier with the plant control system, including but not limited to the following tasks:

1. Provide assistance with control system testing of inputs, outputs, and control strategies as needed.

2. Provide support or interface work necessary to perform physical checkout and field testing to the final field devices. The schedule may require the instrumentation subcontractor and equipment manufacturer personnel to perform loop checks simultaneously, as directed by the Engineer.

3. Coordinate and assist as needed to maintain I/O connectivity throughout the system.

4. Ensure personnel safety while equipment is exercised via the plant control system.

5. Ensure that process, instrumentation, and control equipment are not damaged while equipment is exercised via the plant control system.

6. Provide temporary modifications to field devices and their terminations, if needed.

7. Providing labor and supervision, which may include, but is not limited to, the following: electricians, instrument technicians, manufacturer's representatives, and individual(s) knowledgeable about process startup and operation.

8. Operation of process equipment for verification of each plant control system input and output.

- END OF SECTION -

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SECTION 17140

OPERATOR WORKSTATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all operator workstations, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

B. The Contractor shall provide equipment for new SCADA system related components specified herein through an allowance. Contractor shall obtain quotes for each item listed within six months of Notice-to-Proceed from three suppliers. Quotes shall be submitted to the Owner and Engineer for review. Owner shall approve equipment/supplier to be used. Contractor shall include any overhead cost for allowance equipment and services in the Bid.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Digital System Hardware Configuration

C. Section 17180 – Plant Control System Networks

D. Section 17190 – Uninterruptible Power Systems

E. Section 17200 – Control and Information System Software Requirements

F. Section 17240 – Operator Workstation Software

PART 2 -- PRODUCTS

2.01 OPERATOR WORKSTATIONS

A. The equipment shall be designed to operate in an indoor environment. The equipment shall be capable of operation in an ambient temperature range of 0° to 40°C and a relative humidity of 0-90%, non-condensing. The equipment shall be capable of operation on supply voltages of 102-132 VAC at 47-63 Hz. Each operator workstation shall, as a minimum, include one or more microcomputers (personal computers) and appurtenances as specified below.

B. All operator workstations furnished under this Contract shall contain identical hardware to enable any workstation to function as a primary server node or as a client node, as described in Section 17200.

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C. All operator workstation hardware and associated peripherals shall be approved for use with the operator workstation SCADA software specified in Section 17240.

D. The specifications below are selected based on 2023 technology for acceptable and compatible hardware used in this project. The SCADA system hardware shall have latest features, newer technology available in the current marketplace, and compatibility with the required SCADA software and shall be selected and purchased during construction phase using the allowance.

E. Thin-Client Operator Workstations

1. Thin-client operator workstations shall be located as shown on the Control System Network Architecture Drawing. Thin-client operator workstations shall be connected to the terminal server configured inside the SCADA Servers over the plant control system network backbone for HMI displays. Thin-client operator workstations shall be as manufactured by Arista, Advantech, Wyse, HP, or equal with the following features:

a. Operating Voltage: 115 VAC, single phase, 60 Hz

b. Thin-Client small computer form factor.

c. Industrial Fanless Computer, 14 – 140 °F, 10 – 95% RH non-condensing, UL508A Certification, panel mount.

d. Intel Quad Core processor, 2.0 GHz or greater, or equivalent by AMD.

e. 8GB DDR4 Ram minimum

f. Supported protocols: PCoIP, VMware, and remote desktop (RDP).

g. Graphics Card: 1920 x 1080 pixels, 70 Hz refresh rate, dual monitor support minimum up to 3-monitor support. Port type shall be HDMI, DVI, and/or DisplayPort.

h. USB ports: minimum of one (1) USB-C port; two (2) USB 3.0 ports; two USB 2.0 ports.

i. Network adapters: Gigabit RJ-45 port accepting CAT-6 Ethernet cables.

j. Mouse, keyboard.

F. Thick-client Operator Workstations

1. Thick-client operator workstations or full-blown desktop computers shall not be used under this project as thin-client workstations are preferred for ease of updates and maintenance.

G. SCADA Servers

1. SCADA Servers shall be redundant SCADA Servers as manufactured by Dell PowerEdge Series, or equal with the following features:

   a. Dual Intel Xeon Processor latest version, 2 CPU's, 6 Cores per CPU.

   b. Rack mounted.

   c. Memory: minimum 32 GB RDIMM, or equal.

   d. Hard Drive: 4 TB, RAID 5.

   e. Operating System: MS Windows Server 2022, or latest version.

   f. Virtualization Software: VMWare

   g. Dual, hot-plug, redundant power supplies.

   h. Network adapters: 1GbE Base-T adapter with dual ports minimum

   i. Trusted Platform Module

   j. All documentation, manuals, and licenses, 5-year hardware support service.

H. Computer Monitors

1. Computer monitors shall be used for thin-client operator workstations. Two monitors shall be provided at each Thin-Client Operator Workstation. Monitors shall be as manufactured by Dell, or equal with the following features:

   a. LED, 32-inch.

   b. 1920 x 1080 at 70 Hz minimum.

   c. HDMI, DisplayPort, DVI ports.

   d. VESA compliant.

2. Touchscreen monitors for use with thin client operator workstations in PLC panel or stand-alone enclosures shall be mounted on the front door. These monitors shall be protected with a hinged window kit installed on the front door of the enclosure. A type NEMA 4X/IP66 deep-hinged, 316L stainless steel frame, with thick, clear polycarbonate material viewing area window kit shall be provided for protection, visibility, and easy access to the touchscreen monitor installed behind it. Panel-mount touchscreen monitors shall have the following features:

a. 15.6-inch diagonal, 16:9 aspect ratio, HD 1080p (1920 x 1080 @ 60Hz)

b. 16.7 million number of colors, 3000:1 contrast ratio

c. NEMA 4/4X/12, UL 508A rated

d. High resolution, high brightness, and high contrast

e. Video input: HDMI, DVI, DisplayPort, or compatible with the thin client computer

f. Panel-mount without drilling stud holes

g. Power requirement: 9.6 to 36.6 VDC

h. Operating conditions: 32 to 122 deg. F; 20 to 90% RH non-condensing

I. Large Screen Monitors

1. Large screen monitors shall be used for security camera package. Monitors shall be as manufactured by LG, Samsung, Sony, or equal with the following features:

a. 65-inch.

b. 4K resolution, aspect ratio 16:9.

c. HDMI, DisplayPort ports.

d. Provide wall mounting kits.

G. Uninterruptible Power Systems

1. Uninterruptible power systems shall be furnished for each operator workstation and appurtenances in accordance with Section 17190 of the Specifications.

H. Network Interfaces

1. Network interfaces shall be furnished in accordance with Section 17180 of the Specifications.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000, Part 3 of the Specifications.

- END OF SECTION -

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SECTION 17141

WIRELESS LAPTOP / TABLET WORKSTATIONS

PART 1 – GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all wireless laptop / tablet PC's, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings. The Contractor shall provide two (2) Microsoft Surface Pro 9 Tablet/PC, complete with Thunderbolt 4 Docking Station, Microsoft Surface Pen, Microsoft Surface Touch Cover, Microsoft Surface Pro 9 compatible lock, screen protector, keyboard, and optical mouse.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17100 - Control and Information System, General

C. Section 17186 - Wireless Ethernet Networks

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. For each unit, provide the following additional spares: one screen protector.

PART 2 – PRODUCTS

2.01 WIRELESS LAPTOP / TABLET PC

A. Wireless Laptop / Tablet PC

1. Wireless Laptop / Tablet PC shall be Microsoft Surface Pro 9 Tablet/PC as manufactured by Microsoft with the following features as a minimum:

a. 13 inch display with 2880 X 1920 resolution

b. 16 GB RAM memory

c. 512GB Solid-state drive (SSD)

d. Intel i7 Processor

e. Operating System: Windows 11 Pro

2. Surface Pro 9 compatible lock module

3. Surface Thunderbolt 4 dock

4. AC adapter

5. Microsoft or Logitech USB Optical Wheel Mouse and keyboard

6. Microsoft Surface Pen

7. Microsoft Surface Touch Cover

8. Screen Protector

C. The Contractor shall purchase personal computer equipment and software of the current available technology at the time of shop drawing submittal using the advertised retail price for the above-specified system in order to take advantage of newer technologies during the construction period.

D. The following software shall be furnished on each wireless tablet PC:

1. Microsoft Windows 11 Pro (current release and latest service pack).

2. Microsoft Office 2021 and Antivirus software (current release and latest service pack).

E. A full complement of all digital hardware manufacturers' support software shall be provided.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Tablet PC shall be configured as full SCADA client, i.e., VTScada Internet Client. By enabling this single SCADA Client, the system shall access the server and shall provide full control and data monitoring capabilities at the Treatment Plant.

- END OF SECTION -

SECTION 17180

PROCESS CONTROL SYSTEM NETWORKS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation IEEE 802.3 Ethernet local area network(s) for communications among plant devices.

B. Local area network shall be provided with all spare parts, accessories, and appurtenances as herein specified.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17120 – Programmable Logic Controllers

PART 2 -- PRODUCTS

2.01 LOCAL AREA NETWORK (LAN)

A. An IEEE 802.3 Ethernet local area network shall be used for communications between plant devices.

B. Network wiring shall be unshielded, twisted-pair copper cables for connections within buildings. Fiber optic media shall be used for all inter-device communication links extended outside of a building, unless specifically noted. Cables shall be as specified herein.

C. The Contractor shall supply all hardware, cables, connectors, and software to implement a network as specified herein and shown on drawings.

2.02 INDUSTRIAL ETHERNET NETWORK SWITCHES

A. Except where specifically allowed on the Control System Architecture Drawing, industrial Ethernet network switches shall be provided for each device connected to the process control system network. The switches shall create switched Ethernet networks that conform to the IEEE 802.3 and 802.3u standards using copper wires or optical fibers in a bus, tree or ring network topology as shown on the Drawings. Ethernet network switches shall be modular, rack mounted, or standard DIN-rail mounted within the PLC cabinet or in an adjacent communication cabinet, as shown on the Drawings.

B. Ethernet network switches shall support ring, bus, tree, or point-to-point network topologies. On-line signal monitoring shall be provided to detect and locate impending

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faults. Ethernet network switches shall be replaceable on-line without disrupting the network. The Ethernet network switches shall be integrated into the in-plant Ethernet network to form a star topology. Switches shall support the non-proprietary Media Redundancy Protocol (MRP) and Rapid Spanning Tree Protocol (RSTP) in addition to the switch manufacturer's standard redundant ring network protocol, all of which shall provide self-healing communication recovery.

C. Ethernet network switches shall meet the following minimum performance requirements:

Functions:	Modular managed switch with store and forward switching mode, 10 Mbps Ethernet, or 100 Mbps Fast-Ethernet, or gigabit Ethernet support, multi-address capability, auto-crossing, auto-negotiation, auto-polarity. Port speed and duplex auto-negotiation shall be configurable. Each network switch shall manage up to eight (8) ports possible via integrated media modules specified below.
Management:	Simple Network Management Protocol (SNMP) (v1/v2/v3) and Common Industrial Protocol (CIP) support; IGMP filtering and snooping.
Power Requirements:	Redundant 24 VDC power supply
Operating Temperature:	0° - 60°C
Relative Humidity:	10 - 95%
Network Size:	Up to 50 nodes in ring structure
Port Type & Quantity:	(at each PLC location) • Minimum of eight (8) 10/100/1000Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment • Two (2) 100/1000Base-FX, single mode fiber optic cables (9/125 µm), SFP sockets, 0-5000 meters LAN segment
Link Budget:	1 dB/km @ 1310 nm; 1 dB/km @ 1550 nm
Wavelength:	1310 or 1550 nm

D. Acceptable industrial Ethernet network switches shall be Catalyst IE3200 as manufactured by Cisco Systems. No substitutions will be accepted.

2.03 OFFICE-GRADE ETHERNET NETWORK SWITCHES

A. Office-grade Ethernet switches shall be rack-mounted as shown on the Drawings and shall meet the following specifications:

Functions/Protocol:	Same as industrial switches
Power Requirements:	120 VAC power supply
Operating Temperature:	0° - 40°C
Relative Humidity:	10 - 90%
Port Type & Quantity:	(at each location)

- Minimum of twenty four (24) 10/100/1000Base-TX, twisted pair cable, RJ-45 sockets, 0-100 meters LAN segment
- Four (4) 100/1000Base-FX, single mode fiber optic uplinks (9/125 µm), LC, ST or SC sockets, 0-5000 meters LAN segment

B. Office-grade Ethernet switches shall be Catalyst 9300 Series by Cisco Systems (reference Instrumentation drawing I-2 for specific models and locations). No substitutions will be accepted.

2.04 UNSHIELDED TWISTED PAIR CABLE

A. Unshielded twisted pair cable for drops within buildings shall consist of 4 pair of 24 AWG copper conductors in a flame-retardant jacket. Cable shall be plenum rated (UL 910) and meet EIA/TIA-568 Category 6 specifications. Unshielded twisted pair cable shall be Hyper Grade Extended Distance cable as manufactured by Berk-Tek or equal. Connectors shall be modular RJ-45 plug.

2.05 FIBER OPTIC CABLE

A. Fiber optic cable shall conform to the following specifications:

1.	Fiber Type:	Singlemode
2.	Fiber/Cladding Diameter:	9/125 microns
3.	No. Fibers:	24, Color-coded
4.	Cable Construction:	Tight-buffered, indoor/outdoor distribution cable
5.	Filling:	Central filler/strength member
6.	Armored:	No
7.	Central Member:	Dielectric (Kevlar)
8.	Rating:	Gigabit Ethernet
9.	Bandwidth:	200/500 MHz-km at 1310//1550 nm
10.	Maximum Attenuation:	0.5/0.5 dB/km at 1310/1550 nm
11.	Application Type:	Direct-burial/Conduit/Aerial
12.	Sheath:	UV Resistant

13.	Max. Tensile Load:	670 lb. (3000 N) installation; 220 lb. (1000 N) long term/operational
14.	Minimum Bend Radius:	4.6 in under maximum tensile load; 4.6 in unloaded (installed)
15.	Operating Temperature:	-40 to 70 degrees C
16.	Operating Relative Humidity:	0-100%

B. Fiber optic cable shall be Optical Cable Corporation (OCC) DX Series or equivalent by Corning Cable Systems, or Belden.

C. Upon entering a cabinet, panel or console, fiber optic cable shall be broken out using fan-out kits and terminated in a fiber optic patch panel. All individual fibers shall be terminated and all connections shall be tested. Tight buffered cable shall then be routed to the individual destinations as needed. Cabinet-mounted patch panels shall be Cabinet-Mounted Interconnect Center (C-MIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.

D. Where cable is required to be routed to numerous, separate destinations within a building, fiber cable shall be broken out immediately upon entering the building, all individual fibers terminated in a patch panel, and tight buffered, plenum rated cable shall be routed to the individual destinations. Building patch panels shall be Wall-Mountable Interconnect Center (WIC) or Premises Interconnect Center (PIC) as manufactured by Corning Cable Systems, equivalent by Black Box, Inc., Optical Cable Corporation, or equal.

E. Fiber optic cable for installation within buildings shall comply with all applicable fire and building safety codes for such applications.

F. Fiber optic cable shall utilize mechanically spliced, field installable, SC, LC, or ST compatible connectors to match the Owner's existing installation. Connections shall have a typical loss of 0.35 dB or better and shall provide stable optical performance after numerous rematings. Connections shall utilize physical contact terminations utilizing UV or heat cured adhesive. Where applicable, field terminations shall use a simple procedure requiring minimal training.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. The destination of all network data cables (both copper and fiber) leaving an enclosure, patch panel, or building shall be labeled at each end using industry-standard wire markers.

B. Refer to Section 17000, Part 3 of the Specifications for additional requirements.

- END OF SECTION -

SECTION 17186

WIRELESS ETHERNET NETWORKS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation a wireless Ethernet communications network and other remote communications networks complete with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Scope and General Requirements

B. Section 17180 – Process Control System Networks

C. Section 17560 – Surge Protection Devices

1.03 GENERAL INFORMATION AND DESCRIPTION

A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing, of all materials, equipment and appurtenances for complete systems herein specified, whether specifically mentioned in the Specification or not.

B. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. This installation shall incorporate the highest standards for the type of service shown on the Drawings including field testing of the entire installation and instruction of operating personnel in the care, operation, and maintenance of all equipment.

C. All wireless Ethernet communications network equipment shall be of first class workmanship and shall be entirely designed and suitable for the intended services. All materials used in fabricating the equipment shall be new and undamaged.

1.04 SUBMITTALS

A. General: The Contractor shall submit shop drawings and Operation and Maintenance instructions and other information as specified in accordance with Section 01300 entitled, "Submittals", and Section 17000 entitled Scope and General Requirements".

B. Operations and Maintenance Manuals: The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in

Section 01300 entitled, "Submittals" and Section 17000 entitled "Scope and General Requirements".

1.05 MANUFACTURER'S SERVICE REPRESENTATIVE

A. The Contractor shall provide the services of a qualified wireless Ethernet network subcontractor technical representative who shall adequately supervise the installation, configuration and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's personnel in its maintenance and operation.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident Engineer on each day of arrival at the project.

1.06 PRODUCT DELIVERY STORAGE AND HANDLING

A. All equipment parts shall be properly protected in accordance with manufacturer requirements so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

C. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.07 MANUFACTURER'S EXPERIENCE

A. All wireless Ethernet network equipment provided under this Contract shall be as manufactured by Cisco, as specified.

1.08 TOOLS, SUPPLIES AND SPARE PARTS

A. Parts shall be completely identified with a numerical system to facilitate parts inventory, control and stocking. Each part shall be properly identified by a separate number, and those parts which are identical for more than one size unit shall have the same number. The following shall be supplied:

1. One spare wireless access point (AP) with associated antennas of each type furnished.

2. One spare wireless LAN controller.

3. One spare POE Injector

B. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

PART 2 – EQUIPMENT

2.01 WIRELESS ETHERNET COMMUNICATIONS NETWORK

A. The Contractor shall provide an industrial-grade wireless LAN with high performance Wi-Fi connectivity to deliver a reliable network connection for the plant operators to gain access of SCADA system monitoring and control functionality using tablet PC workstations.

B. Primary Wireless Ethernet Network hardware components shall include the following:

- Cisco Catalyst 9166 Series Wireless Access Points and appurtenances for indoor locations
- Cisco Catalyst IW9167 Series Wireless Access Points and appurtenances for outdoor locations
- Cisco Catalyst 9800-L Wireless LAN Controller

C. Wireless access points shall be located as shown on the Drawings to provide continuous Ethernet connectivity at any location within the plant.

D. Wireless access points in Admin Building shall be mounted on the ceiling at their respective locations as shown on the contract drawings. Wireless access points in Chemical Building shall be mounted inside FRP NEMA 4X panels at their respective locations as shown on the contract drawings. Outdoor wireless access point(s) shall be pole mounted at their respective location(s) as shown on the contract drawings.

E. All wireless access points shall be connected with CAT 6 cable and utilize POE for power. Outdoor wireless access point(s) shall be provided with surge protection at both ends as specified in 17560.

F. Wireless Access Points shall utilize two radio frequency bands for communication: 2.4 GHz frequency and 5.8 GHz frequency.

PART 3 – EXECUTION

3.01 REQUIREMENTS

A. The wireless Ethernet network shall use MAC Address Authentication and Shared Secret Keys configured at the Wireless LAN Controller to limit access to network resources to the aforementioned tablet PC operator workstations.

- END OF SECTION -

SECTION 17190

UNINTERRUPTIBLE POWER SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all uninterruptible power systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

B. One UPS shall be provided for each operator workstation provided under this Contract.

C. One UPS shall be provided for each programmable logic controller (PLC) and its appurtenant equipment provided under this Contract. However, courtesy receptacles in PLC cabinets shall not be powered by the UPS.

D. UPS's shall be mounted in or near enclosures containing digital hardware, unless otherwise specified or shown on the Drawings, as follows:

1. UPS's for operator's consoles shall be mounted within the consoles.

2. UPS's for control panels containing PLCs shall be mounted either within the cabinet or in an adjacent cabinet of suitable environmental rating.

3. Where the UPS is mounted within a dedicated enclosure, that enclosure shall be properly sized for heat dissipation and all other applicable requirements as specified in Section 17500 and its subordinate Sections.

4. Where the UPS is mounted within the PLC cabinet, it shall not interfere with access to other equipment or wiring within the panel (i.e., it shall not be necessary to move or remove the UPS to remove or service other panel-mounted equipment). For floor-mounted PLC cabinets with bottom wiring access (including those cabinets with legs), the UPS shall be placed on a dedicated shelf within the cabinet.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

1.03 SUBMITTALS

A. The Contractor shall submit UPS sizing calculations for all UPS's furnished under this Contract in accordance with Section 17030 - Control and Information System Submittals.

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PART 2 -- EQUIPMENT

2.01 UNINTERRUPTIBLE POWER SYSTEMS

A. Each UPS shall consist of a tower or rack-mounted UPS module and battery modules as required to meet backup run time requirements.

B. UPS's shall be true on-line, double-conversion type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

C. UPS units using line interactive or ferro-resonant transformer technology shall not be acceptable.

D. An automatic bypass switch shall be provided on each UPS. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.

E. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.

F. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.

G. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.

2. Voltage regulation shall be +/-5 percent for line and load changes.

3. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.

4. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for servers, client workstations, and PLC-based control panels, and 45 minutes for remote telemetry units.

5. A status monitoring and control panel shall be provided and shall include the following:

a. Status indicating lights for both normal and abnormal conditions.

b. Common alarm contacts that shall be wired to the closest discrete input subsystem. An RS-232 and USB port shall be provided for communication of UPS status to a server, client, or other suitable hardware. All required interface software and hardware shall be provided.

c. Circuit breaker for the AC input.

6. Sound absorbing enclosure.

7. EMI/RF noise filtering.

8. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

H. UPS systems shall be Eaton Powerware 9130, Emerson Network Power (Liebert) Model GXT3, equivalent by MGE UPS Systems, GE Digital Energy, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17000, Part 3 of the Specifications.

- END OF SECTION -

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SECTION 17200

CONTROL AND INFORMATION SYSTEM SOFTWARE REQUIREMENTS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all control and information system software with all required programming and software appurtenances as herein specified and as shown on the Drawings.

B.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17120 – Programmable Logic Controllers

B. Section 17180 – Process Control System Networks

C. Section 17240 – Control System Software Suite

D. Section 17950 – Functional Control Descriptions

1.03 PRODUCT DELIVERY STORAGE AND HANDLING

A. All software manuals and electronic media shall be protected in accordance with manufacturer requirements so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Software licenses for all operating system software, commercial software and application software packages shall be registered in the Owner's name and address. Coordinate with Owner to confirm all required information.

C. All operating system software, commercial software and application software products installed under this Contract shall be updated to the current software release prior to final system testing, acceptance and placement in service at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. The overall goal of the control and information system is to utilize industry standard equipment such as programmable logic controller (PLC) based controllers and PC based: workstations, laptops, panel-mounted displays and application servers. The system shall utilize a SCADA/HMI system application software product suite (including all required

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additional software components) and ancillary support software, as required, to provide the specified system functionality.

B. The control system server and workstation hardware shall be furnished and installed under this Contract and shall be procured using an allowance in the Contract. All unused monies shall be returned to the Owner.

C. All software shall consist of standard commercial software products which are fully configurable by the user, without custom software programming, to achieve the system requirements described in the Contract.

D. Unless otherwise specified, all application software shall be native 64-bit, Microsoft Windows (current version) certified.

E. Refer to Section 17950 – Functional Control Descriptions for additional project-specific PLC programming, HMI configuration, and Control and Information System functionality requirements.

F. Operating system, antivirus, productivity, and all other ancillary software for the control system PC-based hardware shall be furnished with the associated hardware under the appropriate Contract allowance.

1. All servers shall be provided with the latest version of Microsoft Windows Server operating system compatible with the Human-Machine Interface (HMI) software furnished under this Contract.

2. Antivirus, productivity, and ancillary software shall be provided and shall be fully coordinated with the Owner.

G. The control system application software product suite together with the server platform software, shall provide a redundant, fault tolerant environment, which include but not limited to the following: server-server application synchronization; file synchronization; automatic CPU load balancing; fault detection and seamless automatic failover; integral failover alarming, and data synchronization/re-synchronization (upon recovery).

H. All system software shall be configured to operate on a network consisting of standard firewalls, routers, switches, as well as multiple physical and/or logical networks and sub-networks as required.

I. The system shall monitor, log, and manage all levels of user access, individual user and group permissions in accordance with ISA99 security guidelines.

J. All HMI software configuration performed under this Contract shall be coordinated with the Owner. Existing graphic displays can be used as guidelines and show general arrangement of the existing equipment, piping interconnections, etc. The instrumentation subcontractor shall be responsible for furnishing new graphic displays that capture the information shown but also shall conform to the new graphic displays specifications under Section 17240 – Process Control System Software. It is not the intent of this Contract that the existing graphic displays shown in this Section be replicated in the new SCADA/HMI application. In other words, new graphic layouts and symbols, new pop-ups, new menu bar, etc. shall be provided as required to conform to the requirements specified in Section 17240 rather than using the existing conventions.

K. All new PLC programming shall not use structured text. No exceptions will be permitted.

L. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

2.02 SCADA/HMI SOFTWARE

A. Control system SCADA/HMI software shall be as specified under Section 17240 – Process Control System Software.

B. The SCADA/HMI software shall be provided with all required modules and licenses and shall be configured to perform all functionality as shown on the Drawings and as specified herein.

2.03 THIN CLIENT MANAGEMENT SOFTWARE

A. Thin client management software shall be as specified under Section 17240 - Control System Software Suite.

2.04 ALARM NOTIFICATION SOFTWARE

A. Alarm notification software shall be installed on the SCADA servers to allow for remote notification of alarms to specific telephone numbers. Alarm notification software shall be as specified under Section 17240 - Control System Software Suite.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Software design, implementation and checkout shall satisfy the requirements specified in the various Sections of Division 17.

- END OF SECTION -

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SECTION 17240

PROCESS CONTROL SYSTEM SOFTWARE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place in satisfactory operation all control system software and ancillary software. Services shall include but not be limited to all required configuration, programming, software testing, startup and ancillary services, and appurtenances as necessary for a complete and operating system in accordance with the requirements as shown on the Drawings or specified herein.

B. The control system server and workstation hardware shall be furnished and installed under this Contract and shall be procured using an allowance in the Contract.

C. The Owner's existing SCADA HMI software shall be replaced with VTScada Package by Trihedral at Glenville Lake WTP. The SCADA/OWS software shall be provided with all required modules and licenses and shall be configured to perform all functionality as shown on the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Process Control System General Provisions

B. Section 17030 – Process Control System Submittals

C. Section 17120 – Programmable Logic Controllers

D. Section 17180 – Process Control System Networks

E. Section 17950 – Process Control Descriptions

1.03 GRAPHIC DISPLAY WORKSHOPS

A. The Graphic Display Workshops shall meet for the first time no later than 60 days after Notice to Proceed. The Contractor shall conduct up to four (4) Graphic Display Workshops (approximately 4 hours each) to allow for coordination meetings between the Engineer, the Owner, and the instrumentation subcontractor and ensure HMI graphics design compliance with the guidelines and requirements specified in the Contract Documents.

B. The Graphic Display Workshops shall be a series of meetings to establish design criteria strictly for the HMI graphic display development using the new SCADA/HMI software provided under this Contract. The Graphic Display Workshops shall have the following main focus:

1. Review of existing control strategies and graphic displays.

2. Using the existing graphic displays as guidelines, the workshop shall focus on the new multiple level hierarchy for HMI graphic displays including layout of control and diagnostic pop-up displays as specified in this Section.

3. Develop color schemes for process equipment status, process lines, process symbols, etc.

4. Develop symbol libraries, text styles, object and text dynamic behaviors, navigation techniques, and tag naming conventions.

C. Maintain and submit workshop "action-item" list from prior workshop(s) as a running tabulation of issues identified, discussed and corrective actions proposed for their resolution and completion status of same.

D. Examples of graphic displays resulting from the agreements reached at each workshop shall be submitted not less than one week before the next workshop to allow time for the Owner and Engineer to review them before attending the next workshop.

1.04 CONTROL SYSTEM ARCHITECTURE

A. For Glenville Lake WTP, the requirements specified below shall be used in conjunction with the Control System Architecture drawing to establish the requirements of the Control and Information System architecture.

B. The Control and Information System, in general, shall consist of the following hardware and software:

1. SCADA Server 1: Virtualization software shall be furnished, installed, and configured on the SCADA Server 1 host machine which shall run and manage the following guest virtual machines (VMs):

a. Guest 1A – SCADA Server 1

1) Furnish, install, and configure the primary SCADA I/O/object/alarm server in this VM.

2) The primary SCADA Server 1 shall have auto-failover capability and shall be fully redundant with the secondary SCADA Server 2.

b. Guest 1B – Terminal Server 1

1) Furnish, install, and configure the primary terminal server in this VM.

2) The terminal server shall have auto-failover capability and shall be fully redundant with the secondary Terminal Server 2.

3) The terminal server shall locally host and execute SCADA software runtime sessions for all (thick or thin) SCADA clients within the control system.

4) The terminal server shall be provided with all SCADA/HMI software and licenses, thin client management software and licenses, and Microsoft remote desktop protocol (RDP) client access licenses (CALs) in order to facilitate a complete and working system.

2. SCADA Server 2: Virtualization software shall be furnished, installed, and configured on the SCADA Server 2 host machine which shall run and manage the following guest virtual machines (VMs):

a. Guest 2A – SCADA Server 2

1) Furnish, install, and configure the secondary SCADA I/O/object/alarm server in this VM.

2) The secondary SCADA Server 2 shall have auto-failover capability and shall be fully redundant with the primary SCADA Server 1.

b. Guest 2B – Terminal Server 2

1) Furnish, install, and configure the secondary terminal server in this VM.

2) The terminal server shall have auto-failover capability and shall be fully redundant with the primary Terminal Server 1.

3) The terminal server shall locally host and execute SCADA software runtime sessions for all (thick or thin) SCADA clients within the control system.

4) The terminal server shall be provided with all SCADA/HMI software and licenses, thin client management software and licenses, and Microsoft remote desktop protocol (RDP) client access licenses (CALs) in order to facilitate a complete and working system.

c. Guest 2C – SCADA/Terminal Server 3

1) Furnish, install, and configure the remote access SCADA/Terminal Server 3 in this VM.

2) This terminal server shall locally host and execute a minimum of five concurrent read-only SCADA software runtime sessions for all remote (thick or thin) clients located outside the facility in which the server is deployed.

3) The remote access SCADA server shall be provided with all SCADA/HMI software and read-only licenses, and Microsoft remote desktop protocol (RDP) client access licenses (CALs) in order to facilitate a complete and working system.

4) Remote users shall establish a secure (credentials required) virtual private network (VPN) connection with SCADA/Terminal Server 3 by clicking on a uniform resource locator (URL) link on the remote computer's desktop. Once the VPN connection is established, the user shall select from a list of published applications which include but shall not be limited to: SCADA system HMI displays, SCADA system historical trends/reports, and key performance indicator (KPI) dashboards.

3. Historian/Development Server: Virtualization software shall be furnished, installed, and configured on the Historian/Development Server host machine which shall run and manage the following guest virtual machines (VMs):

a. Guest 3A – SCADA Historical Server

1) Furnish, install, and configure the SCADA Historical Server in this VM.

2) The Historical Server shall be provided with all SCADA/HMI software and licenses, and Microsoft database client access licenses (CALs) in order to facilitate a complete and working system. A minimum of five historian client licenses shall be provided for the CRRF.

3) Historian client licenses shall be independent of the SCADA software such that non-HMI users are able to access historical data.

b. Guest 3C – Domain Controller

1) A Domain Controller shall be furnished as a virtual machine and shall be installed, tested, and run on the new system.

2) The Domain Controller shall provide central network administration and security. Domain Controller configuration services shall be provided as required to create a complete and working system including but not limited to all name servers, Active Directory database, domain controller(s), file servers, and print servers.

C. SCADA clients and programmable logic controllers (PLCs) shall be separated into different virtual local area networks (VLANs) within the overall control system network in order to segment network traffic.

D. All discrete and analog data acquisition, pre-processing, storage and process control functions shall be performed at the PLC level. The HMI software shall not be used for this purpose.

E. The execution of semi-automatic and automatic control strategies to control the process within a desired range of conditions shall be executed at the distributed PLC level and communicated to the SCADA/HMI system real time data servers. The PLC network shall

support the PLC equipment and provide bi-directional communications with the real-time data servers.

1.05 PRODUCT DELIVERY STORAGE AND HANDLING

A. All software manuals and electronic media shall be protected in accordance with manufacturer requirements so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. Software licenses for all operating system software, commercial software and application software packages shall be registered in the Owner's name and address. Coordinate with Owner to confirm all required information.

C. All operating system software, commercial software and application software products installed under this Contract shall be updated to the current software release prior to final system testing, acceptance and placement in service at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 SOFTWARE GENERAL REQUIREMENTS

A. The HMI/SCADA system software shall provide the operations and maintenance personnel with access to processes and system parameters required by each to perform their required tasks. The HMI/SCADA system software shall be designed as a native 64-bit Microsoft Windows® product and shall provide an intuitive, scalable, object-oriented development and runtime platform, browser based graphical interface to the process.

B. Key features shall include, but not be limited to: real time and historical visualization and reporting of process measurements, status, control settings, and alarms; multimedia alarm management and annunciation to external systems; user login security management; redundancy management and auto-failover to hot standby systems; communication among servers, workstations, laptop computers, integrated display computers, programmable logic controllers, and other devices as shown on the Drawings or specified herein.

C. All major and minor updates to the operator workstation software shall be provided to the Owner for no additional cost during the warranty period. Software updates shall be fully installed and made operational on the Owner's system. All additional and replacement documentation associated with the upgrade shall be furnished and updated in the Owner's original software documentation. One day of Owner observation dealing specifically with the software update shall be provided to the Owner's personnel.

D. The system shall be upgradable to newer versions using an automatic mechanism provided by the supplier without the need to rebuild or reconfigure databases, displays, drives or related program modules.

E. A mechanism for on-line maintenance and automatic backup, retrieval and purging of files shall be provided.

2.02 HMI/SCADA SYSTEM SOFTWARE

A. The Owner's existing SCADA HMI software at Glenville Lake WTP shall be replaced entirely with new software package. The Contractor shall provide new SCADA/HMI system configuration to meet the requirements specified herein. New HMI/SCADA software shall be VTScada by Trihedral:

1. One 5000 I/O Development Runtime license**.

2. One 5000 I/O Runtime license**.

   ** or equivalent as a combined license called "Dual Server Redundant"

3. A 10-pack Thin Client license (for concurrence PCs and mobile devices connections)

4. Accessories:

   a. VTScada Internet Client

   b. VTScada Mobile Internet Client

   c. Alarm Notification

B. Key features shall include, but not be limited to: real time and historical visualization and reporting of process measurements, status, control settings, and alarms; multimedia alarm management and annunciation to external systems; user login security management; redundancy management and auto-failover to hot standby systems; communication among servers, workstations, laptop computers, integrated display computers, programmable logic controllers, and other devices as shown on the Drawings or specified herein.

C. All major and minor updates to the operator workstation software shall be provided to the Owner for no additional cost during the warranty period. Software updates shall be fully installed and made operational on the Owner's system. All additional and replacement documentation associated with the upgrade shall be furnished and updated in the Owner's original software documentation. One day of Owner observation dealing specifically with the software update shall be provided to the Owner's personnel.

D. The system shall be upgradable to newer versions using an automatic mechanism provided by the supplier without the need to rebuild or reconfigure databases, displays, drives or related program modules.

E. A mechanism for on-line maintenance and automatic backup, retrieval and purging of files shall be provided.

F. All required software, licenses, and services shall be furnished as necessary for a complete and operating system as specified herein.

2.03 VIRTUALIZATION SOFTWARE

A. Virtualization software shall be the latest version of VMware vSphere Standard with vCenter centralized management software, or an equivalent Microsoft Hyper-V platform.

B. The server virtualization platform shall be provided with the following minimum features:

1. Health monitoring and performance analysis

2. Capacity management and optimization

3. Operations dashboard

4. Root cause analysis tools

5. High availability

6. Data protection

7. Virtual machine (VM) migration and replication

8. CPU and memory hot add functionality

9. System fault tolerance

10. Live file migration

11. Central management toolset for server provisioning, monitoring, and control

C. The virtualization software platform shall be fully compatible with all SCADA/HMI software, thin client management software, and all other SCADA software provided under this Contract.

2.04 THIN CLIENT MANAGEMENT SOFTWARE

A. Thin client management software shall be furnished, installed, and configured on each pair of redundant SCADA terminal servers to be installed at the facility.

B. The thin client management software shall provide for centralized, server-side thin client configuration, monitoring and management. Thin client operational status and parameters including but not limited to on/off status, terminal server assignment, login information, and running processes/applications shall be monitored at the terminal servers via the thin client management software.

C. Each thin client (terminal session) shall be dynamically assigned sufficient memory (RAM) to adequately execute its application(s) without significant delay.

D. Thin client machines shall be compatible with the thin client management software and shall be capable of network (PXE) booting, to download firmware and configuration information from the management software, as required.

E. Thin client management software shall be fully compatible with the selected virtualization software platform.

F. The following minimum features and functionality shall be provided:

1. All thin clients shall connect to fully redundant management servers to receive their firmware and configuration information.

2. All thin clients shall connect to both SCADA terminal servers and launch a session on each simultaneously. A primary terminal server failure shall cause the affected terminals to seamlessly and automatically switch to the session running on the secondary terminal server, thereby providing instant failover.

3. The management software shall poll the terminal servers and shall determine their load based on CPU usage, memory usage and quantity of running sessions. Thin clients shall then connect to the lightest-loaded terminal server, thereby balancing the system load across all available resources.

4. Thin clients shall be able to connect to multiple terminal servers and run multiple simultaneous, cascaded sessions.

5. Thin clients shall be able to have multiple monitors that shall be capable of running the same or independent sessions.

6. PC-based, tablet, and phone clients shall be provided with thin client management client software to allow these machines to run sessions on the SCADA terminal servers and to be monitored and managed by the thin client management software.

G. Thin client management software shall be ACP ThinManager or equal. Thin client management software shall be provided with all ancillary software and licenses required to facilitate a complete and working system.

2.05 ALARM NOTIFICATION SOFTWARE

A. Real time alarm notification software shall be installed on the SCADA servers to allow for remote notification of alarms to specific telephone numbers or text messages to cell phones.

B. All software and licenses shall be provided to create alarm notification functionality on both new SCADA Server 1 and SCADA Server 2. The alarm notification operation shall be fully redundant (standby with hot backup functionality) and the system shall be provided with all required voice notification software module, and text message capability required to provide a complete and working system.

C. Alarm Notification Software shall be VTScada alarm and voice notification software by Trihedral.

PART 3 -- EXECUTION

3.01 HMI GRAPHIC DISPLAYS - GENERAL

A. Multiple HMI graphic display pages shall be able to be viewed on the screen simultaneously. All graphic displays shall be scalable to allow automatic scaling of the display so as to

maintain a full view of the graphics regardless of the window size, screen resolution settings and type(s) of graphics access device(s). Graphical displays shall have no hard-coded limitations for display size. Workstations equipped with multiple display monitors shall be configured to support multiple independent HMI graphic display sessions within the same HMI graphics display client software instance.

B. The graphic display system described in the following paragraphs only defines those types of project specific displays commonly used during normal operations and their overall organization and navigation. Displays and display navigation shall be based upon the display hierarchy described herein and the written control narratives contained in Section 17950 of the Specifications.

C. The Contractor shall provide a comprehensive set of “uniform” system graphic display templates (e.g., trend display templates, equipment control display templates, global object templates, control loop faceplate templates, system maintenance and diagnostic display templates, etc. The resultant collection of said templates shall provide a “uniform” set of graphics for the operator (with appropriate security) to quickly perform various functions such as the selection of equipment and control strategy operating mode(s), manual/automatic control loop selection, loop set point adjustments, manual loop output adjustments, open/close valves, start/stop equipment, etc. Typically, the graphic display templates will be in the form of pop-up window overlays.

D. The collection of templates shall also enable overall system maintenance and troubleshooting, including but not limited to: network and PLC equipment, I/O diagnostics, network diagnostics, control strategies, data file management, etc., by privileged personnel.

E. The Contractor shall submit for review, configure, install and pre-test all five levels of HMI displays (refer to subsection 3.02, below) and “uniform” templates required to satisfy all specified instrumentation and control system requirements prior to commencement of the Factory Acceptance Test. Submittal shall be in the form of a fully functional virtual machine “image”, or equivalent, with sufficient software licensing such that the actual HMI graphic display interactions (display navigation, button bars, pop-up displays, help displays, drag, zoom, sliders and other dynamic navigation properties) can be reviewed through actual use. For purposes of this submittal, security shall be disabled. Refer to Section 17030 of the Specifications for additional submittal requirements.

F. HMI graphic layouts, alarm notification, process graphic display hierarchy, functionality and formats shall adhere to the requirements of the latest editions of the following guidance documents: “Alarm Management A Comprehensive Guide” and “The High Performance HMI Handbook”, together with the additional requirements as specified herein below:

1. The HMI graphic display security model shall ensure that when any HMI graphic or application module embedded within the HMI graphic is accessed by any user, it shall be accessible only with user-level security appropriately established either by the assigned user group security model (as may be further customized for each specific user) or by the assigned individual security model in order to provide secure access and protection of: navigation to/from each individual graphical display; each active component and process set point shown on an individual graphical display; pop-up

control display access and associated control commands. Inaccessible links and/or unmodifiable values and objects due to insufficient user privileges shall be “grayed out” and shall not be clickable.

2. The system shall be configured such that should a dynamic object fail to receive a value from the real-time data server, the dynamic object shall indicate such failure visually on the screen. Data values that are shown numerically shall show question marks (?????) instead of the last known value until a connection to the data server is restored. Loss of data server communication shall be logged in the system event log.

3. Process status shall be indicated using both color and alphanumeric annotations. Symbols and color coding for all displays shall be based on the following example convention: final colors shall be chosen by the Owner during HMI Workshops to be conducted during construction.

    a. All graphic backgrounds shall be black.

    b. All vessels shall be a medium grey.

    c. All process lines shall be a similar color as the physical piping in which they are intended to depict.

    d. All process lines shall be drawn using system piping tool.

    e. Secondary process lines, equipment and vessel outlines shall be 1/3 the width of major process lines, equipment and vessel outlines, respectively.

    f. Acceptable line types shall be: solid, dashed and dotted.

    g. Symbols, equipment, text, live data and other items which are selectable for subsequent actions (such as opening a pop-up faceplate, trend chart, navigating to another display, etc.) shall incorporate a white outline which appears only when a mouse (or equivalent) hovers within the outlined area.

    h. De-energized equipment, regardless of control mode, shall be dark grey.

    i. Energized equipment, regardless of control mode, shall be bright white.

    j. Safety interlocks (when activated) shall be yellow.

    k. Priority 1 high level (critical) alarm objects affecting life or property damage shall appear upon alarm and be red.

    l. Priority 2 medium level alarm objects (such as faulted equipment without automatic failover) shall appear upon alarm and be yellow.

    m. Priority 3 low level alarm objects (such as faulted equipment with automatic failover) shall appear upon alarm and be orange.

n. Priority 4 informational alarm objects (such as diagnostic alarms for out of range data) shall appear upon alarm and be pink.

o. Unacknowledged alarm objects and alarm summary text, unless the alarm has been cleared, shall blink.

p. Acknowledged alarm objects and alarm summary text that have not yet cleared shall be steady.

q. Acknowledged alarm objects and alarm summary text for an alarm which has also been cleared shall disappear from all displays.

r. All text shall be dark gray.

s. All text shall be shown in Arial font.

t. Uppercase text (for isolated words, titles, short labels and equipment designations) and mixed case text (for all other uses) to facilitate readability.

u. Text height shall conform to ANSI recommendations with a minimum height of 2.8 mm, nominal height of 3.5 mm and maximum height of 4.1 mm; based upon a typical workstation display viewing distance of 24 inches.

v. Text entry and data entry background color shall be soft white.

G. Equipment and process vessels shall be depicted as 2 dimensional objects; not 3 dimensional. Interior fill color shall be uniformly shaded. The vessel's shape shall be representative of the physical equipment, but with limited detail. Vessel size shall be relative to process importance or physical size (where practical). No animation of process vessel internals (spinning mixers, rake arms, etc.) shall be allowed. No "cutaways" showing unchanging internals shall be allowed.

H. Process flows shall be depicted consistently between displays. Major process liquid flows shall generally be depicted to progress from left to right. Secondary process liquid flows shall generally be depicted to flow down. Vapors and gasses shall generally be depicted to flow up.

I. Process lines that progress between graphic displays shall enter and leave in a consistent manner. Process line navigation targets and labels shall be clearly differentiated from non-navigation endpoints and labels.

J. The amount of text on a display shall be minimized. Action or status messages shall be brief, simple and to the point. Abbreviations shall be intuitive, consistent and uniformly applied.

K. Live data shall be depicted on displays in dark blue, Arial Bold font. Units of measurements, where necessary, shall be dark blue, Arial, mixed case font. Leading zeros shall not be displayed unless a fractional value. Numerical values shall be displayed to two decimal places, unless otherwise required by the Owner. In tables, align to the

decimal point. By default, signal tag names shall not be shown on displays. A toggle key shall be incorporated into the menu bar to toggle signal tag names on and off for the currently viewed display (including pop-up windows).

L. Key process indicators (KPIs), trends, charts, and all other analog graphic-based trending or productivity objects shall incorporate colored background “zones” to denote whether the associated values are in a normal (green), abnormal (yellow), or alarm (red) range.

M. All system variables and process values and set points shall be viewable regardless of the unit process operational mode. Set points and other modifiable system and process variables which are password-protected shall be legibly displayed but “greyed out”, similar to Microsoft Windows window behavior.

3.02 GRAPHIC SCREEN ORGANIZATION AND NAVIGATION

A. The HMI graphic screen displays shall be organized in a five-tier (level) hierarchy. The primary purpose of the multiple level graphic screen organization is to systematically provide increasing amounts of operating detail to the operator to aid in the performance of their work. A secondary purpose is to provide consistent display navigation.

B. The multiple level hierarchy shall be organized as follows:

1. Level 5 – User Login Display

2. Level 4 – Process Area Overview Displays

3. Level 3 – Process Unit Control Displays

4. Level 2 – Process Unit Detail Control Displays

5. Level 1 – Process Unit Support Displays

C. **Level 5** – **User Login Display:** The purpose of the user login display is to provide a common system security interface which must be satisfied before any user, regardless of security level, is allowed to proceed to the Level 4 through 1 displays, maintenance and diagnostic displays, etc. Once cleared, the operator shall be navigated to the process area overview display. When a user commences login, the security system shall also check the user’s password expiration date (refer to the security section, below) and if the expiration is within 14 calendar days or less (Contractor shall confirm actual number of days with the Owner), a pop-up template shall appear to facilitate updating of the user’s security password. Refer to Figure 17240-1 below for an example user login display.

D. **Level 4** – **Process Area Overview Display:** The process area overview display(s) are intended to show the broadest available view of the facilities managed by the SCADA system. Depending upon the complexity of the facility, one or more displays may be required.

1. The purpose of the process area overview displays shall be to provide an “at-a-glance” view of the subject process area by tracking key performance indicators (safety, environmental, production, efficiency and quality). The overview displays

shall not embody “process pictorial” diagrams, but rather shall incorporate logical groupings of embedded trend charts and moving analog indicators of key process variables, key alarm summary (from all process areas), as well as graphical alarm icons for all alarms. The process overview displays shall also include major equipment status, status of advanced and/or key process controls, key calculated parameters and conditions (for example, storage tank flows and levels), abnormal conditions (and severity), navigation tools, as well as important information from related process areas.

2. Graphical alarm icons for all alarm priorities relevant to the depicted process units within the graphic shall be incorporated in the displays. Icons shall only be visible when the alarm state is activated and shall become invisible after acknowledgement and return to normal state)

3. Refer to Figures 17240-2A and 17240-2B for an example Level 4 – Process Area Overview Display.

4. Specified “Smart Tile” and “Smart Pin” technologies may also be incorporated, as appropriate, and utilized to fulfill certain Level 4 functionality.

5. Special process overview displays featuring KPI information shall be provided for each unit process. These displays shall provide the key information to control and measure the effectiveness of each unit process in one display.

E. Level 3 – Process Unit Control Displays: The unit process displays shall contain all information and controls required to perform most operator tasks associated with a specific process unit from a single graphic. Major process lines together with the status of major equipment, loop controllers, safety interlocks (when activated), and important process indicators shall be shown on the various Level 3 displays. Process vessels and dynamic equipment symbols relevant to the major process schematic shall also be shown. Displays shall incorporate logical groupings of embedded trend charts, spark-lines, moving analog indicators, and moving mass balance indicators. Routine operational changes as well as abnormal situation interventions (such as manipulating loop controllers, operating pumps and equipment, operating blowers, adjusting valves, etc.) shall be available to the operator through pop-up window display overlays containing the appropriate “uniform” template(s). Pop-up displays shall be located as to not obscure the underlying graphic information.

1. For each Level 4 Process Area Overview Display, there shall be multiple Level 3 Process Unit Control Displays. Refer to Figure 17240-3 for an example Level 3 Process Unit Control Display.

2. When the operator wishes to take control of the device or modify set points, the procedure shall be as follows:

   a. The operator shall highlight and click on the device symbol with the mouse.

   b. A “pop-up” dialog box shall appear which provides the current state or set point and enables the operator to make the appropriate change.

c. For two-state devices, the dialog box shall allow the operator to start or stop, open or close, or otherwise change the state of the device.

d. For set points and modulating final control devices (analog outputs), the dialog box shall display the old value, and shall allow the operator to enter a new value using standard Windows editing techniques. It shall also be possible for the operator to ramp the current value up and down by clicking on ramp targets.

e. Prior to the execution of the operator-commanded action, a confirmation message and target shall be displayed stating the old and new values and asking the operator to confirm the modification. A privileged operator shall be able to enable or disable this global feature.

f. Control strategies shall be changed from AUTO to MAN or OFF (or vice versa) in the same manner as two-state devices.

3. In addition, graphical alarm icons for all alarms relevant to the depicted process within the graphic shall be shown. Graphical alarm icons for all alarm priorities relevant to the depicted process units within the graphic shall be incorporated in the displays. Alarm icons shall only be visible when the alarm state is active and shall be invisible after acknowledgement and return to normal state. Access to all important process area safety controls (shutdown, hazardous material isolation/treatment, etc.) shall be provided. The process area displays shall also include display navigation tools, as well as important information from related process areas.

F. Level 2 – Process Unit Detail Displays: The Process Unit Detail Displays are primarily intended for troubleshooting. The process unit detail displays shall contain all control loops (controllers, indicators, alarm icons, status switches, etc.), safety interlocks (when activated), individual equipment items, views of sub-processes, components and related controls and indications. Operational changes not accessible from Level 3 displays shall be available to the operator on Level 2 displays through pop-up window display overlays containing the appropriate “uniform” template(s).

1. For each Level 3 Process Unit Control Display, there shall be multiple Level 2 Process Unit Detail Displays. Refer to Figure 17240-4A and 17240-4B for an example of a Level 2 Process Unit Detail Display with process control display overlays turned off and on, respectively. Refer to Figures 17240-5 through 17240-8 for example pop-up window display overlay “uniform” template(s).

2. Level 2 displays shall also include: pre-built trend charts for specific diagnostics, shutdown system and interlock system diagnostic graphic elements. Graphical alarm icons for all alarm priorities relevant to the depicted process units within the graphic shall be incorporated in the displays. Alarm icons shall only be visible when the alarm state is active and shall be invisible after acknowledgement and return to normal state. Access to all important process unit safety controls (shutdown, lock out, etc.) shall also be provided.

G. Level 1 – Process Unit Support Displays: Process unit support displays shall provide the most detail of equipment items, sub-processes, individual sensors, components and alarm icons; including access to detailed diagnostic and help information through pop-up text box faceplates, external document links (including external document reader) and similar faceplates by right clicking on the affected: equipment item, sub-process, sensor, component or alarm icon. Level 1 displays shall include access to maintenance, diagnostic, control faceplates, PLC diagnostic object faceplates, access to process unit O&M data sheets, and access to process troubleshooting checklist.

H. **Control System and Network Displays:** Provide graphical displays in the form of block diagrams indicating the detailed status of each network device on the control system network. Provide communication alarm programming in PLCs or use SNMP communication drivers as necessary to monitor communication status of all devices on the control system network. For redundant links, indicate which link is active and which is on standby. As a minimum, indicate the status of each PLC including but not limited to all associated I/O modules, PLC faults, control panel DC power supplies, panel high temperature and intrusion alarms, and incoming AC power status; as well as the communication status of all human-machine interfaces (HMIs). Indicate the IP address of each device only when logged in with appropriate security. Manufacturer, model numbers, and location for all PLCs, HMIs, and network interface devices shall be displayed. PLC input/outputs and SCADA I/O tag names shall be displayed for all SCADA system external inputs/outputs.

I. Display Navigation History: The system shall be configured to maintain a history of the last 20 HMI graphic display files accessed (similar to Internet Explorer's back/forward feature), allowing the user to navigate through the display file history via "Display Forward" or "Display Backward" commands. The display file history (forward/back commands) shall remember the settings when moving away from a display and will reset to those settings when returning back to that display in the file history.

J. Menu Bar: Menu bar selections and related pushbutton menu selections and functions shall include a pull-down menu bar with the following selections:

1. LOGOUT selection: shall the system user to login by entering an assigned login name and password.

2. SYSTEM selection: shall provide access to the Windows system environment (access restricted based upon username and password security).

3. MESSAGE selection: shall provide access to a personal message center, through which users shall be able to provide brief messages to other users at any workstation on the network.

4. EVENT selection: shall provide a display of historical and real-time system event activity including operator actions, operator entries, system messages and maintenance / configuration activity logs.

5. ALARM selection: shall provide a pop-up display to access the multimedia alarm system and related displays. Refer to Item 3.04 for additional requirements.

6. NAVIGATION selection: shall display a list of all Level 3 and Level 4 displays which shall automatically navigate to the appropriate display when the text is selected.

7. FORWARD (FWD) selection: shall move to the next display in the navigation history memory (if any).

8. BACK selection: shall move to the prior display in the navigation history memory (if any).

9. PLAYBACK selection: playback, through digital graphic replay, of historical data automatically on the selected HMI graphic display, trend chart, etc. Playback shall occur at an adjustable time step via graphical slider, pull down menu or similar mechanism for selection of time step, start/end date, start/end time, etc.

10. HELP selection: shall provide a context sensitive menu of help text pop-up displays to provide the operator with normal / abnormal condition guidance for specific processes and/or equipment depicted on the active HMI display graphic page. Owner shall be able to enter custom process related guidance text and data. Contractor shall include and enter all context sensitive control system-specific guidance help text pop-up displays relative to the use of the SCADA system software components. The HELP system menu shall also incorporate content search tools based upon Microsoft Help toolsets.

11. TREND selection: shall provide a pull-down menu for operator selection of pre-built, multiple pen historical and real-time graphics. The system shall also permit the operator to add, delete and modify multiple trend displays and incorporate same into the pull-down menu.

12. REPORTS selection: shall provide access to a menu listing for all configured reports with features as described herein.

13. OVERVIEW selection: shall display a pull-down menu of the available process overview screen(s).

14. PRINT selection: shall copy and print the current display on the assigned printer or generate a pdf file attachment and E-Mail messaging form to send the attachment and message to recipients via the Owner's e-mail system. Printer or e-mail selection shall be user selectable by pop-up menu upon selection of COPY command.

15. DOCUMENTATION selection: shall open a pop-up window containing a directory of the Owner's online library of operation and maintenance manuals, as-built and record drawings, control strategies, etc. External communication link shall be secure.

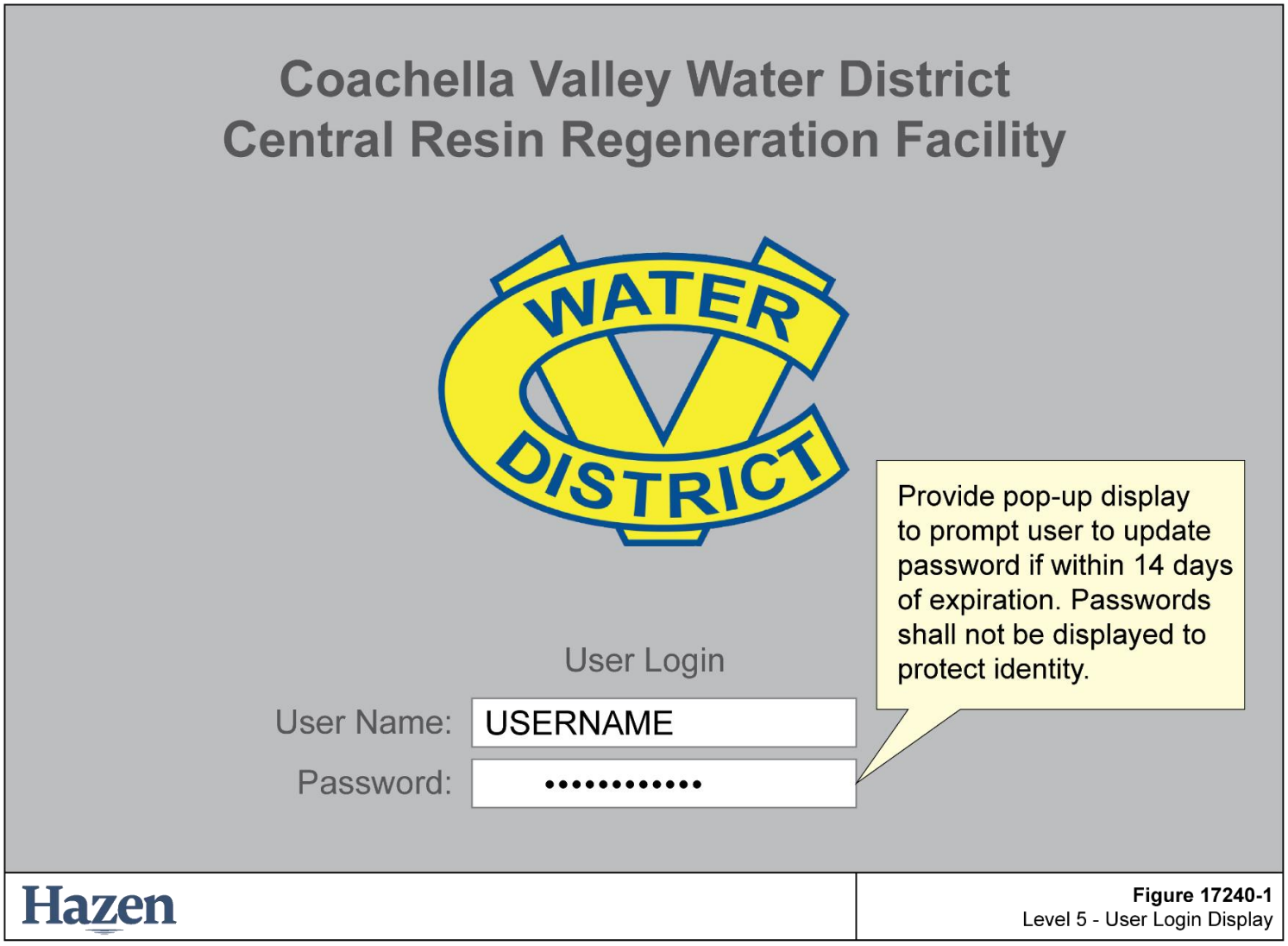

Figure 17240-1
Level 5 - User Login Display

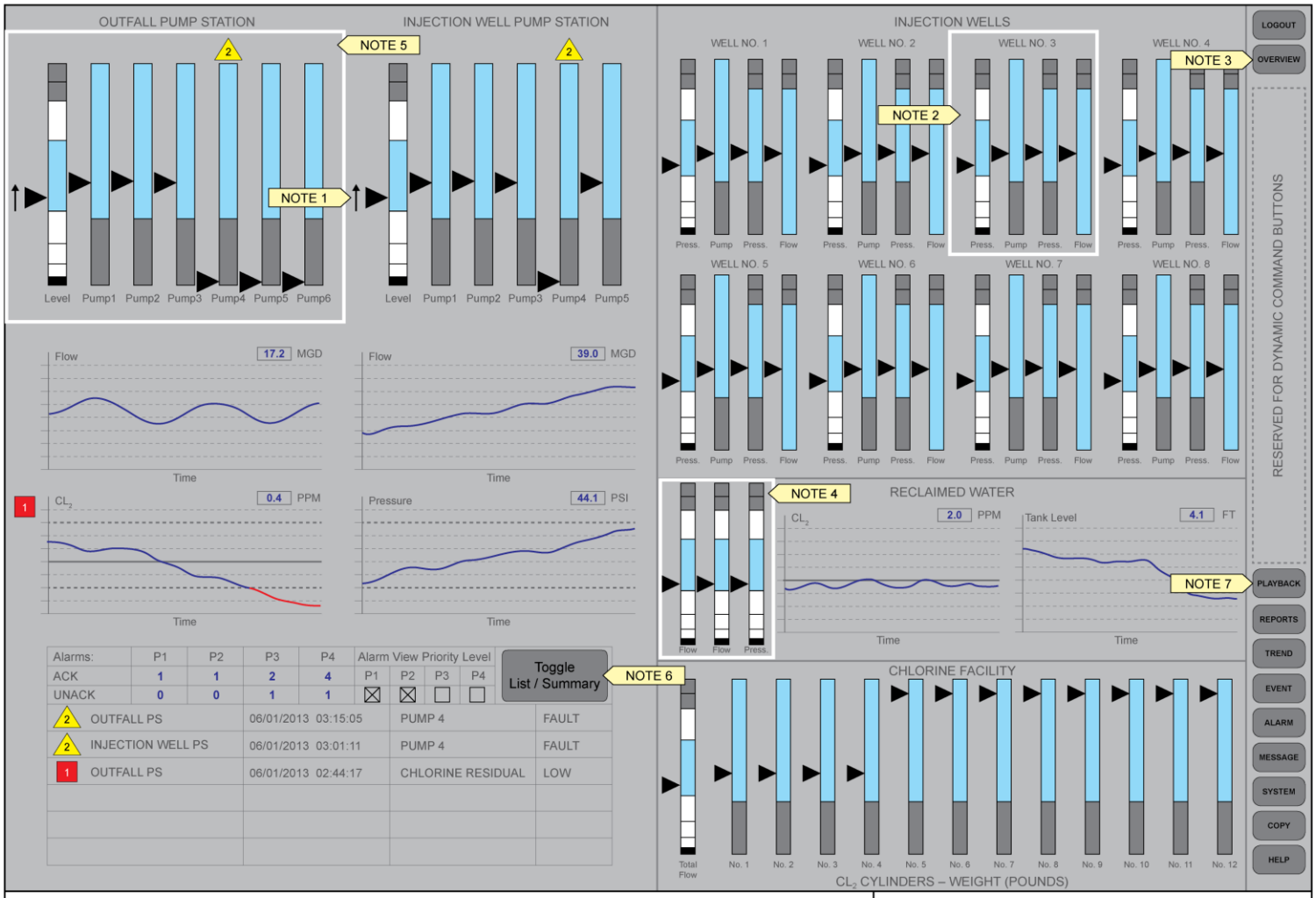

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Figure 17240-2A
Level 4 – Process Overview Display

NOTES:

1. ARROW INDICATES PRIOR 5 MINUTE AVERAGE PROCESS VALUE TREND. AVERAGE SHALL BE CALCULATED AS A 5 MINUTE ROLLING AVERAGE AND UPDATED EACH MINUTE.
2. HIGHLIGHT AND CLICK TO NAVIGATE TO INJECTION WELL NO. 3 PROCESS CONTROL DISPLAY (TYPICAL). REFER TO FIGURE 17240-3 FOR TYPICAL EXAMPLE OF LEVEL 3 PROCESS CONTROL DISPLAY.
3. CLICK ON "OVERVIEW" TO PROVIDE A PULL DOWN MENU OF OVERVIEW DISPLAYS FOR OPERATOR SELECTION. OVERVIEW MENU SHALL INCLUDE:
   - LIQUID TREATMENT PROCESS
   - EFFLUENT DISPOSAL AND RECLAMATION
   - SOLIDS TREATMENT PROCESS
   - PLANT ELECTRICAL SYSTEM
4. HIGHLIGHT AND CLICK TO NAVIGATE TO RECLAIMED WATER SYSTEM PROCESS CONTROL DISPLAY (TYPICAL).
5. HIGHLIGHT AND CLICK TO NAVIGATE TO OUTFALL PUMP STATION PROCESS CONTROL DISPLAY (TYPICAL).
6. CLICK TO TOGGLE BETWEEN ALARM SUMMARY VIEW (SHOWN) AND ALARM LIST POP-UP DISPLAY.
7. CLICK ON "PLAYBACK" TO PROVIDE A PULL-DOWN MENU OF DIGITAL REPLAY START AND FINISH DATES / TIMES, TIME INCREMENT AS WELL AS START / STOP / CANCEL AND FORWARD / FREEZE / REVERSE CONTROLS FOR DIGITAL REPLAY OF DISCRETE AND ANALOG DATA, ALARMS AND EVENTS FOR THE CURRENT GRAPHIC DISPLAY.

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Figure 17240-2B
Level 4 – Process Overview Display Notes

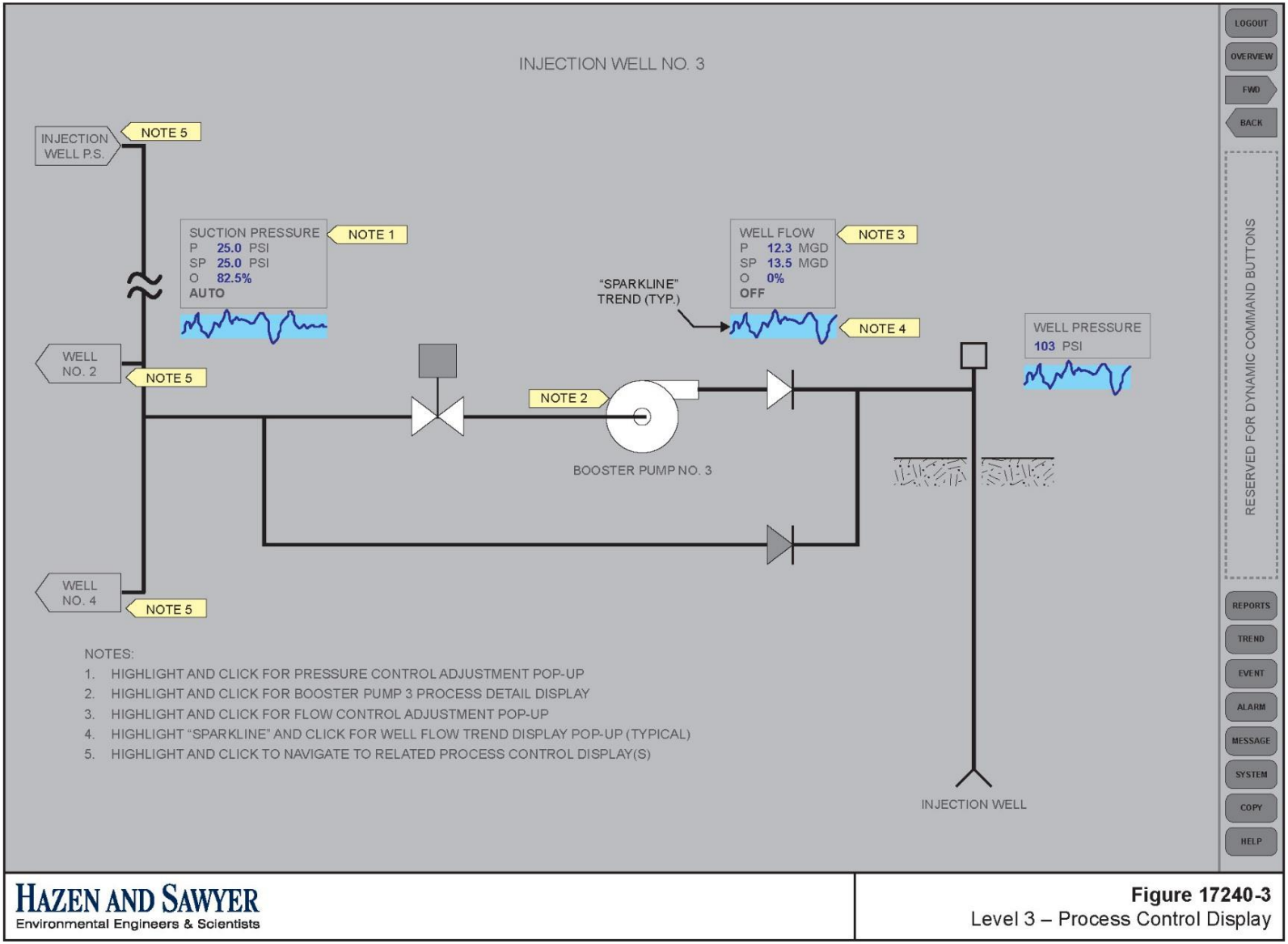

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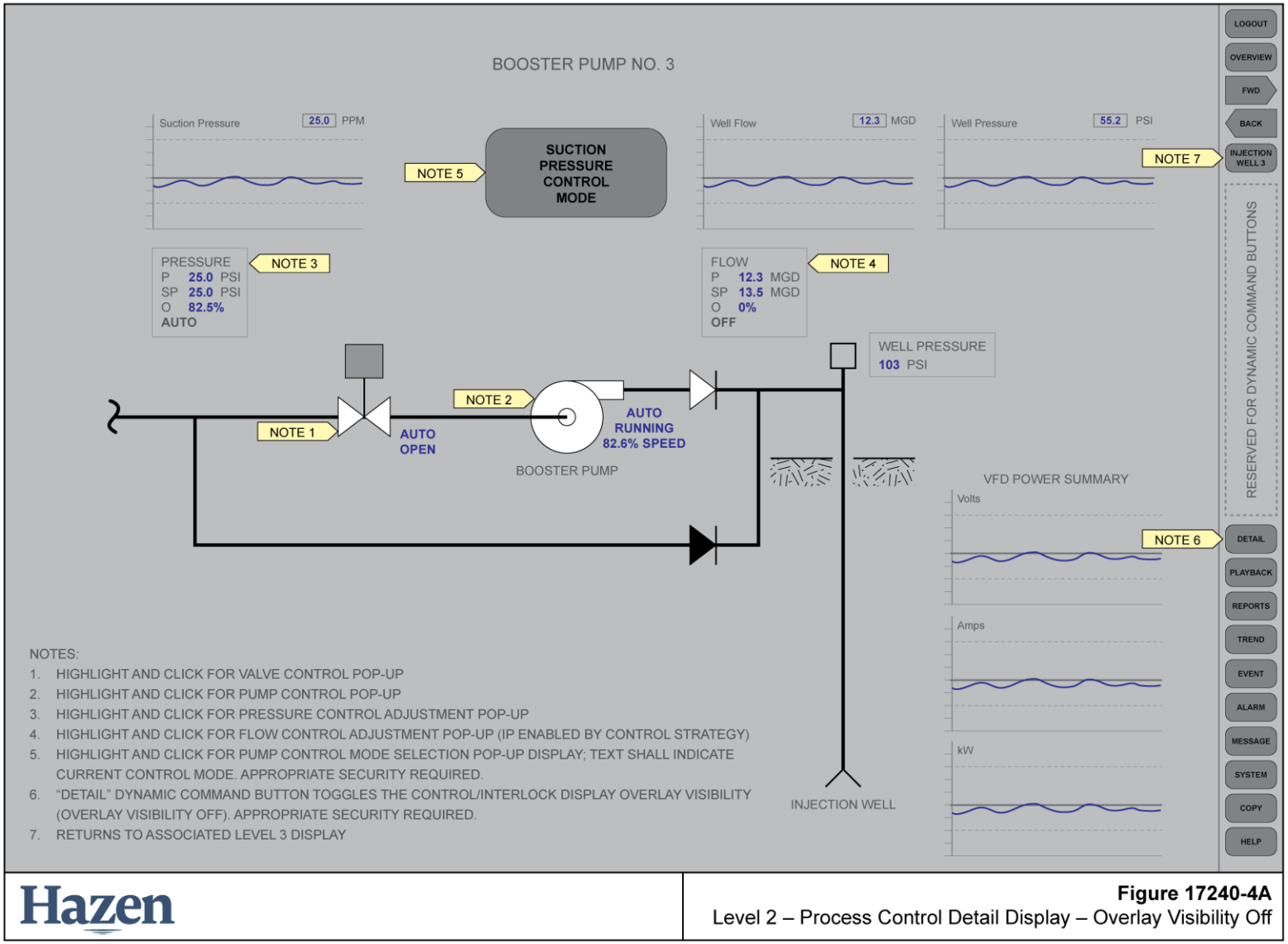
Figure 17240-3
Level 3 – Process Control Display



Hazen

Figure 17240-4A
Level 2 – Process Control Detail Display – Overlay Visibility Off

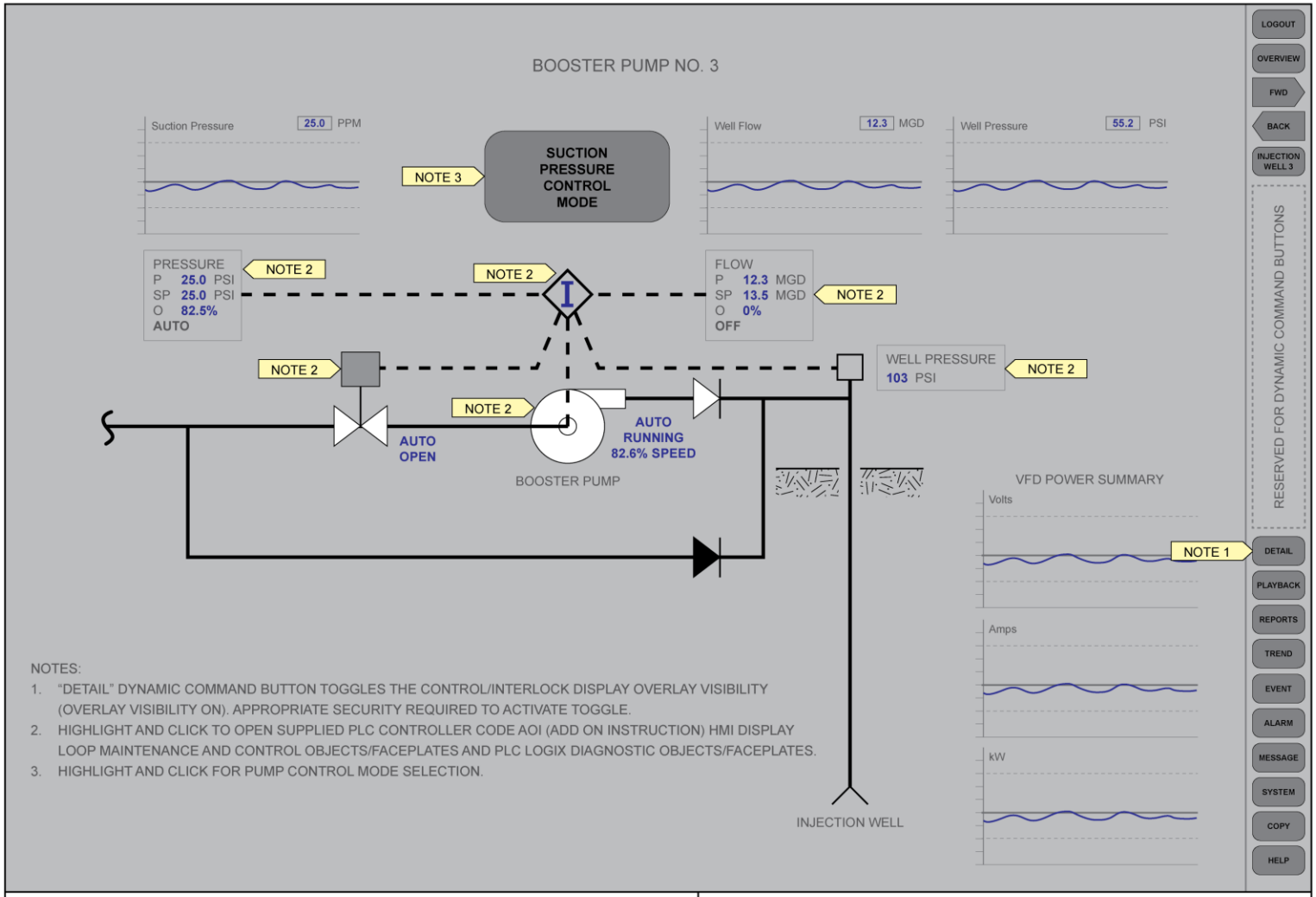


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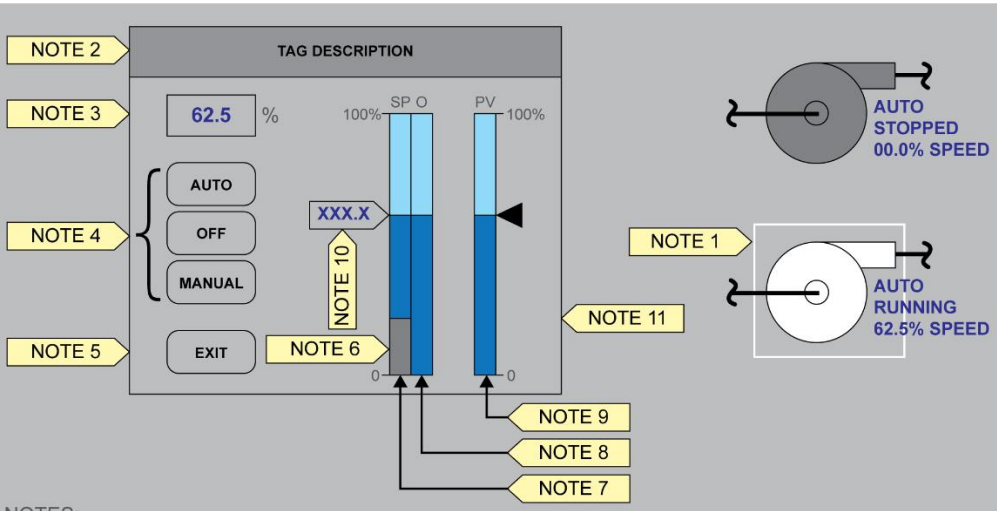
Figure 17240-4B
Level 2 – Process Control Detail Display – Overlay Visibility On

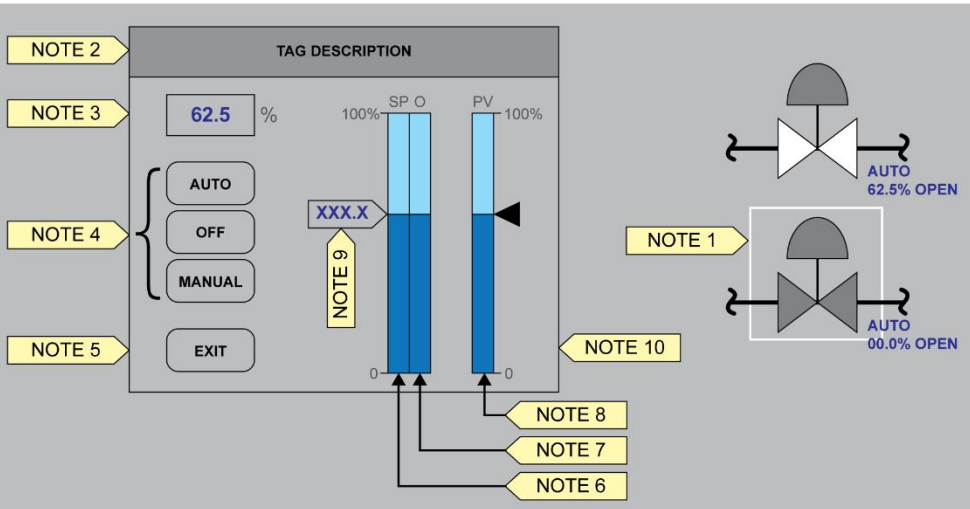


NOTES:

1. HIGHLIGHT EQUIPMENT OBJECT WITH MOUSE; OPEN CONTROL POP-UP UPON MOUSE CLICK. EQUIPMENT MUST BE IN “REMOTE” TO ENABLE POP-UP ACCESS.
2. DESCRIPTION FIELD OF EQUIPMENT TAG
3. CURRENT SPEED OF CONTROLLED EQUIPMENT
4. CONTROL BUTTONS LIGHT GREY IN COLOR, BLACK TEXT. MEDIUM GREY COLOR WHEN SELECTED.
5. CLOSES POP-UP DISPLAY
6. GREY SHADED AREA DEPICTS NON-CONTROLLABLE PORTION(S) OF SPEED RANGE (IE. MINIMUM AND/OR MAXIMUM LIMITS. LIGHT BLUE DEPICTS CONTROLLABLE RANGE.
7. DARK BLUE BAR INDICATES CURRENT SETPOINT (AUTO AND MANUAL MODES)
8. DARK BLUE BAR INDICATES CONTROLLER OUTPUT TO DEVICE
9. DARK BLUE BAR INDICATES FEEDBACK FROM CONTROLLED DEVICE
10. SLIDER ADJUSTS SETPOINT (MANUAL MODE) AND TRACKS OUTPUT (AUTO MODE)\
11. CONTROL POP-UP MAY BE DYNAMICALLY INTEGRATED INTO DYNAMIC COMMAND BUTTON SIDE BAR AREA IN LIEU OF POP-UP DISPLAY

Hazen

Figure 17240-5
Pop-up Controls / Dynamics
Variable Speed Type Equipment

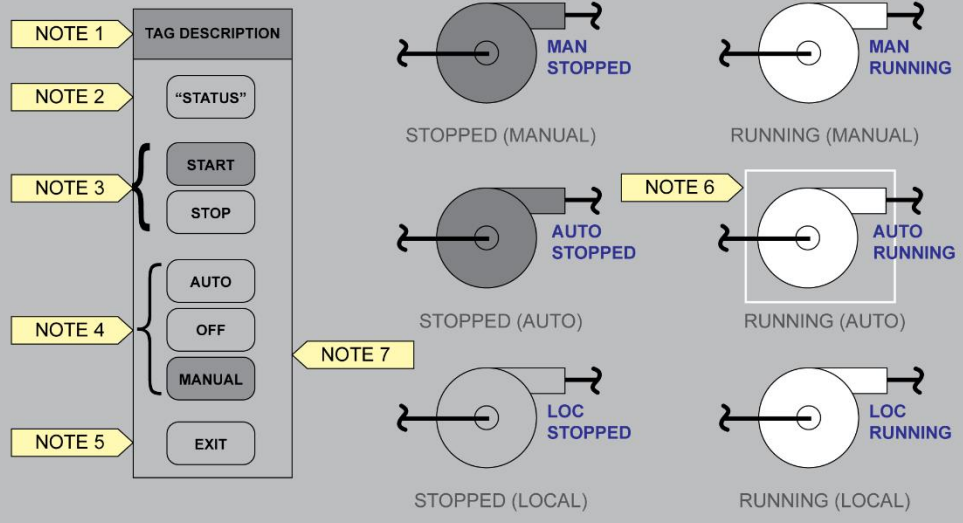


NOTES:

1. HIGHLIGHT EQUIPMENT OBJECT WITH MOUSE; OPEN CONTROL POP-UP UPON MOUSE CLICK. EQUIPMENT MUST BE IN "REMOTE" TO ENABLE POP-UP ACCESS.
2. DESCRIPTION FIELD OF EQUIPMENT TAG
3. CURRENT POSITION (% OPEN) OF CONTROLLED VALVE
4. CONTROL BUTTONS LIGHT GREY IN COLOR, BLACK TEXT. MEDIUM GREY COLOR WHEN SELECTED.
5. CLOSES POP-UP DISPLAY
6. DARK BLUE BAR INDICATES CURRENT SETPOINT (AUTO AND MANUAL MODES)
7. DARK BLUE BAR INDICATES CONTROLLER OUTPUT TO DEVICE
8. DARK BLUE BAR INDICATES FEEDBACK FROM CONTROLLED DEVICE (VALVE % OPEN)
9. SLIDER ADJUSTS SETPOINT (MANUAL MODE) AND TRACKS OUTPUT (AUTO MODE) FOR BUMPLESS TRANSFER
10. CONTROL POP-UP MAY BE DYNAMICALLY INTEGRATED INTO DYNAMIC COMMAND BUTTON SIDE BAR AREA IN LIEU OF POP-UP DISPLAY

Hazen

Figure 17240-6
Pop-up Controls / Dynamics
Modulating Type Valves



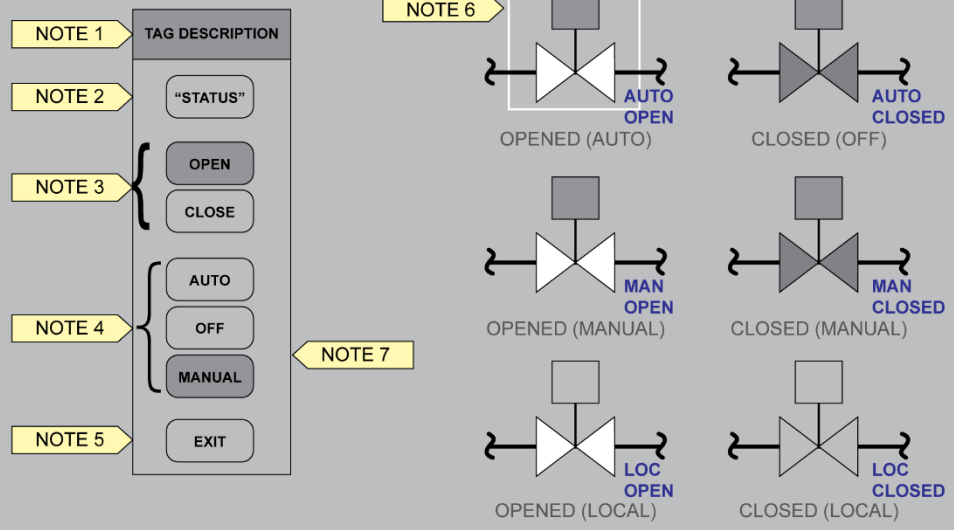
EXAMPLE STATUS DYNAMICS

NOTES:

1. DESCRIPTION FIELD OF EQUIPMENT TAG (IE. "SUCTION VALVE")
2. STATUS (OPENED, CLOSED OR BLANK)
3. CONTROL BUTTONS ENABLED WHEN IN MANUAL MODE
   LIGHT GREY COLOR, BLACK TEXT, MEDIUM GREY COLOR WHEN SELECTED
4. CONTROL BUTTONS LIGHT GREY COLOR, BLACK TEXT, MEDIUM GREY COLOR WHEN SELECTED
5. CLOSES POP-UP DISPLAY
6. HIGHLIGHT BOX AROUND VALVE OBJECT; MOUSE CLICK OPENS POP-UP CONTROL DISPLAY
   EQUIPMENT MUST BE IN "REMOTE" TO ENABLE POP-UP ACCESS
7. CONTROL POP-UP MAY BE DYNAMICALLY INTEGRATED INTO DYNAMIC COMMAND BUTTON
   SIDE BAR AREA IN LIEU OF POP-UP DISPLAY

Hazen

Figure 17240-7
Pop-up Controls / Dynamics
Constant Speed Type Equipment



EXAMPLE STATUS DYNAMICS

NOTES:

1. DESCRIPTION FIELD OF EQUIPMENT TAG (IE. "SUCTION VALVE")
2. STATUS (OPENED, CLOSED OR BLANK)
3. CONTROL BUTTONS ENABLED WHEN IN MANUAL MODE
   LIGHT GREY COLOR, BLACK TEXT, MEDIUM GREY COLOR WHEN SELECTED
4. CONTROL BUTTONS LIGHT GREY COLOR, BLACK TEXT, MEDIUM GREY COLOR WHEN SELECTED
5. CLOSES POP-UP DISPLAY
6. HIGHLIGHT BOX AROUND VALVE OBJECT; MOUSE CLICK OPENS POP-UP CONTROL DISPLAY
   EQUIPMENT MUST BE IN "REMOTE" TO ENABLE POP-UP ACCESS
7. CONTROL POP-UP MAY BE DYNAMICALLY INTEGRATED INTO DYNAMIC COMMAND BUTTON
   SIDE BAR AREA IN LIEU OF POP-UP DISPLAY

Hazen

Figure 17240-8
Pop-up Controls / Dynamics
Open-Close Type Values

3.03 ALARMS AND EVENTS CONFIGURATION

A. Each alarm notification shall include a set of fields containing data that describes the alarm such as tag name, alarm state, alarm “on” timestamp, alarm “off” timestamp, message text describing the alarm, alarm time deadbands, alarm priority, alarm category, and alarm acknowledgement. The following types of alarms shall be configured and routed to workstations, printer, or saved as historical data:

1. State alarms (Boolean alarms) corresponding to discrete tags with two possible states (TRUE or FALSE state).

2. Limit alarms.

3. Target deviation alarms.

4. Rate of change alarms.

B. Events shall be detected, reported, and saved as historical data. Event logs shall be able to be queried, filtered and/or sorted by event type and/or date. The following types of run-time events, which are saved as historical data shall be configured:

1. System events.

2. Security-audit events.

3. Application (or process) related events.

C. Alarm management capabilities shall be provided for each discrete and analog database field input and output as well as all virtual (internal to the SCADA HMI application) inputs and outputs. Alarm management capabilities shall include:

1. Alarm suppression to avoid nuisance alarms such as startup spiking.

2. Re-alarming and temporary “shelving” of alarm points.

3. Help text and operator input text field for each point.

4. Alarm routing to specific workstations and printers as appropriate.

5. Alarm grouping for specific visual and audible group notification.

6. Analog alarm types to include (as a minimum): low low; low; high; high high; rate of change; deviation; dead-band; bad input; and off scan.

7. Discrete alarm types to include (as a minimum): change from normal; return to normal; change of state; bad input; and off scan.

8. Seamless alarm acknowledgement.

9. Navigation to relevant HMI display upon clicking on any alarm, regardless of the alarm state.

D. All points or modules that have the capability of being alarmed for amplitude or rate of change limit violations, and all discrete alarm inputs shall be linked to an associated discrete point for alarm suppression under specified conditions. For example, when there is no flow through a flow meter, the "not running" signal from the associated prime mover shall be used to suppress all alarms associated with the flow signal. Time delays shall be provided as necessary to eliminate transient alarm annunciation under start-up/shutdown conditions.

E. Each alarm and event shall be able to be logged, stored and forwarded to the historical database resident in the historical server, and shall be fully available for digital graphic replay and reporting.

F. The user shall also be able to access the alarm and event history page that displays the sequence of events that are associated with its specific alarm or event group. Event pages shall not be mixed with alarm pages.

G. The system shall provide an alarm summary display as a pre-defined dynamic link within the graphics package. This alarm summary display shall show a list of the pending alarms in the system. As new alarms are detected, entries shall be made to the display list. As the alarm conditions clear, the entries shall be removed from the list.

H. The alarm summary display shall be user-configurable to the extent that the user can select the placement of tag name, current value, descriptor, time of alarm, and alarm status on the line as well as the color codes to be used to indicate the various alarm conditions.

I. Alarms shall be reported to the alarm summary displays, which shall allow the operator to sort alarms in descending or ascending time order and one or more alarm priority level filters through pop-up sorting control tools. The operator shall also be allowed to reconfigure, hide, or expand alarm summary columns for detailed analyses, while actively viewing.

J. Alarms shall be acknowledged from the alarm summary display either individually (by clicking on an alarm acknowledgement field) or by a full page using a menu pull-down. The system shall support up to twenty (adjustable) alarm messages in the summary display. Alarm notification shall be synchronized between all workstations. Alarms acknowledged from any local or remote location, device or HMI graphic display shall be reflected throughout the system; including redundant servers. It shall not be necessary to acknowledge the same alarm at multiple workstations.

K. All Level 3 and Level 2 graphic displays shall be configured with the indication of the last three alarms stacked in contiguous rows at the bottom of the screen. Alarms shown shall include Priority 4, 3 and 2.

L. An unacknowledged alarm shall flash in configured colors until it is acknowledged. When an alarm is acknowledged, it shall stop flashing but remain displayed until the alarm condition is cleared.

M. When an alarm is acknowledged, the operator shall have the opportunity to enter a comment to be stored in the alarm log database. The operator shall be able to select from

a pre-configured list of comments or directly enter comments. Operator comments shall be viewable from the alarm log. Comments shall be appended and stored along with logged alarms to the process historian database.

N. When an alarm condition has been both acknowledged and cleared, the alarm statement shall be removed from the alarm summary.

O. Alarm summaries shall provide the following column information, as a minimum:

1. Date and time

2. Tag number

3. Tag description

4. Alarm condition

5. Tag value

6. Operator Comment pop-up control to allow operator entry of comments (if any) for any specific alarm message. Operator comments shall be logged along with alarms.

P. The following alarm condition statements shall be provided as a minimum:

1. RTN NRML - Return to Normal

2. HIHI LMT - Second High Limit

3. HI LMT - High Limit

4. LO LMT - Low Limit

5. LOLO LMT - Second Low Limit

6. ROC LMT - Rate of Change Limit

7. STAT CHGE - State Change

8. OFF SCAN - Off Scan

9. OPEN FAIL - Open Failure

10. CLOSE FAIL - Close Failure

11. START FAIL - Start Failure

12. STOP FAIL - Stop Failure

13. FAULT - Fault

14. HI DEV - High Deviation

15. LO DEV - Low Deviation

16. DISCREP - Discrepancy

17. UNAVAIL - Unavailable

P. All date and time stamped alarm fields shall be sent to the loggers and historian for archival and retrieval for generation of alarm summary reports either upon operator request or via automatic schedule. Report writing system shall be utilized for development of alarm reports.

Q. The system alarm and history display, with on-line height and width adjustment capabilities, shall be displayed as part of operator screens, upon demand. The operator shall be able to resize and move the display, as desired. Further, the operator shall be able to close this display upon demand or cause it to be continually displayed as the operator navigates through operator screens.

3.04 TRENDS CONFIGURATION

A. The Contractor shall provide a minimum of 30 pre-built trends as directed by the Owner. Each pen shall be configured with a unique color or line type for ease of viewing

B. The trending system shall accommodate all work performed under this Contract. Real-time and historical trends shall be developed with close coordination with the Owner.

C. All attributes of each historical display chart shall be able to be configured or modified at any time.

D. In addition, the user shall be able to make temporary, view-only modifications, while viewing historical trend charts.

E. The system shall provide multiple sets of real-time and/or historical trends in operator screens. Each set shall be capable of the following:

1. Displaying up to eight pens. Each set of trends can be either pre-configured trends as defined by the Owner or ad-hoc trends as created from any variable in the system.

2. Being temporarily modified, while viewing.

3. Displaying straight line or varying data value "target" curves.

4. Full screen trend curve displays when trend screen is opened.

5. Historical data and real-time data of the same variable can be displayed on a single window, full screen trend display.

6. Variables within multi-variable trends shall be capable of being offset from one another instead of being shown on top of one another in order to improve readability.

F. Each live trend chart shall allow temporary, on-line pen, range and chart X-Y parameter changes by the user. Each trend display shall allow for the creation of an online, user modifiable straight-line "target" curve for each trended data point and a user selected varying data value "target" curve based on pre-defined modeling for trended data points.

G. Trends shall automatically shut down and release system resources when closed.

H. The system shall be configured for the following online historical data user functionality without pausing or stopping any system function:

1. Zoom to any specific area of a chart.

2. Automatic real-time update of historical data, upon demand.

3. Reset to original trend chart parameters, upon demand.

4. Request completely different start/stop time and duration parameters, upon demand.

5. Chart data display update forward or backward in time, by a single point-click for two sets of modifiable time increments in each direction.

6. Export displayed trend chart data into a text file with a user defined acronymic, mnemonic file name.

7. Print any displayed historical trend chart, upon demand.

8. Display multiple historical trend charts at the same time with time synchronizing for detailed analyses.

9. Data trend charts configured by combining any pen and time groups.

10. Trend chart display format changes including colors, titles, legends, etc.

I. When configuring tag pen groups, the system shall provide for user configuration of at least:

1. Individual tag and related attributes.

2. Default or specific data value range.

3. Individual color for each tag pen.

4. A specific letter to further document each pen related curve.

5. Trend charts display format.

J. Time group configuration shall include at least the following:

1. Start/stop dates and times.

2. Duration.

3. Sample, average value, high value and low value displays individually or together.

4. Trend chart display format.

K. Operator access for viewing or printing any individual project specific, pre-defined historical trend chart shall be through a single point-click action while viewing on operator screens, via the TREND Menu bar selection.

3.05 HISTORICAL DATA MANAGEMENT AND CONFIGURATION

A. The historian server shall be configured to perform real time and historical data collection, analysis, visualization (trending), evaluation for system and operations validating, testing, maintenance and regulatory reporting, and data storage for an extended period of time.

B. For data and system resource management, the system shall allow the assignment of any number and type of database tags and tag groups for historical data collection with the following attributes:

1. Collection rate and phasing.

2. Data collection start/stop condition.

3. Data collection dead-band.

C. Naming convention for database tags, which are categorized by different attributes such as types, format, etc., and their service descriptions shall be as follows:

1. Analog tag: Refer to Section 17920.

2. Analog Summary Tag

3. Discrete tag: Refer to Section 17920.

4. String tag (or text expression)

5. Event tag

D. Database tags shall be specified a storage method which defines how the tag's data is saved as historical records. The following types of storage modes (methods) shall be provided:

1. Analog tag: forced storage, i.e., all data values are stored or cyclic storage, i.e., data values are stored based on specified time interval.

2. Discrete tag: delta storage, i.e., data values are stored based on a change in a value with deadbands. For example, pump ”ON” is stored with a timestamp when the change from OFF to ON occur.

E. The Historian Server shall provide automatic creation of archive files and the ability to automatically overwrite the oldest archive for unattended operation. The Historian Server shall provide a method for backing up all on-line archives on-line without the need to stop the archive system.

F. The historian server shall be furnished with software tools for automated retrieval of older historical records indexed on portable media to the historian server for subsequent use. Configure each historian server for historical data file backup, archiving and retrieval via the network or local DVD drive. The system shall allow these files to be restored to the appropriate system file path and reviewed with all system functions at any time, as if they had continued to be hard disk resident. Historical data file backup, disk space management toolsets and procedures shall be fully automated and automatically documented.

G. The historian server shall be configured to receive data or tag values from the SCADA application runtime environment servers. In addition, the historian server shall be configured to receive/query data or tag values from the following sources:

1. HACH Water Information Management Solution (HACH WIMS) software.

2. Laboratory Information Management System (LIMS) software.

3. Application object server data arriving late from “store-and-forward” cache. Any and all data gaps in the historical server due to loss of communication shall be automatically filled in by the application object servers.

H. The collection of data or tag values shall begin automatically upon software system start-up.

I. The historian server(s) shall be configured to record all process data, calculated data, set point data, alarms, events and operator interaction data. Collected data shall be historically recorded regardless of its use in operational activities. For example, in addition to process variables such as flows and levels; data such as: pump run status, in “remote” and “fault” status, remote-manual and automatic control status, equipment run times, operator-adjustable set points, operator alarm acknowledgement, and operator control actions shall also be logged and recorded. This data, in conjunction with storage of alarm and event data, shall provide a comprehensive record of every aspect of facility operation which can be used to achieve business objectives.

J. The historian servers shall apply data compression filters on the data as it is written to disk as follows:

1. Maximum value;

2. Minimum value;

3. Time-weighted average value;

4. Standard deviation;

5. Rate-of-change;

6. Running totalizer;

7. Running maximum value (the maximum value over the entire logging period);

8. Running minimum value (the minimum value over the entire logging period)

9. Running average value (using an exponentially weighted moving average filter, giving more "weight" to newer samples);

10. Moving maximum value (the maximum value over a user-defined "sliding window" of time);

11. Moving minimum value (the minimum value over a user-defined "sliding window" of time);

12. Moving average value (the average value over a user-defined "sliding window" of time).

K. The timestamps used for logged data shall utilize either the Universal Time Code (UTC), or local time with automatic correction for Daylight Savings Time. The software shall support logging of the time stamp to a precision of 1 millisecond (time stamp as supplied by the real-time data servers).

L. Historical data files shall be saved to computer backup media including tapes, network attached storage (NAS), or optical disks if the operator chooses this option. The system shall allow these files to be restored to the appropriate system file path and reviewed with all system functionality at any time, as if they had continued to be hard disk resident.

3.06 REPORTS

A. The Contractor shall furnish the following automatically generated reports:

1. Shift, daily, monthly, and annual operating reports that include all monitored and generated analog values in the Control and Information System, with the exception of percent speed and position feedback values. Shift and daily reports shall include columns of hourly data, monthly reports shall include columns of daily data, and annual reports shall include columns of monthly data. Total, average, maximum, and minimum values, as appropriate to each variable, shall be printed at the bottom of each column of data.

2. The facility’s monthly state operating report in the correct format. Facility shall be provided to manually enter any data that is not automatically collected by the Control and Information System.

3. Reports shall be entered into the report generation software's scheduler, and shall be run and printed to file or printer or both, as selected by the user, at the correct interval.

B. The specified report generation software shall be furnished with all required applications and macros to perform the specified reporting functions. Reports shall be created in Excel, portable document format (PDF), and email format including data-driven tabular format, pie charts, bar charts, X-Y plot charts, and dashboard reports. Refer to the Contract Documents for reports that are pre-defined by the Owner to be developed and provided under this Contract.

C. User access to the report generation from the HMI/SCADA display shall be provided by means of a single point-click from an icon/button on the operator menu bar.

D. The software shall permit arithmetic, relational, logical and statistical operations on individual or groups of data values contained in the historical database. Report generation software shall provide personnel with the following capabilities as a minimum:

1. Set up and configure reports to be generated based on schedules, e.g., a dashboard report for each shift, each day, or each month, a billing report for each month, State regulatory report for each month, etc. These reports shall be either pre-set, built-in reports from the software package or custom-built reports based on the Owner specific needs.

2. Set up and configure reports to be generated based on demand, e.g., generate ad-hoc reports manually by personnel.

3. Set up and configure reports to be generated based on events, alarms or sequence.

E. All tags in the SCADA system, including inputs, outputs, alarms, events, and calculated values, operator entered data, operator entered comments, and all other historical data shall be available in the database resident in the historical server for use in reports. In addition, the report generation software shall be capable of retrieving data to generate special reports from other data sources using OPC, ODBC.

F. Reports shall display entries indicating "no data" and "bad data" to distinguish error conditions from zero values for individual report data links.

G. The report software window shall open on top of operator HMI screens, so that, upon exiting, the previous operator screen shall be automatically displayed, and shall be fully functioning and updating.

H. Where appropriate, report data shall consist of the arithmetic average and sums of variable readings taken by the control system on scans made during the previous 24-hour period and from manually entered data.

I. Each report shall include controls to select one or more destinations for the generated report, including but not limited to: printer, pdf file saved on the historian, pdf file attached to an e-mail and automatically sent to a defined list of recipients, or posted on a secure web server or other destination(s).

3.07 SYSTEM SECURITY

A. The HMI shall use the Microsoft Windows® operating system security, and shall integrate it into its own security level access system. For example, when a user (facility personnel) logs in at an operator workstation (physically or to the SCADA terminal server via a remote desktop session) with a Windows operating system, the user must have a valid user account, consisting of a login ID and password. After Windows login, the user shall be automatically logged into the HMI and granted only those access rights associated with that user or user group. The HMI shall inherit all the benefits from the Microsoft Windows® security system in terms of password definition, domain settings, and policy settings (allowing users to access applications and resources).

B. For accessing the historian databases, the SCADA software shall use the security features offered by the Historian software. The Contractor shall coordinate with the Owner to define the number of users who need to be granted access to the historical databases for this particular security model (database roles, user accounts, user security groups, and SQL Server login ID's).

C. The HMI shall recognize who is logged onto the system and using the system at any given time, and then shall orient itself to meet the specific needs of that user, according to that user's profile. Furthermore, all user login attempts shall be logged and a complete record shall be kept as to who and when data is entered, changed, or deleted.

D. The HMI/SCADA system security model shall provide a configurable security component that can be used to restrict access, application navigation and configuration of databases or displays. Security privileges, policies, and settings shall be configured for all individual and group users, with security privilege checking at the individual workstation (where applicable) as well as across the local area network. It shall support categorization (grouping) of those users and assignment of users to more than one category. Security model and strategy shall be fully coordinated with the Owner.

E. Through appropriate password clearance, individual workstation security enable/disable, configuration or modification shall be done on-line and at any time, without rebooting the workstation software system, software platform or the computer.

F. The security software shall make items available to lock out certain aspects and features of the software product on a per group or per user basis including, but not limited to: Individual modules of the product; exiting the application; utilizing templates; runtime; configuration; mouse operations (zoom, drag and drop, mouse clicks); menu operation; starting/stopping of alarms or data logging; and filtering, editing, refreshing or exporting data; filtering, acknowledging or changing alarms; printing; switching languages; running a script; accessing windows desktop; and opening/closing graphics displays.

G. The Contractor together with the Owner shall jointly develop an overall system and software access security matrix, define user groups and allowable functions, assign personnel to groups, etc.

H. The security system shall be configured to provide the following password-based security access levels. Note that this is a general guideline for configuring the password levels. A

minimum of four (4) password levels shall be configured, from lowest to highest priorities, as determined by the Owner:

1. Observer (default)

    a. Graphic display viewing and navigation.

    b. Historical data display.

    c. Password login and logout.

    d. Observer shall be the system default security mode.

2. Operator

    a. Observer privileges.

    b. Password protected start/stop, set-point entries, alarm acknowledgements, control strategy mode changes, system activity display, etc.

3. Lead Operator/Supervisor

    a. Operator privileges.

    b. Historical data chart configuration.

    c. Report viewing, modification and exporting/printing.

    d. Task switching to the Windows operating system.

    e. Software system shut down.

    f. Windows “Task Manager” access.

4. System Administrator/Engineer

    a. All privileges.

I. The software at each workstation shall be configured to automatically open the login display upon system startup. Navigation shall be disabled until user login is successfully completed.

J. The security model shall provide for configuration of an Auto-Logout period, whereby the user is automatically logged out of the system after a specified amount of time has elapsed. There shall be an early warning message prior to the logout action. It shall be possible to optionally require a password for logging out early (so someone doesn’t log another user out against their wishes).

K. The security system at each workstation shall be configured to prevent SCADA software shut down, exit to Windows operating system or Windows server security access unless requested through the Supervisors' or System Administrator/Engineer security privileges.

L. The following features associated with the system security are also known as the “audit trail” system provided by the SCADA/HMI software. The audit trail system shall be configured as follows:

1. All workstation security activity, including violations, shall be reported in a date and time stamped format to a daily text file for review and evaluation at any time. This security text file shall have a file name indicating the date that the security file was created. It shall be possible for any text editor to edit these files.

2. The audit trail shall show the most recent data changes first when called up.

3. The audit trail shall display all of the values that were inserted, along with the user login and the date and time stamp.

4. The audit trail shall be provided with filtering (query) feature to provide date range or user names.

M. User access to the audit trail from the HMI/SCADA display shall be provided by means of a single point-click from an icon/button on the operator menu bar made by a privileged operator.

N. Each workstation shall be configured for security activity file backup and archival.

3.08 NEWORK DIAGNOSTICS

A. The network diagnostics software shall provide on-line diagnostics of all SNMP-supported devices on the control system network. The Contractor shall configure this software to provide the following features:

1. Provide graphical display(s) showing detailed status and properties of the control system network devices such as network switches (managed, unmanaged switches and hubs), PCs and thin clients, PLCs, PLC I/O modules, HMI panels, and network links.

2. Provide graphical display in the form of block diagrams.

3. Connectivity of network devices with IP addresses and active port numbers.

B. An additional display shall show the current session status (established, pending, offline) of all stations on the network. A session monitor program that automatically monitors and recovers communications shall be supplied with the system.

C. When any PLC on the Network Diagnostic display is selected, a pop-up shall be displayed listing all SCADA software database points associated with that specific PLC.

3.09 DATA MANAGEMENT

A. System configuration and management shall incorporate “versioning” of each of the files used in the project. The software shall generate reports on the resources used for each “project” (e.g., listing the files, types, etc.). Reports shall be configurable to encompass the entire project, or selected files associated with a particular application used within the project (e.g., graphics module, alarm module, etc.). The reports shall list all parts of the project, giving details as to when each file was created, modified, its size, as well as a summary of the project disk space required. The report shall contain a project summary information field for such items as: project name; project version number; author name(s); last modified by; and comments. Versioning shall include the user option to list all OPC tag names used in a project, and shall flag any points that cannot be verified.

B. System configuration and management shall include links to tools for trouble-shooting a project (e.g., network connection diagnostics, OPC server diagnostics, etc.) as well as

utilities to globally search and/or replace text throughout a project and all of its sub-documents.

C. System configuration and management shall include a centralized diagnostic area or form and support visualization of application version information; application runtime status; and connections including OPC licensing and runtime status.

D. The system redundancy components shall provide that, when the primary server goes off line, the backup server shall automatically take over. When the primary server comes back on-line, there shall be an option to automatically switch back to that server, or keep the “backup” server as the “new primary”. A global diagnostic HMI graphic display interface displaying the status of redundant systems to users across the network shall be provided for dynamic system status indication.

E. The SCADA application shall be configured for continuous or exception polling of external data sources, as appropriate. Scanning rates from servers to the PLC’s shall be set to 1.0 seconds or less (faster). Critical alarm points shall be scanned at 0.5 seconds or less (faster), where scheduled.

F. The SCADA application data “collector” (logger) modules shall include “store and forward” buffers and shall “push” historical data to the process data historian servers. In the event that a data historian server is offline, the data shall automatically buffer until the historian returns to active service. Historians shall automatically re-synchronize all data. Data “collectors” (loggers) shall be fully redundant with automatic failover and recovery and resident on each SCADA server as appropriate and consistent with the supplied software suite requirements.

G. The SCADA software shall also include, with appropriate security, HMI graphic access to PLC discrete and analog I/O and control parameter adjustments, PLC logic adjustments and PLC diagnostics through a series of pop-up control and diagnostics faceplates. The pop-up control and diagnostics graphical faceplate designs shall be fully compatible with specified PLC programming software and associated custom instructions and diagnostics libraries.

H. The system shall support and incorporate embedded video (embedded and streaming) and integrated video camera controls for facility security video or other types of video feeds. Standard static protocols such as WMV, AVI, MPEG and MP4 as well as streaming protocols such as HTTP shall be supported.

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SECTION 17500

ENCLOSURES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the control enclosures, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

B. Control enclosures shall be assembled, wired, and tested in the instrumentation subcontractor's own facilities, unless specified otherwise. All components and all necessary accessories such as power supplies, conditioning equipment, mounting hardware, signal input and output terminal blocks, and plug strips that may be required to complete the system shall be provided.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17510 – Cabinets and Panels

C. Section 17520 – Field Panels

D. Section 17550 – Panel Instruments and Accessories

E. Section 17560 –Surge Protection Devices

F. Refer to Division 16 for additional requirements for cable, circuit breakers, disconnect switches, etc.

1.03 GENERAL INFORMATION AND DESCRIPTION

A. The cabinet itself and all interior and exterior equipment shall be identified with nameplates. The equipment shall be mounted such that service can occur without removal of other equipment. Face mounted equipment shall be flush or semi-flush mounted with flat black escutcheons. All equipment shall be accessible such that adjustments can be made while the equipment is in service and operating. All enclosures shall fit within the allocated space as shown on the Drawings.

B. Either manufacturer-standard or custom cabinetry may be furnished subject to the requirements of the Contract Documents and favorable review by the Owner.

C. Due consideration shall be given to installation requirements for enclosures in new and existing structures. The Contractor shall examine plans and/or field inspect new and existing structures as required to determine installation requirements, and shall

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coordinate the installation of all enclosures with the Owner and all affected contractors. The Contractor shall be responsible for all costs associated with installation of enclosures, including repair of damage to structures (incidental, accidental or unavoidable).

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050 - Tools, Supplies and Spare Parts. In addition, the spare parts items shall be provided as specified in the individual cabinet and panel specification sections (175XX).

PART 2 -- PRODUCTS

2.01 TERMINAL BLOCKS

A. Terminal blocks shall be assembled on non-current carrying galvanized steel DIN mounting rails securely bolted to the cabinet subpanel. Terminals shall be of the screw down pressure plate type as manufactured by Phoenix Contact, Weidmuller, Wieland, Square D, or equal.

B. Power terminal blocks for both 120 VAC and 24 VDC power shall be single tier with a minimum rating of 600 volts, 30 amps.

C. Discrete signal terminal blocks shall be 2-tier with a minimum rating of 600 volts, 20 amps. One terminal block shall be used for each signal. The hot wire shall be installed on the top terminal.

D. Analog signal terminal blocks shall be 3-tier with a minimum rating of 600 volts, 20 amps. One terminal block shall be used for each signal. The + wire shall be installed on the top terminal and the shield wire shall be installed on the bottom terminal.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top (NEMA 12 cabinets only).

2. Thermostatically controlled, low noise internal air blowers (initial setpoint 75°F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. The temperature inside each enclosure containing digital hardware (i.e., cabinet, panel or console) shall be continuously monitored and shall generate an alarm to the nearest PLC if the temperature rises to an adjustable, preset high temperature. This thermostat shall be independent and separate from the thermostat used to control the temperature in the enclosure described above. Enclosure interior temperature alarm shall be displayed on the HMI.

E. Intrusion alarm switches shall be provided on all enclosures containing digital hardware and shall generate an alarm to the nearest PLC when any enclosure door is opened.

F. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal. Subject to the approval of the Engineer, a vendor's pre-engineered and prefabricated wiring termination system will be acceptable.

G. Wiring within cabinets, panels, and consoles shall be installed neatly and shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 16 of the Specifications, except that the minimum wire size for discrete signal wiring may be 16 AWG, and for analog wiring may be 18 AWG. For each pair of parallel terminal blocks, the field wiring shall be between the blocks.

H. Separate terminal strips shall be provided for each type of power and signal used within each cabinet. Where applicable, terminal strips for different voltages of discrete signal wiring shall also be separated. Terminal strips shall be labeled as to voltage and function.

I. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

J. Spare field wiring shall be bundled, tied, and labeled as specified above, and shall be neatly coiled in the bottom of the cabinet.

K. All installed spare I/O hardware shall be wired along with live I/O wiring to the field wiring terminal blocks within the cabinet.

L. A copper ground bus shall be installed in each cabinet, and shall be connected to the building power ground.

M. Interior panel wiring shall be tagged at all terminations with machine-printed self-laminating labels. Labeling system shall be Brady TLS 2200 Printer with TLS 2200®/TLS PC Link™ labels, or equivalent system by Seton or Panduit. The wire numbering system and identification tags shall be as specified in Section 16123 - Building Wire and Cable. Field wiring terminating in panels shall be labeled in accordance with the requirements of Section 16123. Where applicable, the wire number shall be the ID number listed in the input/output schedules.

N. Wires shall be color coded as follows:

Equipment Ground - GREEN

120 VAC Power - BLACK
120 VAC Power Neutral - WHITE

120 VAC Control (Internally Powered) - RED
120 VAC Control (Externally Powered) - YELLOW

24 VAC Control - ORANGE

DC Power (+) - RED
DC Power (-) - BLACK
DC Control - BLUE

Analog Signal – BLACK/WHITE or BLACK/RED

O. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

P. Enclosures with any dimension larger than 36 inches shall be provided with 120-volt duplex receptacles for service equipment and LED service lights. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

Q. Where applicable, enclosures shall be furnished with red laminated plastic warning signs in each section. The sign shall be inscribed "WARNING - This Device Is Connected to Multiple Sources of Power". Letters in the word "WARNING" shall be 0.75 inch high, white.

R. The interconnection between equipment and panel shall be by means of flexible cables provided to permit withdrawal of the equipment from the cabinet without disconnecting the plugs.

3.02 PAINTING/FINISHING

A. All steel enclosures shall be free from dirt, grease, and burrs and shall be treated with a phosphatizing metal conditioner before painting. All surfaces shall be filled, sanded, and finish coated by spraying a 1-2 mil epoxy prime coat and smooth, level, high grade textured finish between flat and semi-gloss shine. The colors shall be selected by the Owner from a minimum of six color samples provided. Refer to Division 9 for additional requirements.

B. Materials and techniques shall be of types specifically designed to produce a finish of superior quality with respect to adherence, as well as impact and corrosion resistance.

C. Panels fabricated from stainless steel shall not be painted.

D. Panels fabricated from non-metallic materials (e.g., FRP) shall be gel-coated and shall not be painted.

3.03 INSTALLATION

A. Refer to Section 17000 for additional requirements.

- END OF SECTION -

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SECTION 17510

CABINETS AND PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the cabinets and panels, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17100 – Control and Information System Hardware, General

C. Section 17500 – Enclosures, General

PART 2 -- PRODUCTS

2.01 CABINETS AND PANELS

A. Cabinets and panels shall be formed or welded construction, reinforced with Unistrut, Powerstrut, or equal to facilitate mounting of internal components or equipment. Sufficient access plates and doors shall be provided to facilitate maintenance and testing of the cabinet's equipment. Doors shall be removable. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common-keyed locks.

B. Cabinets and panels shall be minimum 14 USS gauge. Cabinets and panels with any dimension greater than 36 inches shall be 12 USS gauge.

C. Cabinets and panels located inside buildings, but located in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction, or as specified or shown on the Drawings for hazardous area classification (Class, Division, Group), or submersible (NEMA 6) applications. Epoxy coated cast copper-free aluminum construction shall also be acceptable for NEMA 4, 6 and 7 applications. Cabinets located in storage/feed areas for chlorine or other applicable corrosive chemicals shall be of non-metallic construction, rated NEMA 4X, and fully compatible with the associated chemical.

D. Cabinets and panels within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

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E. Cabinets and panels shall have doors on the front and shall be designed for front access. NEMA 12 cabinets shall be fitted with three-point door latches. Doors for NEMA 4X cabinets shall be all stainless steel with piano hinges and three-point latches. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

F. Panels and cabinets located outside fence-secured areas shall be fitted with padlockable latch kits.

G. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

H. Panels with any dimension greater than 36 inches that contain a programmable controller (PLC) shall be provided with a folding laptop programmer shelf on the inside of the door. When deployed, the laptop shelf shall not be greater than 48 inches above finished floor. Laptop shelf shall be fitted to door with factory applied weld-studs. Weld discoloration and enclosure penetrations will not be accepted.

I. Unless otherwise noted, panel-mounted control devices (OIUs, hand switches, etc.) requiring operator access shall be mounted between 48 and 60 inches above the floor or work platform.

J. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman or Saginaw Control and Engineering (SCE). The Contractor may optionally provide cabinets that are custom-fabricated by the instrumentation subcontractor or by a reputable panel fabrication shop acceptable to the Engineer.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17520

FIELD PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the field panels, with all spare parts, accessories, and appurtenances as specified or shown.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

PART 2 -- PRODUCTS

2.01 FIELD PANELS

A. Field panels for outdoor service shall be suitable for wall or pipe mounting. Panels shall have the following features:

1. Type 316L stainless steel NEMA 4X construction unless located in chlorine environments. Chlorine environment shall be nonmetallic NEMA 4X construction.

2. Hinged and foamed-in-place continuous gasketed door(s). Door material shall match enclosure and shall have piano hinge(s) and three-point latches.

3. Field panels located outside fence-secured areas shall be fitted with staple and hasp. Provide padlock and coordinate keying with Owner.

4. Thermal insulation and thermostatically controlled space heaters where required to prevent condensation or maintain environmental conditions for installed components.

5. External sun shields or shades constructed of the same materials as the associated enclosure, unless otherwise specified. Sun shield or shade shall be fitted to enclosure supports and not to enclosure. Sunshield or shade shall have a slightly sloped top to shed water and shall extend past the front of the enclosure by at least 6 inches and extend down the side and back of enclosure.

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B. All external sample/process piping, including valves and appurtenances, shall be insulated with weather-proof insulation and heat-taped to prevent freezing. Heat taping shall be thermostatically controlled and self-regulating, and shall adjust its heat output to the temperature of the lines. Heat tape shall be powered from a GFCI circuit from within panel, unless otherwise shown or specified.

C. Field panels shall be adequately sized to house instruments, power supplies, surge protection, and appurtenant equipment required for operation. Sufficient space shall be provided for servicing instruments without removal of equipment from the enclosure.

D. Field panels shall be as manufactured by Hoffman, Saginaw Control and Engineering (SCE), or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17550

PANEL INSTRUMENTS AND ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the panel instruments and accessories, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All equipment mounted on the face of a panel shall conform to the same NEMA rating specified for the panel construction.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. One of each type of panel mounted equipment (i.e., indicators, signal converters, etc.) provided under this Contract.

2. Five of each type of interposing relay provided under this Contract.

PART 2 -- PRODUCTS

2.01 ELECTRONIC INDICATORS

A. Electronic indicators shall be 3.5 or 6 digit, as appropriate, with 0.56" high red LED display. Indicators shall be provided with nameplate and scale calibrated to match the calibration of the primary element. The unit shall be designed primarily for use with 4-20 mA current loop signal circuits. Indicator operating voltage shall be 115 VAC 10%, 60 Hz. Indicator controls shall include three (3) front-panel pushbuttons for modifying alarm values and other indicator setup. Two (2) form-C relays shall be provided for each indicator. Relay contact outputs shall be rated 5A, 120/240 VAC, resistive load. Where required, a regulated and isolated 24 V excitation power supply shall be provided. Indicators shall be suitable for indoor or outdoor service as required and shall have the same NEMA enclosure rating as the associated enclosure. Indicators shall be Red Lion Model IMP or APLCL, or equivalent by Precision Digital.

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2.02 SIGNAL CONVERTERS

A. Signal converters shall be provided as required to provide control functions and to interface instrumentation and controls, equipment panels, motor control centers and other instrumentation and controls supplied under other Divisions to the controls provided herein.

B. General Requirements – Converters shall be of the miniature type, utilizing all solid state circuitry suitable for mounting within new or existing cabinetry. Where sufficient cabinet space is not available, sub panels or supplemental enclosures shall be provided. Power supply shall be 120V, 60 hertz where required by the converter. Repeatability shall be 0.1% of span, deadband shall be 0.1% span, maximum. Where specific converters are not listed, but are required to interface with the process control system, they shall comply with the general requirements stated herein.

C. Current to Current Isolators – Current to current isolators shall be furnished where necessary to provide an isolated current loop, calculations or signal amplification between the plant process control system and instrumentation and control loops. Isolators shall be sized such that resistance of existing loops shall not exceed maximum rated resistance. Isolators shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

D. Voltage to Current Transducers – Voltage to current (or current to voltage) transducers shall convert a voltage signal of one magnitude to a 4-20 milliamp DC current signal. The output current shall be directly proportional to the input signal voltage. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

E. Frequency to Current Transducers – Frequency to current transducers shall convert pulse-rate and pulse-duration signals to 4-20 mA, 24 VDC analog signals. Converters shall include field-adjustable input frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5100 as manufactured by AGM, or equivalent by Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

F. Current to Frequency Transducers – Current to frequency transducers shall convert 4-20 mA, 24 VDC analog signals to pulse-rate and pulse-duration signals. Converters shall include field-adjustable output frequency range. Converter power shall be 120 VAC, 60 hertz. Transducers shall be sized such that loop resistance does not exceed maximum rated resistance. Transducers shall be suitable for signal transmission via leased telephone lines. Transducers shall be Series 5016 as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

G. Integrators – Integrators shall be provided as interchangeable plug-in modules with zero and span adjustment available on the front plate of the units. Output shall range from 0 to 0.1 through 0 to 10 pulses per second. Accuracy shall be $\pm$ 0.1% of input span.

Integrators shall convert linear analog signals to pulse rate and provide a solid-state output. Integrators shall be as manufactured by AGM Electronics, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

H. Electronic Switches (Alarm Relays) – Electronic switches shall be furnished with a calibrated dial for adjusting set points. The input to the switch shall be 4-20 mADC, and the set point shall be adjustable over the full range. Unless otherwise noted, the dead band shall be fixed at less than 2 percent of span. The set point stability shall be ±0.1% per degree F. The repeatability shall be ±0.1% of span. The units shall be furnished with SPDT relays rated at 10 amperes at 115 VAC. Electronic switches shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

I. RTD to Current Signal Converters – RTD to current signal converters shall convert a 3-wire RTD input signal to an isolated 4-20 mADC output signal. Each converter shall operate from a 120 VAC power source. Accuracy shall be 0.10 percent of span or better. Calibrated span of each converter shall be as indicated on the instrument list. The Contractor shall coordinate calibration of the signal converters with existing RTD elements. The signal converters shall be furnished in the manufacturer's standard enclosure for installation in an existing indoor electrical cabinet. Signal converters shall be as manufactured by AGM, Moore Industries, Rochester Instrument Systems (RIS), Phoenix Contact, Weidmuller, Acromag, or equal.

J. Interposing Relays – Where required to interface between motor control centers, equipment controls, and control panels, interposing relays and associated control wiring circuitry shall be furnished and installed to provide the monitoring and/or control functions specified herein. Interposing relays shall be small format type, DPDT, minimum 10 amp, 120 VAC contact rating. Relay coils shall be 120 VAC or 24 VDC as required. Relays shall have a flag indicator to show relay status, a pushbutton to allow manual operation of the relay, and an internal pilot light to indicate power to the coil. Relays shall be as manufactured by Square D, Potter & Brumfield, Allen-Bradley, or equal.

K. Timing Relays – Timing Relays (TR) shall be the general purpose plug-in type, Type JCK as manufactured by Square D Company, Cutler-Hammer/Westinghouse Electric Corporation equivalent, Allen-Bradley equivalent, or equal. Timing relays shall be electronic type with 120 VAC coils unless otherwise specified or indicated on the Drawings. Timers shall be provided with a minimum of two SPDT timed output contacts and instantaneous contacts where required. Contact ratings shall be the same as for interposing relays as specified above.

L. Intrinsically Safe Relays and Barriers – Intrinsically safe relays and barriers shall be provided where required to interface with equipment such as float level switches that are located in NFPA-classified hazardous areas. Intrinsically safe relays and barriers shall be FM approved and shall be manufactured by Pepperl and Fuchs, Crouse Hinds, Square D, or equal.

2.03 ACCESSORIES

A. Control operators such as pushbuttons (PB), selector switches (SS), and pilot lights (PL) shall be Cutler-Hammer/Westinghouse Type E34, Square D Company Type SK, or equal. Control operators shall be 30.5 mm, round, heavy-duty, oil tight NEMA 4X corrosion resistant.

B. Pushbuttons shall be non-illuminated, spring release type. Pushbuttons shall include a full guard. Panic stop/alarm pushbuttons shall be red mushroom type with manual-pull release. Selector switches shall be non-illuminated, maintained contact type. Pilot lights shall be of the proper control voltage, push-to-test LED type with light lens colors as specified below.

Color	Function
Red	Running (Open)
Green	Stopped or Off (Closed)
Amber	Fault
White	Other

C. Control operators shall have legend plates as specified herein, indicated on the Drawings, or otherwise directed by the Engineer. Legend plates shall be plastic, black field (background) with white lettering. Engraved nameplates shall be securely fastened above each control operator. If adequate space is not available, the nameplate shall be mounted below the operator.

D. Control operators for all equipment shall be as specified herein and of the same type and manufacturer unless otherwise specified or indicated on the Drawings.

E. Alarm horns shall be general-purpose type, panel-mounted, and shall be suitable for indoor or weatherproof service, as required. Power supply shall be either 115 VAC or 24 VDC. Horns shall be capable of producing 100 dB at 10 feet, and shall have adjustable volume. Horns shall be Vibratone series as manufactured by Federal Signal Corporation, McMaster-Carr equivalent, Edwards Signaling Company equivalent, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17560

SURGE PROTECTION DEVICES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install and place in satisfactory operation the surge protection devices (SPDs) as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

1.03 GENERAL INFORMATION AND DESCRIPTION

A. All surge protectors of each type provided under this Contract shall be furnished by a single manufacturer.

1.04 TOOLS, SUPPLIES AND SPARE PARTS

A. The following specific spare parts items shall be provided:

1. Five of each type of surge protection device provided under this Contract.

PART 2 -- PRODUCTS

2.01 SURGE PROTECTION, GENERAL

A. All electrical and electronic elements shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical systems.

B. Manufacturer's Requirements: All surge protection devices shall be manufactured by a company that has been engaged in the design, development, and manufacture of such devices for at least 5 years. Acceptable manufacturers shall be Phoenix Contact, Weidmuller, Transtector, or equal.

C. Surge protection device installations shall comply with UL 94, the National Electric Code (NEC), and all applicable local codes.

D. Surge protection devices shall be installed as close to the equipment to be protected as practically possible.

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E. Device Locations: As a minimum, provide surge protection devices at the following locations:

1. At any connections between ac power and electrical and electronic equipment, including panels, assemblies, and field mounted analog transmitters.

2. At both ends of all analog signal circuits that have any portion of the circuit extending outside of a protecting building.

3. At both ends of all copper-based communication cables which extend outside of a building, including at field instruments and the field side of analog valve position signals.

4. On all external telephone communication lines.

2.02 AC POWER PROTECTION

A. Surge protection device assemblies for connections to AC power supply circuits shall:

1. Be provided with two 3-terminal barrier terminal strips capable of accepting No. 12 AWG solids or stranded copper wire. One terminal strip shall be located on each end of the unit.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements. The surge protection device shall be provided with provisions for mounting to interior of equipment racks, cabinets, or to the exterior of freestanding equipment.

3. Be constructed as multistage devices consisting of gas tube arrestors, high energy metal oxide varistors, or silicon avalanche suppression diodes. Assemblies shall automatically recover from surge events, and shall have status indication lights.

4. Comply with all requirements of UL 1449, latest edition.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Have the following characteristics:

a. Maximum Continuous Operating Voltage: 150VAC
b. Maximum Operating Current: 20 amps
c. Ambient Temperature Range: -20 degrees C to +65 degrees C
d. Response Time: 5 nanoseconds

2.03 ANALOG SIGNAL CIRCUIT PROTECTION

A. Surge protection device assemblies for analog signal circuits shall:

1. Have four lead devices with DIN Rail mounting.

2. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

3. Be constructed as multistage devices consisting of gas tube arrestors and silicon avalanche suppression diodes. Gas tube arrestors and diodes shall be separated by a series impedance of no more than 20 ohms. Assemblies shall automatically recover from surge events.

4. Comply with all requirements of UL 497B.

5. Be able to withstand a peak surge current of 10,000 amps based on a test surge waveform with an 8-microsecond rise time and a 20-microsecond exponential decay time, as defined in UL 1449.

6. Limit line-to-line voltage to 40 volts on 24VDC circuits.

7. Have the following characteristics:

a. Maximum Continuous Operating Voltage: 28VDC
b. Ambient Temperature Range: -20 degrees C to +65 degrees C
c. Response Time (Line-to-Line): 5 ns

2.04 COMMUNICATION CIRCUIT PROTECTION

A. Surge protection devices for copper-based data communication circuits shall:

1. Be designed for the specific data communication media and protocol to be protected (i.e. telephone, serial, parallel, network, data highway, coax, twinaxial, twisted pair, RF, etc.).

2. Provide protection of equipment to within the equipment's surge withstand levels for applicable standard test wave forms of the following standards:

a. IEC 60-1 / DIN VDE 0432 part 2
b. CCITT K17 / DIN VDE 0845 part 2
c. IEEE C62.31

3. Have a nonflammable enclosure that meets or exceeds UL 94 V0 flammability requirements.

4. Provide automatic recovery.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17500 for additional requirements.

- END OF SECTION -

SECTION 17600

INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, test and place in operation process instrumentation as scheduled herein, as shown on the Drawings and as specified. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of this Specification and the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract, except where noted otherwise.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. It is the Contractor's responsibility to ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 –Control and Information System Scope and General Requirements

B. Section 17698 – Instrumentation and Control System Accessories

C. Instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

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C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Floating outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -15 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz alternating current power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.02 ANALYTICAL INSTRUMENTS

A. Analyzers shall be industrial grade, suitable for continuous and automatic on-line analysis of the required parameter under the conditions indicated and shall produce a 4-20 milliampere transmission signal proportional to the measured variable. Transmission signal output shall be electrically isolated. Liquid samples shall not pass through housings containing analyzer electronics. Equipment shall operate satisfactorily in an ambient temperature range of minus 20 to plus 50 degrees C and 99 percent relative humidity. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.

B. All enclosures shall be suitable for wall or pipe stand mounting. Indication in process units and calibration facilities shall be provided at the analyzer. Process fluid temperature will be within a range of 5 to 30 degrees C.

C. Sample assemblies shall be suitable for submersion or flow-through as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.

D. Each analyzer requiring reagents and/or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.

E. The Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.

F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in AWWA "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The Contractor shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter aluminum pipe stands welded to a 10-inch square 1/2-inch thick aluminum base plate unless shown adjacent to a wall or otherwise noted. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The Contractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation tests, inspection, and calibration requirements specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or

commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

2. The Contractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

B. Field Instrument Calibration Requirements

1. The Contractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The Contractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the Contractor shall perform a loop check where applicable. The Contractor shall submit final loop test results with all

instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

SECTION 17635

ROTAMETERS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all rotameters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.01 ROTAMETERS

A. Rotameters shall consist of a float chamber, tapered float, and a measuring ring.

B. Rotameters shall have the following specifications:

1.	Process Fluid Temperature:	32° F to 110° F
2.	Accuracy:	+/- 2.0% of full scale
3.	Repeatability:	0.5% of full scale

C. The body material shall be 316 stainless steel. Wetted parts shall be as follows:

1.	Float:	316 stainless steel minimum; or compatible with process fluid
2.	Glass Tube:	Borosilicate glass
3.	O-Rings:	Viton minimum; or compatible with process fluid
4.	Others:	Compatible with process fluid

D. A graduated metal scale plate shall be provided for flow indication. A graduated metal scale plate shall be provided for flow indication. The indicator shall be large, easy to read, and calibrated in gallons per hour.

E. A latching reed flow switch shall be provided integral to the rotameter that shall activate on loss of flow through the rotameter. A dry contact output shall be required for remote indication.

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F. Attachment to the piping shall be as shown on the Contract Drawings.

G. Rotameters shall be as manufactured by Brooks, Fischer & Porter, King Instruments, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

SECTION 17640

TURBINE WATER FLOWMETERS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all turbine water flowmeters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.01 TURBINE WATER FLOWMETER

A. Turbine flowmeter shall have lead-free bronze body, ryton rotor and 316 stainless steel rotor shaft with ceramic rotor radial bearings. The meter shall have integral 316 stainless steel straightening vanes and a nose cone in the inlet side. O-ring seals shall be Buna-N. Flowmeter shall have flange end connections, 4-bolt, round.

B. Meter shall be rated for a maximum of 150 psi service. Meter accuracy shall be ±1.5% of full range. Repeatability shall be ± 0.25%. The flow meter shall be provided with an integrally mounted analog flow transmitter to convert meter mechanical motion into a pulse signal output and analog output. Analog output signal shall be 4-20 mA and linearly proportional to the rate of flow through the meter. Analog output shall be isolated 4-20 mA signal output to be connected to the Plant Control System for remote monitoring purposes. The pulse output signal shall be converted to square wave signal that is available as an open collector transistor output. The flow transmitter shall be a two-wire loop powered device and shall receive 10 - 36 VDC supply voltage from the digital display indicator/batching unit as specified below. Flow transmitter shall be NEMA 4X rated. All unit of measure shall be in Gallons.

2.02 DILUTION WATER BATCH CONTROLLER

A. Dilution water batch controller shall be a microprocessor-driven instrument which includes a digital display for totalized flow, accumulated total flow, and instantaneous rate of flow. The controller shall also control valves, motors, and other process control devices. The

controller shall accept pulse output from the flow transmitter and shall convert pulse count to volumetric flow display. Controller display shall be 7-digit LED with floating decimal. Pushbutton shall be provided to toggle between flowrate and totalized flow indication. Flowrate shall be displayed in gallons per minute and totalized flow in gallons. Front panel mounted pushbutton shall be provided to reset display number. Keypad shall also be provided for the operator to enter the number of gallons to be used in batch control. The controller shall include two relay outputs with contact rated 3A, 120 VAC for control of external batching equipment. Setup shall be accomplished through menu-driven software in the unit. Setup and start/stop control shall be by front-panel mounted pushbuttons. Display shall operate on 120 VAC, 60 Hz, single phase power. Accuracy shall be ±0.3%. The controller shall be mounted in an enclosure as shown on the Drawings. Controller shall be IP65/NEMA 4X rated.

B. The associated dilution water solenoid valve shall be controlled by the batch controller to energize and de-energize based on a pre-set (adjustable) volume of dilution water fed into the storage tank. The batch controller shall totalize dilution water flow as seen from the turbine flow meter. The batch controller shall energize the solenoid valve to feed water to the tank and shall de-energize the solenoid valve when the pre-set volume of water has been sent to the tank.

C. Turbine Flowmeter shall be the Recordall Turbo Meter Series complete with flow transmitter Model HR-LCD 4-20, the Batch Controller Model PC-200 Panel Mount Series by Badger Meter, Inc., or equivalent by Hoffer Flow Controls, Inc.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of Specifications

- END OF SECTION -

SECTION 17650

PRESSURE GAUGES

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

C. Section 17698 – Instrumentation Accessories

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".

B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.

C. Features

1. Mounting: ½" NPT, lower stem mount type
2. Accuracy: 0.5% full scale
3. Case: Solid front, black phenolic material
4. Dial: White background and black letters
5. Glass: Shatterproof
6. Blow-out protection: Back
7. Pressure element: stainless steel bourdon tube
8. Movement: Stainless steel, Teflon coated pinion gear and segment
9. Gaskets: Buna-N

D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid

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shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.

F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 17698 - Instrumentation and Control System Accessories.

G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation stainless steel ball valve shall be provided for each gauge assembly.

H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3.

- END OF SECTION -

SECTION 17670

LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

PART 2 -- PRODUCTS

2.01 LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

A. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5 inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings. Float switches shall be Model ENM as manufactured by Flygt, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

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SECTION 17675

PRESSURE SWITCHES

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17600 - Unpowered Instruments, General

PART 2 -- PRODUCTS

2.01 PRESSURE SWITCHES

A. Pressure, vacuum, and differential pressure switches shall be single or dual action with an adjustable setpoint for the process requirement and/or as specified herein. Switches shall be diaphragm or piston operated and activate S.P.D.T. snap action switches on increasing or decreasing pressure. Minimum differential shall be less than 10 percent of the range. Deadband shall be adjustable. Allowable surge pressure shall be a minimum 1.5 times the range. Each pressure switch shall have visible scale.

B. Pressure switches shall have a contact rating of 10 amperes at 120 volts AC. Pressure switches shall be in NEMA 4X enclosures. Switches shall have a repeatable accuracy of 1 percent of range. Pressure switches shall be isolated from the process fluid by a diaphragm seal or an isolation ring in locations as shown on the Contract Drawings and/or as specified. Wetted parts materials shall be compatible with the process fluid for corrosion resistance. Pressure switches shall be manufactured by ASCO, SOR, Inc., Ashcroft, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600 Part 3.

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- END OF SECTION -

SECTION 17698

INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the instrumentation and control system accessories with all spare parts, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Instruments, General

C. Section 16902 – Electric Controls and Relays

PART 2 -- PRODUCTS

2.01 INSTRUMENTATION AND CONTROL SYSTEM ACCESSORIES

A. General: Accessories include various items of equipment that may be required in the system but are not scheduled. Accessories are shown on details, flow sheets or plans. Accessories are also called out in specifications for scheduled instruments and in the installation specifications. It is not intended, however, that each piece of hardware required will be specifically described herein. This subarticle shall be used as a guide to qualify requirements for miscellaneous hardware whether the specific item is described or not.

B. Process Tubing: Process tubing shall be 1/2 x 0.065-inch seamless, annealed, ASTM A-269 Type 316L stainless steel with Type 316 - 37 degrees stainless steel flared fittings or Swagelock or Parker-CPI flareless fittings.

C. Power, Control and Signal Cables: Power, control and signal wiring shall be provided under Division 16 of the Specifications.

D. Chemical Diaphragm Seals:

1. Diaphragm seals shall be provided for isolation of pressure gauges, switches and transmitters attached to systems containing chemical solutions or corrosive fluids. As a minimum, seals shall be of all 316 stainless steel construction. In general, diaphragms shall be 316L stainless steel for operating pressures at or above 15 psi and elastomers for operating pressures below 15 psi. However, all components shall be non-reactive with the process fluid in all cases. Refer to the Process Control System Instrument Lists for specific materials requirements.

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2. Seal shall have fill connection, 1/4-inch NPT valved flush port and capable of disassembly without loss of filler fluid. Where specified, diaphragm seals shall comply with the above requirements and shall be provided with 316 SS factory filled capillaries.

3. Seals shall be Helicoid Type 100 HA, Mansfield & Green, Ashcroft, or equal.

E. For solids bearing fluids, line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the associated pressure sensing instrument(s).

1. Full Line Size Isolating Ring Seals

a. Where indicated, the sensor body shall be full line size wafer design.

b. Full line size isolating ring seals shall have 316 stainless steel housing and assembly flanges and Buna N flexible cylinder lining for in line mounting. The wafer shall have through bolt holes or centerline gauge for positive alignment with the associated flanged piping. Gauge or readout shall be oriented for viewing.

c. The captive liquid chamber and associated instrument(s) shall be furnished with threaded drain tap and plug. Manufacturer shall furnish seals with a quick-disconnect-type fitting for field disassembly and reassembly, however, seal and instruments shall be factory assembled prior to arriving at the job site

d. Isolating ring seals shall be RED Valve Series 40, Ronningen Petter Iso Ring, Moyno RKL Series W, Onyx Isolator Ring, or equal.

2. Tapped Isolating Ring Seals

a. Where indicated, pressure shall be sensed via a minimum 1-1/2" diameter spool type isolating ring seal mounted on a 1-1/2" pipe nipple at 90 degrees from the process piping.

b. An isolation ball valve shall be provided between the process piping and the ring seal, and a cleanout ball valve shall be provided between the ring seal and the atmosphere. The factory assembled and filled pressure instrument shall be back or side mounted to the ring seal such that the gauge or readout may be viewed normally.

c. Tapped isolating ring seals for solids service shall be Red Valve Series 42/742, Ronningen Petter Iso Spool, Onyx Isolator Ring, or equal.

F. Filling Medium: The filling medium between instruments, isolating ring seals and diaphragm seals shall be a liquid suitable for operation in an ambient temperature ranging from -10°F

to +150°F. Filling medium shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

G. Isolation Valves: Isolation valves shall be 1/2 - inch diameter ball valves with 316 stainless steel body, 316 stainless steel ball, except that materials of construction shall be suitable for the associated process fluid where applicable (i.e., chemical service).

2.02 ALARM ANNUNCIATION DEVICE

A. Sirens:

1. For Class I, Division 2 areas and non-hazardous areas:

a. Provide NEMA 4X and Class I, Division 2 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.

b. Alarm horn shall be the SelecTone 302GCX series with UTM tone module as manufactured by Federal Signal Corporation.

2. For Class I, Division 1 areas:

a. Provide NEMA 4X and Class I, Division 1 rated alarm horn capable of 32 selectable warning tones. Coordinate tone selection with Owner. Volume shall be field adjustable between 0 and 114 dBA measured at 10 feet.

b. Alarm horn shall be the SelecTone 302X series with UTM tone module as manufactured by Federal Signal Corporation.

B. Strobe Lights:

1. Strobes located within the same room, or otherwise visible from any shared frame of view, shall be synchronized per the requirements of NFPA 72. Strobes shall by synchronized by the strobe manufacturer’s synchronization module. Strobe circuits shall not exceed the continuous duty current rating of the synchronization module. Synchronization module shall be Federal Signal Model SSM, Edwards Signaling Model EG1M-RM, or equal.

2. For Class I, Division 2 areas and non-hazardous areas:

a. Provide red strobe status indicator. Unit shall be rated NEMA 4X and Factory Mutual approved for a Class I, Division 2, Group D area. Unit shall contain a durable polycarbonate housing and be surface mount. Unit shall be UL listed. Strobe shall be powered from 24VDC.

b. Alarm strobe shall be Federal Signal Model 225XST, Edwards Signaling Model 116DEGEX-FJ, or equal.

3. For Class I, Division 1 areas:

   a. Provide red explosion proof dome covered strobe unit rated NEMA 4X and Factory Mutual certified for a Class I, Division 1, Group D area. Unit shall be UL listed. Strobe shall be powered from 24VDC.

   b. Alarm strobe shall be Federal Signal Model 27XST, Edwards Signaling Model 116DEGEX-FJ, or equal. Compatible mounting hardware by the strobe manufacturer shall be furnished.

4. Lens color shall be as indicated on the Drawings.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

SECTION 17700

POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The instrumentation subcontractor shall furnish, install, test and place in operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments that require power (120 VAC or 24 VDC loop power) to operate. The Contractor may elect to install primary elements (flowmeters, etc.) on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

C. Section 17600 – Unpowered Instruments, General

D. Section 17698 – Instrumentation and Control System Accessories

E. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

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PART 2 -- PRODUCTS

2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures which are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Engineer, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

2. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

3. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

B. Field Instrument Calibration Requirements

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. If the manufacturer's recommendations require calibration, each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

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SECTION 17702

INSERTION FLOW METERS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one sensor installation tool for installation, profiling and maintenance of the sensor.

PART 2 -- PRODUCTS

2.01 INSERTION FLOW METER SYSTEMS

A. The insertion flow meter shall consist of an electromagnetic averaging sensor (multi-electrode design) and a converter unit. The sensor shall automatically correct for shifting velocity profiles in the pipe by constantly obtaining an area weighted mean average. The sensor shall have reverse flow measurement capability. The repeatable, stable measurement of full pipe profile (across the entire flow profile) shall compensate for variable flow profiles, including swirl and turbulent conditions. Single point insertion or pressure port sensors shall not be acceptable.

B. Each meter shall be furnished with a hot tap full profile insertion assembly. Assembly shall include a full port 2 inch, 316SS ball valve, silicone rubber compression seal and 316SS insertion rods.

C. The sensor measuring electrodes and reference ground electrodes shall be constructed of 316 SS to ensure that no corrosion occurs by the passing fluid. Sensor shall have an epoxy coating over the stainless steel to further aid against corrosion or buildup. Sensor shall not be damaged by extended operation at partially full or empty pipe conditions.

D. The flow sensor shall meet or exceed the following:

1. Forward: ± 1% of reading ± 0.3 ft/s (± 0.09 m/s)

2. Reverse: ± 1% of reading ± 0.3 ft/s (± 0.09 m/s)

3. Linearity: 0.3% of range

4. Repeatability: 0.2% of reading

5. Operating Temperature: -10 to 60°C

6. Operating Pressure: Up to 250 PSI

E. The converter (transmitter) shall be microprocessor-based with a keypad for instrument set up and LCD displays for the totalized flow, flow rate engineering units, settings, and fault conditions. The converter power supply shall be 120 VAC, 60 Hz. The converter shall power the flow sensor and provide an isolated 4-20 mA flow proportional output and HART communication protocol output. The output shall be split for forward and reverse flow: 4-12 mA = reverse flow; 12 mA = zero flow, 12-20 mA = forward flow. Converter enclosure shall be NEMA 4X (IP67) rated. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be remotely mounted as shown in the Drawings and/or as specified.

F. Each system shall be factory calibrated and assigned a calibration constant or factor and factory settings matching the sensor to be entered into the associated converter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. Certification of calibration shall accompany each flow sensor.

G. The converter shall have built-in flow meter verification feature for troubleshooting purposes.

H. The converter shall have two separate and fully programmable alarm outputs to indicate high/low flow rates, empty pipe, fault conditions, flow directional indication, and over-range conditions.

I. The signal cable shall be abrasive resistant and PVC jacketed cable. The sensor cable shall be permanently bonded to the sensor.

J. Insertion flow meter systems shall be the 394L and a PROCOMM Converter as manufactured by McCrometer or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3, for further requirements.

- END OF SECTION -

SECTION 17740

ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one hand-held programmer under this Contract to calibrate and configure the level controllers specified herein. The programmer shall be furnished complete with battery plus one spare battery, carrying case and accessories. Programmer shall be furnished by the level instrument manufacturer, and shall be fully matched to the instrument furnished.

PART 2 -- PRODUCTS

2.01 ULTRASONIC LEVEL CONTROLLERS

A. Each ultrasonic level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the level of process liquids or solids as shown on the Drawings and/or as specified herein. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the tank flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of 316 stainless steel material. Sensor mounting thread shall be 1" NPT.

C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. The sensor shall also be fully submersible and resistant to corrosive materials. Sensor accuracy shall be a minimum of 0.25 percent of level measurement range, and include integral temperature compensation with an accuracy

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of 0.09% of range. Resolution shall be at least 0.1 percent of full range or 0.08 inches, whichever is greater.

D. The transmitter shall be programmable by using a hand-held programmer. Display shall be LCD with backlighting, shall have the capability to display a minimum of 4 characters at one time, and shall be shielded from direct sunlight. The units shall have as a minimum, the required number of programmable set points to perform the functions specified. Each set point shall operate a set of contacts rated at 5 amps, 250 VAC, non-inductive.

E. The transmitter shall compensate for changes in temperature and air density. The controller shall be capable of performing the following functions: level monitor, both linear and nonlinear level to flow relationships, volumetric, open channel flow monitoring, differential control, and control of up to 6 pumps, alarms, monitor pump runtime and pump sequencing. Output level signal shall be linear, isolated 4-20 mA DC. Power requirement for the transmitter shall be 120 VAC, 60 Hz. The units shall have a NEMA 4X stainless steel or nonmetallic enclosure.

F. Ultrasonic level measurement system shall be the HydroRanger 200/Echomax Series Transducers by Siemens/Milltronics, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where two or more ultrasonic level instruments are mounted in close proximity to each other, the transmitters shall coordinate operation to prevent interference from adjacent units. Coordination shall be accomplished via an interconnecting communication cable furnished by the manufacturer.

B. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.

C. Refer to Section 17600, Part 3 of the specifications for additional requirements.

- END OF SECTION -

SECTION 17745

RADAR LEVEL MEASUREMENT SYSTEMS

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the radar liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 RADAR LEVEL CONTROLLERS

A. Each radar level monitoring system shall include one radar level transmitter sensor with microprocessor-based signal conditioning. The system shall be capable of measuring liquids with dielectric constant greater or equal to 1.5.

B. Process connection shall be a minimum 4” ASME B16.5 Class 150 raised face flanged connection. Instrument flange connection shall be compatible with the process connection and its material of construction shall be compatible with the process liquid. Contractor shall be responsible for coordinating flange dimension, tank nozzle dimensions, and antenna length with the tank design and the instrumentation supplier as required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process liquid and the tank flange connection.

C. The antenna shall be non-contact, horn (cone-shaped), teardrop-shape type, or encapsulated type. Antenna material shall be 316 stainless steel, PTFE, polypropylene, or non-metallic to be compatible with process liquid. Antenna shall be suitable for operating temperature range of -40 to 175 ºF and pressure of full vacuum to 155 psi. Antenna extension shall be provided as necessary. For concrete or open tanks, frequency shall be otherwise as approved by FAA and/or FCC for free air, outdoors operation.

D. Radar level measurement system shall operate on the frequency modulated continuous wave (FMCW) radar signaling technology. Sensor accuracy shall be a ± 2 mm. Resolution shall be ± 0.04”. Repeatability shall be ± 0.04 inch.

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E. The system shall include an integrally or remotely mounted signal converter (transmitter) with LED display and keypad that allows complete field configuration of all settings and control modes of the system. The transmitter shall compensate for temperature and air density. The unit shall provide level monitoring and volumetric calculation. Output level signal shall be linear, isolated 4-20 mA DC superimposed with a HART digital signal. The transmitter shall be a loop-powered, 2-wire device. The units shall have as a minimum, the required number of programmable set points to perform the functions specified.

F. The units shall have a NEMA 4X and 6P, aluminum alloy with polyester-epoxy coated enclosure or equivalent Ingress Protection IP 66/67/68. Integrally mounted transmitter and antenna unit shall have FM approvals for IS Class 1, Division 1, and Group A through G.

G. For outdoor installations, the instrument shall be provided with weather protection cover.

H. Radar level measurement system shall be Krohne Model 5200C/F Series; E&H Model Micropilot FMR 51 Series; Rosemount Series 5400; or equivalent by Siemens.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17784

POINT LEVEL CONDUCTIVE LEVEL SWITCHES

(ALTERNATE BID)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the conductance-actuated, probe-type liquid level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

PART 2 -- PRODUCTS

2.01 POINT LEVEL CONDUCTIVE SWITCH

A. Point level conductive switch shall consist of a high (or low) liquid level sensing probe and a reference probe, sensing probe fitting, and control relay. Probes shall be metallic solid rods extended down into the process liquid. Probe fitting housing shall be die-cast aluminum with epoxy-coated, pressure-tight assemblies sized to accommodate the number of probes. Probe fitting shall be flange mounted style that can be mated with standard pipe flanges coupled to the top of the process tank. Mating flange material shall be PVC. Flange size shall be 4 ½" or 6" depends on the number of probes used per application.

B. Control relay shall be solid-state type with the connected load is switched via double-pole, double-throw (DPDT) potential-free relay contacts rated not less than 5 A at 120 VAC. The control relay primary power supply shall be 120 volts ac, 60 Hz, single phase. Intrinsically safe control relays with FM Approved for use in Class I, Division 1, Group A-G hazardous area shall be utilized whenever the electrodes are located in a hazardous or explosion-proof classified area.

C. Control relay shall be housed in a NEMA Type 4X enclosure as indicated on the Drawings.

D. Point level conductive switch shall be Series 16 Solid-State Relay complete with Series 3F Top Mount Fitting Fixture and Series 3R Probes as manufactured by Warrick Controls, Inc., or Model Liquipoint FTW31 as manufactured by Endress & Hauser, or equal.

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17900

SCHEDULES AND CONTROL DESCRIPTIONS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all hardware and software required to provide the Control and Information System as specified herein and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17910 – Instrument Schedule

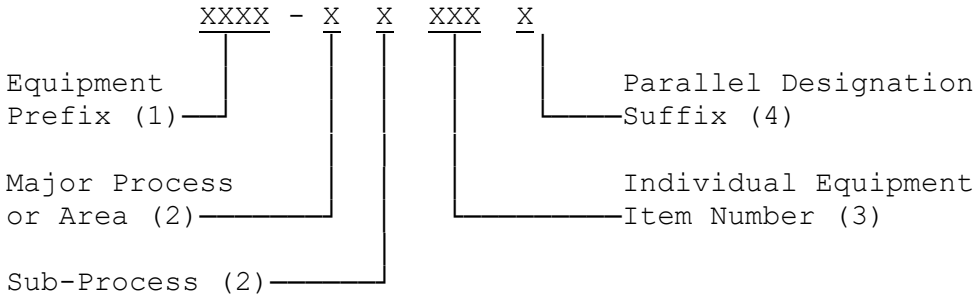
B. Section 17920 – Control System Input/Output Schedule

C. Section 17950 – Functional Control Descriptions

PART 2 -- CONVENTIONS

1.01 PLANT NUMBERING SYSTEM

A. The plant equipment numbering system is based on a 5-digit code preceded by an equipment identification prefix and followed by a parallel designation suffix. The numbering system is broken down as follows:



1. Prefix letters are added as required to label a piece of equipment or describe instrumentation/control signal types. Instrumentation prefixes shall use the convention shown in the following table.

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INSTRUMENT PREFIX LETTERS					
FIRST LETTER			SUCCEEDING LETTERS		
LETTER	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM OR PLC/DCS DISCRETE ALARM INPUT		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	CONDUCTIVITY (ELECTRICAL)			CONTROL OR PLC/DCS ANALOG OUTPUT	
D	DENSITY (MASS) OR SPECIFIC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS OR VIEWING DEVICE		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE OR PLC/DCS ANALOG INPUT		
J	POWER	SCAN			
K	TIME OR TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE OR HUMIDITY	MOMENTARY			MIDDLE OR INTERMEDIATE
N	USER'S CHOICE		NOTIFY OR PLC/DCS DISCRETE STATUS INPUT	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE (RESTRICTION)		
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE OR TOTALIZE	INTEGRATE OR TOTALIZE		
R	RADIATION		RECORD OR PRINT		
S	SPEED OR FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION OR MECHANICAL ANALYSIS			VALVE, DAMPER OR LOUVER	
W	WEIGHT OR FORCE		WELL		
X	UNCLASSIFIED	X AXIS	UNCLASSIFIED	UNCLASSIFIED OR PLC/DCS DISCRETE OUTPUT	UNCLASSIFIED
Y	EVENT, STATE OR PRESENCE	Y AXIS		RELAY, COMPUTE, OR CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVE, ACTUATOR OR UNCLASSIFIED FINAL CONTROL ELEMENT	

2. Major process areas and associated sub-processes shall use the following numbering convention:

NOTE: THE FOLLOWING TABLE APPLIES TO P.O. HOFFER WTP ONLY.

First Digit	Second Digit	Third Digit & Description
1	-	RAW WATER (ALTERNATE BID)
	0	1 – Raw Water Pump No. 1
	0	2 – Raw Water Pump No. 2
	0	3 – Raw Water Pump No. 3
	0	4 – Raw Water Pump No. 4
	0	5 - Raw Water Pump No. 5
	1	1- Raw Water Flow No. 1
	1	2- Raw Water Flow No. 2

	2	1- Rapid Mix No. 1
	2	2- Rapid Mix No. 2
	2	3- Rapid Mix No. 3
	2	4- Rapid Mix No. 4
	3	
	4	
	5	
	6	
	7	
	8	
	9	

First Digit	Second Digit	Third Digit & Description
2	-	PRE-TREATMENT
	0	1 – Flocculator No. 1
	0	2 – Flocculator No. 2
	0	3 – Flocculator No. 3
	0	4 – Flocculator No. 4
	0	5 – Flocculator No. 5
	0	6 – Flocculator No. 6
	0	7 – Flocculator No. 7
	0	9 – Flocculator No. 8
	1	0 - Flocculator No. 10
	1	1 – Flocculator No. 11
	1	2 – Flocculator No. 12
	1	3 – Flocculator No. 13
	1	4 – Flocculator No. 14
	1	5 – Flocculator No. 15
	1	6 – Flocculator No. 16
	1	7 – Flocculator No. 17
	1	8 – Flocculator No. 18
	1	9 – Flocculator No. 19
	2	0 – Flocculator No. 20 (ALT BID)
	2	1 – Flocculator No. 21
	2	2 – Flocculator No. 22
	2	3 – Flocculator No. 23 4 – Flocculator No.
	2	24
	3	
	4	
	5	
	6	
	7	
	8	
	9	

3	-	FILTRATION
	0	1 - Filter No. 1
	0	2 – Filter No. 2
	0	3 – Filter No. 3
	0	4 – Filter No. 4
	0	5 – Filter No. 5
	0	6 – Filter No. 6
	0	7 – Filter No. 7
	0	8 – Filter No. 8
	0	9 – Filter No. 9
	1	0 – Filter No. 10
	1	1 – Filter No. 11
	1	2 – Filter No. 12
	1	3 – Filter No. 13
	1	4 – Filter No. 14
	1	5 – Filter No. 15
	1	6 – Filter No. 16
	1	7 – Filter No. 17
	1	8 – Filter No. 18
	1	9 – Filter No. 19
	2	0 – Filter No. 20
	2	1 – Filter No 21
	2	2 – Filter No. 22
	2	3 – Filter No. 23
	2	4 – Filter No. 24
	3	
	4	
	5	
	6	
	7	
	8	Filtered Water Mixer
	9	Influent Channel
4	-	FINSHED WATER
	1	1 – Finished Water Pump No. 1
	1	2 – Finished Water Pump No. 2
	1	3 – Finished Water Pump No. 3
	1	4 – Finished Water Pump No. 4
	1	5 – Finished Water Pump No. 5
	1	6 – Finished Water Pump No. 6
	1	7 – Finished Water Pump No. 7
	1	8 – Finished Water Pump No. 8
	2	1- Backwash Pump No. 1
		2- Backwash Pump No. 2

	3	Finished Water Mixer
	4	4 MGD Clearwell
	5	12 MGD Clearwell
	6	Finished Water Meter Vault
	7	
	8	
	9	
	0	
5	-	CHEMICAL FEED SYSTEMS (ALTERNATE BID)
	1	Carbon Slurry
	2	Orthophosphate
	3	Fluoride
	4	Caustic
	5	Ferric
	6	Aqua Ammonia (EXISTING)
	7	Sodium Hypochlorite (EXISTING)
	8	
	9	
	0	Miscellaneous

First Digit	Second Digit	Description
6	-	SOLIDS HANDLING
	1	Sludge thickener No. 1
	2	Sludge Thickener No. 2
	3	Sludge Thickener No. 3 (FUTURE)
	4	EQ Basin
	5	Residuals Meter Vault
	6	Residual pumps
	7	
	8	
	9	NPDES Meter
	0	
7	-	ELEVATED TANKS
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	0	

8	-	PUMP STATIONS
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	0	
9	-	MISCELLANEOUS
	1	Administration
	2	Generator
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	0	

3. Individual equipment item numbers are assigned per equipment type and shall use the following numbering convention:

   00-09 Mechanical Equipment
   10-19 Gates
   20-39 Valves
   40-59 Instrumentation
   60-79 Electrical
   80-89 HVAC
   90-99 Miscellaneous

4. The parallel designation suffix shall be used to differentiate items of similar function and service that would otherwise have the same number. The suffix shall use the following conventions depending on application:

   a. {none}
   b. A, B, C,...
   c. A1, A2, A3,...B1, B2, B3,...C1, C2, C3,...

- END OF SECTION -

SECTION 17910

INSTRUMENT SCHEDULE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17920 – Control System Input/Output Schedule

B. Section 17950 – Functional Control Descriptions

PART 2 -- INSTRUMENT SCHEDULE

GLENVILLE LAKE WTP

Flow Switches - (See Note 1)			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FSH-0001	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0002	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0003	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0004	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0005	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0006	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0007	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0008	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0009	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping
FSH-0010	Emergency Shower/Eyewash Station	3 gpm-23 gpm	Line Size: ½ ” NPT inlet piping

080805BR

Ultrasonic Level Transmitters - Section 17740			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LE/LIT-5401	Filter No. 1 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5402	Filter No. 2 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5403	Filter No. 3 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5404	Filter No. 4 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5405	Filter No. 5 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5406	Filter No. 6 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5407	Filter No. 7 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5408	Filter No. 8 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5409	Filter No. 9 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5410	Filter No. 10 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5411	Filter No. 11 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-5412	Filter No. 12 Level	0 – 7 ft	Provide mounting bracket
LE/LIT-4401A	Sedimentation Basin Effluent Channel	0 – 4 ft	Provide mounting bracket
LE/LIT-4401B	Sedimentation Basin Effluent Channel	0 – 4 ft	Provide mounting bracket

Notes:

1. Flow switches shall be Model S19-319S2 as manufactured by Bradley.

P.O. HOFFER WTP (ALTERNATE BID)

Rotameters – Section 17635			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FI-51403	Carrier Water for Powdered Activated Carbon	0 – 20 gpm	
FI-51404	Carrier Water for Powdered Activated Carbon	0 – 20 gpm	
FI-51405	Carrier Water for Powdered Activated Carbon	0 – 20 gpm	

Turbine Flow Meters – Section 17640			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FE/FIT-51400 and FIC-51400	Dilution Water for Powdered Activated Carbon Tanks	0 – 250 gpm	3” line, turbine meter with batch controller

Pressure Gauges – Section 17650			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PI-51406	Carrier Water for Powder Activated Carbon	0 – 100 psig	

PI-51407	Carrier Water for Powder Activated Carbon	0 – 100 psig	

Level Switches (Suspended Float) – Section 17670			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LSH - 51408	PAC Pump Room Pipe Pit Level Alarm	Set in Field	
LSH - 51409	PAC Chemical Injection Manhole	Set in Field	

Pressure Switches – Section 17675			
Tag Number	**Service Description**	**State/Span**	**Remarks**
PSH-51010	PAC Slurry Metering Pump (PACMP-1) High Discharge Pressure		Diaphragm seal required.
PSH-51020	PAC Slurry Metering Pump (PACMP-2) High Discharge Pressure		Diaphragm seal required.
PSH-51030	PAC Slurry Metering Pump (PACMP-3) High Discharge Pressure		Diaphragm seal required.
PSH-51040	PAC Slurry Metering Pump (PACMP-4) High Discharge Pressure		Diaphragm seal required.
PSH-51050	PAC Slurry Metering Pump (PACMP-5) High Discharge Pressure		Diaphragm seal required.
PSH-51060	PAC Slurry Metering Pump (PACMP-6) High Discharge Pressure		Diaphragm seal required.

Insert Magnetic Flow Meters – Section 17702			
Tag Number	**Service Description**	**State/Span**	**Remarks**
FE/FIT-10401	North 36” Raw Water Flow	0 – 32 MGD	Line Pressure: 30 psi; Pipe Size: 36”; Remote Transmitter
FE/FIT-10402	South 36” Raw Water Flow	0 – 32 MGD	Line Pressure: 30 psi; Pipe Size: 36”; Remote Transmitter

Radar Level Transmitters – Section 17745			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LE/LIT-51401	PAC Slurry Tank No. 1	0 – 20 Feet	Antenna Size: 4” Horn; Analog and 120 VAC surge protection required. Provide remote mount transmitter
LE/LIT-51402	PAC Slurry Tank No. 2	0 – 20 Feet	Antenna Size: 4” Horn; Analog and 120 VAC surge protection required.

			Provide remote mount transmitter

Point Level Conductive Level Switches – Section 17784			
Tag Number	**Service Description**	**State/Span**	**Remarks**
LSHH – 51411	PAC Slurry Tank No. 1 Point Level Detection		Two-Rod Probes, See Note 1
LSHH - 51412	PAC Slurry Tank No. 2 Point Level Detection		Two-Rod Probes, See Note 1

NOTES:

1. Probe shall be mounted vertically for single-point level detection. Probe length shall be set to the required point level which shall be 2'-6" to detect the maximum level in the tank (i.e., high-high level alarm, which is approximately 6" below the invert of overflow pipe in the tank). Probe material shall be 316 stainless steel.

- END OF SECTION -

SECTION 17920

CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install, and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17910 - Instrument Schedule

B. Section 17950 - Functional Control Descriptions

PART 2 -- CONTROL SYSTEM INPUT / OUTPUT LIST

GLENVILLE LAKE WTP (BASE BID)

Service Description	State/Span	Type	Field Tag Number	RTU
Raw Water Pump 2006	Start	DO	HAS-2006	1
Raw Water Pump 2006	Stop	DO	HSB-2006	1
Raw Water Pump 2006	Run	DI	YN-2006	1
Raw Water Pump 2006	Fail	DI	YA-2006	1
Raw Water Pump WW Low Level Alarm		DI	LSL - 2403	1
Raw Water Pump 2007	Start	DO	HAS-2007	1
Raw Water Pump 2007	Stop	DO	HSB-2007	1
Raw Water Pump 2007	Run	DI	YN-2007	1
Raw Water Pump 2007	Fail	DI	YA-2007	1
Raw Water Pump 2010	Start	DO	HAS-2010	1
Raw Water Pump 2010	Stop	DO	HSB-2010	1
Raw Water Pump 2010	Run	DI	YN-2010	1
Raw Water Pump 2010	Fail	DI	YA-2010	1
Raw Water Pump 2010 Low Level Alarm		DI	LSL - 2404	1
Rapid Mix RM-3031	Run	DI	YN-3031	1
Rapid Mix RM-3031	Fail	DI	YA-3031	1
Rapid Mix RM-3032	Run	DI	YN-3032	1
Rapid Mix RM-3032	Fail	DI	YA-3032	1
Rapid Mix RM-3033	Run	DI	YN-3033	1
Rapid Mix RM-3033	Fail	DI	YA-3033	1
Rapid Mix RM-3034	Run	DI	YN-3034	1
Rapid Mix RM-3034	Fail	DI	YA-3034	1
Flocculator Basin Mixer FLM-3041 VFD	Run	DI	YN-3041	1
Flocculator Basin Mixer FLM-3041 VFD	Fail	DI	YA-3041	1
Flocculator Basin Mixer FLM-3042 VFD	Run	DI	YN-3042	1
Flocculator Basin Mixer FLM-3042 VFD	Fail	DI	YA-3042	1
Flocculator Basin Mixer FLM-3043 VFD	Run	DI	YN-3043	1
Flocculator Basin Mixer FLM-3043 VFD	Fail	DI	YA-3043	1
Flocculator Basin Mixer FLM-3044 VFD	Run	DI	YN-3044	1
Flocculator Basin Mixer FLM-3044 VFD	Fail	DI	YA-3044	1
Flocculator Basin Mixer FLM-3045 VFD	Run	DI	YN-3045	1
Flocculator Basin Mixer FLM-3045 VFD	Fail	DI	YA-3045	1
Flocculator Basin Mixer FLM-3046 VFD	Run	DI	YN-3046	1
Flocculator Basin Mixer FLM-3046 VFD	Fail	DI	YA-3046	1
Flocculator Basin Mixer FLM-3047 VFD	Run	DI	YN-3047	1
Flocculator Basin Mixer FLM-3047 VFD	Fail	DI	YA-3047	1
Flocculator Basin Mixer FLM-3048 VFD	Run	DI	YN-3048	1

Service Description	State/Span	Type	Field Tag Number	RTU
Flocculator Basin Mixer FLM-3048 VFD	Fail	DI	YA-3048	1
Flocculator Basin Mixer FLM-3049 VFD	Run	DI	YN-3049	1
Flocculator Basin Mixer FLM-3049 VFD	Fail	DI	YA-3049	1
Flocculator Basin Mixer FLM-3050 VFD	Run	DI	YN-3050	1
Flocculator Basin Mixer FLM-3050 VFD	Fail	DI	YA-3050	1
Flocculator Basin Mixer FLM-3051 VFD	Run	DI	YN-3051	1
Flocculator Basin Mixer FLM-3051 VFD	Fail	DI	YA-3051	1
Flocculator Basin Mixer FLM-3052 VFD	Run	DI	YN-3052	1
Flocculator Basin Mixer FLM-3052 VFD	Fail	DI	YA-3052	1
Flocculator Basin Mixer FLM-3053 VFD	Run	DI	YN-3053	1
Flocculator Basin Mixer FLM-3053 VFD	Fail	DI	YA-3053	1
Flocculator Basin Mixer FLM-3054 VFD	Run	DI	YN-3054	1
Flocculator Basin Mixer FLM-3054 VFD	Fail	DI	YA-3054	1
Sedimentation Basin #1 Sludge Collection Panel	Run	DI	YN-4031	1
Sedimentation Basin #1 Sludge Collection Panel	Fail	DI	YA-4031	1
Sedimentation Basin #1 Sludge Collection Panel	Open	DI	ZIC-4201	1
Sedimentation Basin #1 Sludge Collection Panel	Close	DI	ZIO-4201	1
Sedimentation Basin #2 Sludge Collection Panel	Run	DI	YN-4032	1
Sedimentation Basin #2 Sludge Collection Panel	Fail	DI	YA-4032	1
Sedimentation Basin #2 Sludge Collection Panel	Open	DI	ZIC-4202	1
Sedimentation Basin #2 Sludge Collection Panel	Close	DI	ZIO-4202	1
Sedimentation Basin #3 Sludge Collection Panel	Run	DI	YN-4033	1
Sedimentation Basin #3 Sludge Collection Panel	Fail	DI	YA-4033	1
Sedimentation Basin #3 Sludge Collection Panel	Open	DI	ZIC-4203	1
Sedimentation Basin #3 Sludge Collection Panel	Close	DI	ZIO-4203	1
Sedimentation Basin #4 Sludge Collection Panel	Run	DI	YN-4034	1
Sedimentation Basin #4 Sludge Collection Panel	Fail	DI	YA-4034	1
Sedimentation Basin #4 Sludge Collection Panel	Open	DI	ZIC-4204	1
Sedimentation Basin #4 Sludge Collection Panel	Close	DI	ZIO-4204	1
Sedimentation Basin #5 Sludge Collection Panel	Run	DI	YN-4035	1
Sedimentation Basin #5 Sludge Collection Panel	Fail	DI	YA-4035	1
Sedimentation Basin #5 Sludge Collection Panel	Open	DI	ZIC-4205	1
Sedimentation Basin #5 Sludge Collection Panel	Close	DI	ZIO-4205	1
Sedimentation Basin #6 Sludge Collection Panel	Run	DI	YN-4036	1
Sedimentation Basin #6 Sludge Collection Panel	Fail	DI	YA-4036	1
Sedimentation Basin #6 Sludge Collection Panel	Open	DI	ZIC-4206	1
Sedimentation Basin #6 Sludge Collection Panel	Close	DI	ZIO-4206	1
Sedimentation Basin #7 Sludge Collection Panel	Run	DI	YN-4037	1
Sedimentation Basin #7 Sludge Collection Panel	Fail	DI	YA-4037	1
Sedimentation Basin #7 Sludge Collection Panel	Open	DI	ZIC-4207	1
Sedimentation Basin #7 Sludge Collection Panel	Close	DI	ZIO-4207	1
Sedimentation Basin #8 Sludge Collection Panel	Run	DI	YN-4038	1
Sedimentation Basin #8 Sludge Collection Panel	Fail	DI	YA-4038	1
Sedimentation Basin #8 Sludge Collection Panel	Open	DI	ZIC-4208	1
Sedimentation Basin #8 Sludge Collection Panel	Close	DI	ZIO-4208	1
Sedimentation Basin #9 Sludge Collection Panel	Run	DI	YN-4039	1
Sedimentation Basin #9 Sludge Collection Panel	Fail	DI	YA-4039	1
Sedimentation Basin #9 Sludge Collection Panel	Open	DI	ZIC-4209	1
Sedimentation Basin #9 Sludge Collection Panel	Close	DI	ZIO-4209	1
Sedimentation Basin #10 Sludge Collection Panel	Run	DI	YN-4040	1
Sedimentation Basin #10 Sludge Collection Panel	Fail	DI	YA-4040	1
Sedimentation Basin #10 Sludge Collection Panel	Open	DI	ZIC-4210	1
Sedimentation Basin #10 Sludge Collection Panel	Close	DI	ZIO-4210	1
Sedimentation Basin #11 Sludge Collection Panel	Run	DI	YN-4141	1
Sedimentation Basin #11 Sludge Collection Panel	Fail	DI	YA-4141	1
Sedimentation Basin #11 Sludge Collection Panel	Open	DI	ZIC-4211	1
Sedimentation Basin #11 Sludge Collection Panel	Close	DI	ZIO-4211	1
Sedimentation Basin #12 Sludge Collection Panel	Run	DI	YN-4142	1

Service Description	State/Span	Type	Field Tag Number	RTU
Sedimentation Basin #12 Sludge Collection Panel	Fail	DI	YA-4142	1
Sedimentation Basin #12 Sludge Collection Panel	Open	DI	ZIC-4212	1
Sedimentation Basin #12 Sludge Collection Panel	Close	DI	ZIO-4212	1
Settled Water Mixer SWM 4000	Run	DI	YN-4000	1
Settled Water Mixer SWM 4000	Fail	DI	YA-4000	1
Low Service Pump LSP 7002	Start	DO	HAS-7002	1
Low Service Pump LSP 7002	Stop	DO	HSB-7002	1
Low Service Pump LSP 7002	Run	DI	YN-7002	1
Low Service Pump LSP 7002	Fail	DI	YA-7002	1
Low Service Pump LSP 7003	Start	DO	HAS-7003	1
Low Service Pump LSP 7003	Stop	DO	HSB-7003	1
Low Service Pump LSP 7003	Run	DI	YN-7003	1
Low Service Pump LSP 7003	Fail	DI	YA-7003	1
High Service Pump HSP 7004	Start	DO	HAS-7004	1
High Service Pump HSP 7004	Stop	DO	HSB-7004	1
High Service Pump HSP 7004	Run	DI	YN-7004	1
High Service Pump HSP 7004	Fail	DI	YA-7004	1
5 kV MCC	Bus 1	Di	EVA-5000	1
5 kV MCC Tie Switch	Tie	DI	EV-5000	1
5 kV MCC	Bus 2	DI	EVB-5000	1
480 V MCC	Bus 1	DI	EVA-0480	1
480 V MCC	Bus 2	DI	EVB-0480	1
High Service Pump HSP 7005	Start	DO	HAS-7005	1
High Service Pump HSP 7005	Stop	DO	HSB-7005	1
High Service Pump LSP 7005	Run	DI	YN-7005	1
High Service Pump HSP 7005	Fail	DI	YA-7005	1
High Service Pump HSP 7008	Start	DO	HAS-7008	1
High Service Pump HSP 7008	Stop	DO	HSB-7008	1
High Service Pump HSP 7008	Run	DI	YN-7008	1
High Service Pump HSP 7008	Fail	DI	YA-7008	1
High Service Pump HSP 7009	Start	DO	HAS-7009	1
High Service Pump HSP 7009	Stop	DO	HSB-7009	1
High Service Pump HSP 7009	Run	DI	YN-7009	1
High Service Pump HSP 7009	Fail	DI	YA-7009	1
Residuals Pump RP-1050-1	Start	DO	HAS-1050-1	1
Residuals Pump RP-1050-1	Stop	DO	HSB-1050-1	1
Residuals Pump RP-1050-1	Run	DI	YN-1050-1	1
Residuals Pump RP-1050-1	Fail	DI	YA-1050-1	1
Residuals Pump RP-1050-2	Start	DO	HAS-1050-2	1
Residuals Pump RP-1050-2	Stop	DO	HSB-1050-2	1
Residuals Pump RP-1050-2	Run	DI	YN-1050-2	1
Residuals Pump RP-1050-2	Fail	DI	YA-1050-2	1
Residuals Tank (from Residuals Tank Control Panel)	High Level	DI	LAH-1050	1
Residuals Tank (from Residuals Tank Control Panel)	Low Level	DI	LAL-1050	1
Residuals Tank (from Residuals Tank Control Panel)	Override	DI	YN-1050	1
Residuals Tank (from Residuals Tank Control Panel)	Reset	DO	HS-1050	1
Raw Water	Turbidity	AI	AI-2405	1
Raw Water	pH	AI	AI-2406	1
Train A Treated Water	Streaming Current	AI	AI-3401	1
Train A Treated Water	pH	AI	AI-3402	1
Train B Treated Water	Streaming Current	AI	AI-3403	1
Train B Treated Water	pH	AI	AI-3404	1
Raw Water Train A	Flow	AI	FI-2401	1
Raw Water Train A MOV-2201	Open	DO	HSA-2201	1
Raw Water Train A MOV-2201	Close	DO	HSB-2201	1
Raw Water Train A MOV-2201	Position	AI	ZI-2201	1
Raw Water Train B	Flow	AI	FI-2402	1
Raw Water Train B MOV-2202	Open	DO	HSA-2202	1
Raw Water Train B MOV-2202	Close	DO	HSB-2202	1
Raw Water Train B MOV-2202	Position	AI	ZI-2202	1

Service Description	State/Span	Type	Field Tag Number	RTU
Sedimentation Basin Effluent Channel	Level	AI	LI-4401A	1
Sedimentation Basin Effluent Channel	Level	AI	LI-4401B	1
Sedimentation Basin	Turbidity	AI	AI-4403	1
Sedimentation Basin	pH	AI	AI-4404	1
Combined Filtered Water	Residual Cl2	AI	AI-5460	1
5 MG Clearwell Level		AI	LI-6401	1
1 MG Clearwell - Inlet Flow		AI	FI-6403	1
1 MG Clearwell MOV-6201	Open	DO	HSA-6201	1
1 MG Clearwell MOV-6201	Close	DO	HSB-6201	1
1 MG Clearwell MOV-6201	Position	AI	ZI-6201	1
1 MG Clearwell Level		AI	LI-6402	1
Clearwell Effluent Free Cl2		AI	AI-6404	1
Clearwell Effluent pH		AI	AI-6405	1
High Service Pump Station Wet Well Level		AI	LI-7401	1
Chloramines		AI	AI-XXXX	1
Low Service Water	pH	AI	AI-7403	1
Low Service Water	Residual Cl2	AI	AI-7404	1
Low Service Water	Turbidity	AI	AI-7407	1
Low Service Water	Pressure	AI	PI-7405	1
High Service	Pressure	AI	PI-7402	1
High Service	Flow	AI	FI-7410	1
High Service	Flow	AI	FI-7420	1
High Service	Flow	AI	FI-7430	1
High Service	Flow	AI	FI-7440	1
High Service	Flow	AI	FI-7450	1
Wash Water Sludge Equalization Basin	Level	AI	LI-9401	1
Plant Power Demand #1	Reuse Pulse-To-Current	AI	JY-9601	1
Plant Power Demand #2	Reuse Pulse-To-Current	AI	JY-9602	1
Finished Water	pH	AI	AI-XXXX	1
Washwater Pump	Start	DO	HSA-7001	1
Washwater Pump	Stop	DO	HSB-7001	1
Washwater Pump	Run	DI	YN-7001	1
Washwater Pump	Fail	DI	YA-7001	1
Washwater Control Valve	Remote	DI	YN-7206	1
Washwater Control Valve	Position	AO	ZC-7206	1
Washwater Control Valve	Position Feedback	AI	ZI-7206	1
Washwater Flow		AI	FIT-7406	1
RTU Intrusion Alarm		DI		1
Carbon Room Flood Alarm	Activated	DI	YA-XXXX	2
Ferric Pump 1	Run	DI	YN-XXXX	2
Ferric Pump 1	Pulse	DI		2
Ferric Pump 1	Fail	DI	YA-XXXX	2
Ferric Pump 1	Start/Stop	DO	HS-XXXX	2
Ferric Pump 1 Speed Feedback	0-100%	AI	SI-XXXX	2
Ferric Pump 2	Run	DI	YN-XXXX	2
Ferric Pump 2	Pulse	DI		2
Ferric Pump 2	Fail	DI	YA-XXXX	2
Ferric Pump 2	Start/Stop	DO	HS-XXXX	2
Ferric Pump 2 Speed Feedback	0-100%	AI	SI-XXXX	2
Ferric Pump 3	Run	DI	YN-XXXX	2
Ferric Pump 3	Pulse	DI		2
Ferric Pump 3	Fail	DI	YA-XXXX	2
Ferric Pump 3	Start/Stop	DO	HS-XXXX	2
Ferric Pump 3 Speed Feedback	0-100%	AI	SI-XXXX	2
Ferric Bulk Tank 1 Level		AI	LI-XXXX	2
Ferric Bulk Tank 2 Level		AI	LI-XXXX	2
Caustic Transfer Pump 1	Run	DI	YN-XXXX	2

Service Description	State/Span	Type	Field Tag Number	RTU
Caustic Transfer Pump 1	Fail	DI	YA-XXXX	2
Caustic Transfer Pump 1	Start/Stop	DO	HS-XXXX	2
Caustic Transfer Pump 1 Speed Feedback	0-100%	AI	SI-XXXX	2
Caustic Transfer Pump 2	Run	DI	YN-XXXX	2
Caustic Transfer Pump 2	Fail	DI	YA-XXXX	2
Caustic Transfer Pump 2	Start/Stop	DO	HS-XXXX	2
Caustic Transfer Pump 2 Speed Feedback	0-100%	AI	SI-XXXX	2
Caustic Transfer Pump 3	Run	DI	YN-XXXX	2
Caustic Transfer Pump 3	Fail	DI	YA-XXXX	2
Caustic Transfer Pump 3	Start/Stop	DO	HS-XXXX	2
Caustic Transfer Pump 3 Speed Feedback	0-100%	AI	SI-XXXX	2
Caustic Transfer Pump 3 Speed Control	0-100%	AO	SC-XXXX	2
Caustic Transfer Pump 4	Run	DI	YN-XXXX	2
Caustic Transfer Pump 4	Fail	DI	YA-XXXX	2
Caustic Metering Pump 1	Fail	DI	YA-XXXX	2
Caustic Metering Pump 1 Discharge Pressure	Low	DI	PAL-XXXX	2
Caustic Metering Pump 1 Speed Control	0-100%	AO	SC-XXXX	2
Caustic Metering Pump 2	Fail	DI	YA-XXXX	2
Caustic Metering Pump 2 Discharge Pressure	Low	DI	PAL-XXXX	2
Caustic Metering Pump 2 Speed Control	0-100%	AO	SC-XXXX	2
Caustic Metering Pump 3	Fail	DI	YA-XXXX	2
Caustic Metering Pump 3	0-100%	AO	SC-XXXX	2
Caustic Room Sump Level	High	DI	LAH-XXXX	2
Caustic Room Shower/Eyewash	Activated	DI		2
Caustic Bulk Tank Level		AI	LI-XXXX	2
Caustic Bulk Tank 1 Level		AI	LI-XXXX	2
Caustic Bulk Tank 2 Level		AI	LI-XXXX	2
Caustic Bulk Day Tank Level		AI	LI-XXXX	2
Carbon Feed Pump Speed Control	0-100%	AO		2
Sodium Hypo Recirc Pump 1	Run	DI	YN-XXXX	2
Sodium Hypo Recirc Pump 1	Fail	DI	YA-XXXX	2
Sodium Hypo Recirc Pump 2	Run	DI	YN-XXXX	2
Sodium Hypo Recirc Pump 2	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 1	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 1	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 1 Discharge Pressure	Low	DI	PAL-XXXX	2
Sodium Hypo Metering Pump 1 Speed Control	0-100%	AO	SC-XXXX	2
Sodium Hypo Metering Pump 2	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 2	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 2 Discharge Pressure	Low	DI	PAL-XXXX	2
Sodium Hypo Metering Pump 2 Speed Control	0-100%	AO	SC-XXXX	2
Sodium Hypo Metering Pump 3	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 3	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 3 Discharge Pressure	Low	DI	PAL-XXXX	2
Sodium Hypo Metering Pump 3 Speed Control	0-100%	AO	SC-XXXX	2
Sodium Hypo Metering Pump 4	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 4	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 4 Discharge Pressure	Alarm	DI	PAL-XXXX	2
Sodium Hypo Metering Pump 4 Speed Control	0-100%	AO	SC-XXXX	2
Sodium Hypo Metering Pump 5	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 5	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 5 Discharge Pressure	Low	DI	PAL-XXXX	2
Sodium Hypo Metering Pump 5 Speed Control	0-100%	AO	SC-XXXX	2
Sodium Hypo Metering Pump 6	Auto	DI	YN-XXXX	2
Sodium Hypo Metering Pump 6	Run	DI	YN-XXXX	2
Sodium Hypo Metering Pump 6	Fail	DI	YA-XXXX	2
Sodium Hypo Metering Pump 6	Start/Stop	DO	HS-XXXX	2
Sodium Hypo Metering Pump 6 Speed Control	0-100%	AO	SC-XXXX	2

Service Description	State/Span	Type	Field Tag Number	RTU
Sodium Hypo Metering Pressure Relief	Activated	DI	YA-XXXX	2
Sodium Hypo Sump Level	High	DI	LAH-XXXX	2
Sodium Hypo CL2 Gas	Alarm	DI	YA-XXXX	2
Sodium Hypo Room Shower/Eyewash	Activated	DI	YA-XXXX	2
Sodium Hypo Bulk Tank 1 Level		AI	LI-XXXX	2
Sodium Hypo Bulk Tank 2 Level		AI	LI-XXXX	2
Sodium Hypo Bulk Tank 3 Level		AI	LI-XXXX	2
Fire Valve	Closed	DI		2
Fire Flow Switch	Activated	DI		2
RTU Intrusion Alarm		DI		2
Finished Water Flow from 5 MG Clearwell (30" line)		AI		3
Flow Metering Vault Sump Level	Alarm	DI		3
Chemical Injection Vault Sump Level	Alarm	DI		3
Aqua-Ammonia Tank 1 Level		AI		3
Aqua-Ammonia Tank 2 Level		AI		3
Aqua-Ammonia Metering Pump 1	Start/Stop	DO		3
Aqua-Ammonia Metering Pump 1	Run	DI		3
Aqua-Ammonia Metering Pump 1	Fail	DI		3
Aqua-Ammonia Metering Pump 1	Auto	DI		3
Aqua-Ammonia Metering Pump 1 Speed Control	0-100%	AO		3
Aqua-Ammonia Metering Pump 2	Start/Stop	DO		3
Aqua-Ammonia Metering Pump 2	Run	DI		3
Aqua-Ammonia Metering Pump 2	Fail	DI		3
Aqua-Ammonia Metering Pump 2	Auto	DI		3
Aqua-Ammonia Metering Pump 2 Speed Control	0-100%	AO		3
Aqua-Ammonia Metering Pump 3	Start/Stop	DO		3
Aqua-Ammonia Metering Pump 3	Run	DI		3
Aqua-Ammonia Metering Pump 3	Fail	DI		3
Aqua-Ammonia Metering Pump 3	Auto	DI		3
Aqua-Ammonia Metering Pump 3 Speed Control	0-100%	AO		3
Aqua-Ammonia Feed Facility Sump Level	Alarm	DI		3
Ammonia Metering Pump Discharge Header Pressure Relief Return Line Flow Detection	Alarm	DI		3
RTU Intrusion Alarm		DI		3
Filter No. 1	Level	AI	LI-5401	4
Filter No. 1	Loss-of Head	AI	PDIT-5401	4
Filter No. 1	Effluent Turbidity	AI	AI-5441	4
Filter No. 1	Effluent Flow Rate	AI	FI-5421	4
Filter No. 1 Influent Valve	Remote	DI	YN-5201	4
Filter No. 1 Influent Valve	Open	DO	HSA-5201	4
Filter No. 1 Influent Valve	Close	DO	HSB-5201	4
Filter No. 1 Influent Valve	Opened	DI	ZIO-5201	4
Filter No. 1 Influent Valve	Closed	DI	ZIC-5201	4
Filter No. 1 Effluent Valve	Remote	DI	YN-5301	4
Filter No. 1 Effluent Valve	Position	AO	SC-5301	4
Filter No. 1 Effluent Valve	Position	AI	SI-5301	4
Filter No. 1 Backwash Supply Valve	Remote	DI	YN-5281	4
Filter No. 1 Backwash Supply Valve	Open	DO	HSA-5281	4
Filter No. 1 Backwash Supply Valve	Close	DO	HSB-5281	4
Filter No. 1 Backwash Supply Valve	Opened	DI	ZIO-5281	4
Filter No. 1 Backwash Supply Valve	Closed	DI	ZIC-5281	4
Filter No. 1 Backwash Waste Valve	Remote	DI	YN-5221	4
Filter No. 1 Backwash Waste Valve	Open	DO	HSA-5221	4
Filter No. 1 Backwash Waste Valve	Close	DO	HSB-5221	4
Filter No. 1 Backwash Waste Valve	Opened	DI	ZIO-5221	4
Filter No. 1 Backwash Waste Valve	Closed	DI	ZIC-5221	4
Filter No. 1 Rewash Valve	Remote	DI	YN-5261	4

Service Description	State/Span	Type	Field Tag Number	RTU
Filter No. 1 Rewash Valve	Open	DO	HSA-5261	4
Filter No. 1 Rewash Valve	Close	DO	HSB-5261	4
Filter No. 1 Rewash Valve	Opened	DI	ZIO-5261	4
Filter No. 1 Rewash Valve	Closed	DI	ZIC-5261	4
Filter No. 1 Surface Wash Valve	Energize	DO	HS-5241	4
Filter No. 2	Level	AI	LI-5402	4
Filter No. 2	Loss-of Head	AI	PDIT-5402	4
Filter No. 2	Effluent Turbidity	AI	AI-5442	4
Filter No. 2	Effluent Flow Rate	AI	FI-5422	4
Filter No. 2 Influent Valve	Remote	DI	YN-5202	4
Filter No. 2 Influent Valve	Open	DO	HSA-5202	4
Filter No. 2 Influent Valve	Close	DO	HSB-5202	4
Filter No. 2 Influent Valve	Opened	DI	ZIO-5202	4
Filter No. 2 Influent Valve	Closed	DI	ZIC-5202	4
Filter No. 2 Effluent Valve	Remote	DI	YN-5302	4
Filter No. 2 Effluent Valve	Position	AO	SC-5302	4
Filter No. 2 Effluent Valve	Position	AI	SI-5302	4
Filter No. 2 Backwash Supply Valve	Remote	DI	YN-5282	4
Filter No. 2 Backwash Supply Valve	Open	DO	HSA-5282	4
Filter No. 2 Backwash Supply Valve	Close	DO	HSB-5282	4
Filter No. 2 Backwash Supply Valve	Opened	DI	ZIO-5282	4
Filter No. 2 Backwash Supply Valve	Closed	DI	ZIC-5282	4
Filter No. 2 Backwash Waste Valve	Remote	DI	YN-5222	4
Filter No. 2 Backwash Waste Valve	Open	DO	HSA-5222	4
Filter No. 2 Backwash Waste Valve	Close	DO	HSB-5222	4
Filter No. 2 Backwash Waste Valve	Opened	DI	ZIO-5222	4
Filter No. 2 Backwash Waste Valve	Closed	DI	ZIC-5222	4
Filter No. 2 Rewash Valve	Remote	DI	YN-5262	4
Filter No. 2 Rewash Valve	Open	DO	HSA-5262	4
Filter No. 2 Rewash Valve	Close	DO	HSB-5262	4
Filter No. 2 Rewash Valve	Opened	DI	ZIO-5262	4
Filter No. 2 Rewash Valve	Closed	DI	ZIC-5262	4
Filter No. 2 Surface Wash Valve	Energize	DO	HS-5242	4
Filter No. 3	Level	AI	LI-5403	4
Filter No. 3	Loss-of Head	AI	PDIT-5403	4
Filter No. 3	Effluent Turbidity	AI	AI-5443	4
Filter No. 3	Effluent Flow Rate	AI	FI-5423	4
Filter No. 3 Influent Valve	Remote	DI	YN-5203	4
Filter No. 3 Influent Valve	Open	DO	HSA-5203	4
Filter No. 3 Influent Valve	Close	DO	HSB-5203	4
Filter No. 3 Influent Valve	Opened	DI	ZIO-5202	4
Filter No. 3 Influent Valve	Closed	DI	ZIC-5203	4
Filter No. 3 Effluent Valve	Remote	DI	YN-5303	4
Filter No. 3 Effluent Valve	Position	AO	SI-5303	4
Filter No. 3 Effluent Valve	Position	AI	SC-5303	4
Filter No. 3 Backwash Supply Valve	Remote	DI	YN-5283	4
Filter No. 3 Backwash Supply Valve	Open	DO	HSA-5283	4
Filter No. 3 Backwash Supply Valve	Close	DO	HSB-5283	4
Filter No. 3 Backwash Supply Valve	Opened	DI	ZIO-5283	4
Filter No. 3 Backwash Supply Valve	Closed	DI	ZIC-5283	4
Filter No. 3 Backwash Waste Valve	Remote	DI	YN-5223	4
Filter No. 3 Backwash Waste Valve	Open	DO	HSA-5223	4
Filter No. 3 Backwash Waste Valve	Close	DO	HSB-5223	4
Filter No. 3 Backwash Waste Valve	Opened	DI	ZIO-5223	4
Filter No. 3 Backwash Waste Valve	Closed	DI	ZIC-5223	4
Filter No. 3 Rewash Valve	Remote	DI	YN-5263	4
Filter No. 3 Rewash Valve	Open	DO	HSA-5263	4
Filter No. 3 Rewash Valve	Close	DO	HSB-5263	4
Filter No. 3 Rewash Valve	Opened	DI	ZIO-5263	4
Filter No. 3 Rewash Valve	Closed	DI	ZIC-5263	4
Filter No. 3 Surface Wash Valve	Energize	DO	HS-5243	4
Filter No. 4	Level	AI	LI-5404	4
Filter No. 4	Loss-of Head	AI	PDIT-5404	4
Filter No. 4	Effluent Turbidity	AI	AI-5444	4
Filter No. 4	Effluent Flow Rate	AI	FI-5424	4
Filter No. 4 Influent Valve	Remote	DI	YN-5204	4
Filter No. 4 Influent Valve	Open	DO	HSA-5204	4
Filter No. 4 Influent Valve	Close	DO	HSB-5204	4
Filter No. 4 Influent Valve	Opened	DI	ZIO-5202	4
Filter No. 4 Influent Valve	Closed	DI	ZIC-5204	4
Filter No. 4 Effluent Valve	Remote	DI	YN-5304	4
Filter No. 4 Effluent Valve	Position	AO	SC-5304	4
Filter No. 4 Effluent Valve	Position	AI	SI-5304	4

Service Description	State/Span	Type	Field Tag Number	RTU
Filter No. 4 Backwash Supply Valve	Remote	DI	YN-5284	4
Filter No. 4 Backwash Supply Valve	Open	DO	HSA-5284	4
Filter No. 4 Backwash Supply Valve	Close	DO	HSB-5284	4
Filter No. 4 Backwash Supply Valve	Opened	DI	ZIO-5284	4
Filter No. 4 Backwash Supply Valve	Closed	DI	ZIC-5284	4
Filter No. 4 Backwash Waste Valve	Remote	DI	YN-5224	4
Filter No. 4 Backwash Waste Valve	Open	DO	HSA-5224	4
Filter No. 4 Backwash Waste Valve	Close	DO	HSB-5224	4
Filter No. 4 Backwash Waste Valve	Opened	DI	ZIO-5224	4
Filter No. 4 Backwash Waste Valve	Closed	DI	ZIC-5224	4
Filter No. 4 Rewash Valve	Remote	DI	YN-5264	4
Filter No. 4 Rewash Valve	Open	DO	HSA-5264	4
Filter No. 4 Rewash Valve	Close	DO	HSB-5264	4
Filter No. 4 Rewash Valve	Opened	DI	ZIO-5264	4
Filter No. 4 Rewash Valve	Closed	DI	ZIC-5264	4
Filter No. 4 Surface Wash Valve	Energize	DO	HS-5244	4
RTU Intrusion Alarm		DI		4
Filter No. 5	Level	AI	LI-5405	5
Filter No. 5	Loss-of Head	AI	PDIT-5405	5
Filter No. 5	Effluent Turbidity	AI	AI-5445	5
Filter No. 5	Effluent Flow Rate	AI	FI-5425	5
Filter No. 5 Influent Valve	Remote	DI	YN-5205	5
Filter No. 5 Influent Valve	Open	DO	HSA-5205	5
Filter No. 5 Influent Valve	Close	DO	HSB-5205	5
Filter No. 5 Influent Valve	Opened	DI	ZIO-5205	5
Filter No. 5 Influent Valve	Closed	DI	ZIC-5205	5
Filter No. 5 Effluent Valve	Remote	DI	YN-5305	5
Filter No. 5 Effluent Valve	Position	AO	SC-5305	5
Filter No. 5 Effluent Valve	Position	AI	SI-5305	5
Filter No. 5 Backwash Supply Valve	Remote	DI	YN-5285	5
Filter No. 5 Backwash Supply Valve	Open	DO	HSA-5285	5
Filter No. 5 Backwash Supply Valve	Close	DO	HSB-5285	5
Filter No. 5 Backwash Supply Valve	Opened	DI	ZIO-5285	5
Filter No. 5 Backwash Supply Valve	Closed	DI	ZIC-5285	5
Filter No. 5 Backwash Waste Valve	Remote	DI	YN-5225	5
Filter No. 5 Backwash Waste Valve	Open	DO	HSA-5225	5
Filter No. 5 Backwash Waste Valve	Close	DO	HSB-5225	5
Filter No. 5 Backwash Waste Valve	Opened	DI	ZIO-5225	5
Filter No. 5 Backwash Waste Valve	Closed	DI	ZIC-5225	5
Filter No. 5 Rewash Valve	Remote	DI	YN-5265	5
Filter No. 5 Rewash Valve	Open	DO	HSA-5265	5
Filter No. 5 Rewash Valve	Close	DO	HSB-5265	5
Filter No. 5 Rewash Valve	Opened	DI	ZIO-5265	5
Filter No. 5 Rewash Valve	Closed	DI	ZIC-5265	5
Filter No. 5 Surface Wash	Energize	DO	HS-5245	5
Filter No. 6	Level	AI	LI-5406	5
Filter No. 6	Loss-of Head	AI	PDIT-5406	5
Filter No. 6	Effluent Turbidity	AI	AI-5446	5
Filter No. 6	Effluent Flow Rate	AI	FI-5426	5
Filter No. 6 Influent Valve	Remote	DI	YN-5206	5
Filter No. 6 Influent Valve	Open	DO	HSA-5206	5
Filter No. 6 Influent Valve	Close	DO	HSB-5206	5
Filter No. 6 Influent Valve	Opened	DI	ZIO-5206	5
Filter No. 6 Influent Valve	Closed	DI	ZIC-5206	5
Filter No. 6 Effluent Valve	Remote	DI	YN-5306	5
Filter No. 6 Effluent Valve	Position	AO	SC-5306	5
Filter No. 6 Effluent Valve	Position	AI	SI-5306	5
Filter No. 6 Backwash Supply Valve	Remote	DI	YN-5286	5
Filter No. 6 Backwash Supply Valve	Open	DO	HSA-5286	5
Filter No. 6 Backwash Supply Valve	Close	DO	HSB-5286	5
Filter No. 6 Backwash Supply Valve	Opened	DI	ZIO-5286	5
Filter No. 6 Backwash Supply Valve	Closed	DI	ZIC-5286	5
Filter No. 6 Backwash Waste Valve	Remote	DI	YN-5226	5
Filter No. 6 Backwash Waste Valve	Open	DO	HSA-5226	5
Filter No. 6 Backwash Waste Valve	Close	DO	HSB-5226	5
Filter No. 6 Backwash Waste Valve	Opened	DI	ZIO-5226	5
Filter No. 6 Backwash Waste Valve	Closed	DI	ZIC-5226	5
Filter No. 6 Rewash Valve	Remote	DI	YN-5266	5
Filter No. 6 Rewash Valve	Open	DO	HSA-5266	5
Filter No. 6 Rewash Valve	Close	DO	HSB-5266	5
Filter No. 6 Rewash Valve	Opened	DI	ZIO-5266	5
Filter No. 6 Rewash Valve	Closed	DI	ZIC-5266	5
Filter No. 6 Surface Wash	Energize	DO	HS-5246	5

Service Description	State/Span	Type	Field Tag Number	RTU
Filter No. 7	Level	AI	LI-5407	5
Filter No. 7	Loss-of Head	AI	PDIT-5407	5
Filter No. 7	Effluent Turbidity	AI	AI-5447	5
Filter No. 7	Effluent Flow Rate	AI	FI-5427	5
Filter No. 7 Influent Valve	Remote	DI	YN-5207	5
Filter No. 7 Influent Valve	Open	DO	HSA-5207	5
Filter No. 7 Influent Valve	Close	DO	HSB-5207	5
Filter No. 7 Influent Valve	Opened	DI	ZIO-5207	5
Filter No. 7 Influent Valve	Closed	DI	ZIC-5207	5
Filter No. 7 Effluent Valve	Remote	DI	YN-5307	5
Filter No. 7 Effluent Valve	Position	AO	SC-5307	5
Filter No. 7 Effluent Valve	Position	AI	SI-5312	5
Filter No. 7 Backwash Supply Valve	Remote	DI	YN-5287	5
Filter No. 7 Backwash Supply Valve	Open	DO	HSA-5287	5
Filter No. 7 Backwash Supply Valve	Close	DO	HSB-5287	5
Filter No. 7 Backwash Supply Valve	Opened	DI	ZIO-5287	5
Filter No. 7 Backwash Supply Valve	Closed	DI	ZIC-5287	5
Filter No. 7 Backwash Waste Valve	Remote	DI	YN-5227	5
Filter No. 7 Backwash Waste Valve	Open	DO	HSA-5227	5
Filter No. 7 Backwash Waste Valve	Close	DO	HSB-5227	5
Filter No. 7 Backwash Waste Valve	Opened	DI	ZIO-5227	5
Filter No. 7 Backwash Waste Valve	Closed	DI	ZIC-5227	5
Filter No. 7 Rewash Valve	Remote	DI	YN-5267	5
Filter No. 7 Rewash Valve	Open	DO	HSA-5267	5
Filter No. 7 Rewash Valve	Close	DO	HSB-5267	5
Filter No. 7 Rewash Valve	Opened	DI	ZIO-5267	5
Filter No. 7 Rewash Valve	Closed	DI	ZIC-5267	5
Filter No. 7 Surface Wash	Energize	DO	HS-5247	5
Filter No. 8	Level	AI	LI-5408	5
Filter No. 8	Loss-of Head	AI	PDIT-5408	5
Filter No. 8	Effluent Turbidity	AI	AI-5448	5
Filter No. 8	Effluent Flow Rate	AI	FI-5428	5
Filter No. 8 Influent Valve	Remote	DI	YN-5208	5
Filter No. 8 Influent Valve	Open	DO	HSA-5208	5
Filter No. 8 Influent Valve	Close	DO	HSB-5208	5
Filter No. 8 Influent Valve	Opened	DI	ZIO-5208	5
Filter No. 8 Influent Valve	Closed	DI	ZIC-5208	5
Filter No. 8 Effluent Valve	Remote	DI	YN-5308	5
Filter No. 8 Effluent Valve	Position	AO	SC-5308	5
Filter No. 8 Effluent Valve	Position	AI	SI-5312	5
Filter No. 8 Backwash Supply Valve	Remote	DI	YN-5288	5
Filter No. 8 Backwash Supply Valve	Open	DO	HSA-5288	5
Filter No. 8 Backwash Supply Valve	Close	DO	HSB-5288	5
Filter No. 8 Backwash Supply Valve	Opened	DI	ZIO-5288	5
Filter No. 8 Backwash Supply Valve	Closed	DI	ZIC-5288	5
Filter No. 8 Backwash Waste Valve	Remote	DI	YN-5228	5
Filter No. 8 Backwash Waste Valve	Open	DO	HSA-5228	5
Filter No. 8 Backwash Waste Valve	Close	DO	HSB-5228	5
Filter No. 8 Backwash Waste Valve	Opened	DI	ZIO-5228	5
Filter No. 8 Backwash Waste Valve	Closed	DI	ZIC-5228	5
Filter No. 8 Rewash Valve	Remote	DI	YN-5268	5
Filter No. 8 Rewash Valve	Open	DO	HSA-5268	5
Filter No. 8 Rewash Valve	Close	DO	HSB-5268	5
Filter No. 8 Rewash Valve	Opened	DI	ZIO-5268	5
Filter No. 8 Rewash Valve	Closed	DI	ZIC-5268	5
Filter No. 8 Surface Wash	Energize	DO	HS-5248	5
RTU Intrusion Alarm		DI		5
Filter No. 9	Level	AI	LI-5409	6
Filter No. 9	Loss-of Head	AI	PDIT-5409	6
Filter No. 9	Effluent Turbidity	AI	AI-5449	6
Filter No. 9	Effluent Flow Rate	AI	FI-5429	6
Filter No. 9 Influent Valve	Remote	DI	YN-5209	6
Filter No. 9 Influent Valve	Open	DO	HSA-5209	6
Filter No. 9 Influent Valve	Close	DO	HSB-5209	6
Filter No. 9 Influent Valve	Opened	DI	ZIO-5209	6
Filter No. 9 Influent Valve	Closed	DI	ZIC-5209	6
Filter No. 9 Effluent Valve	Remote	DI	YN-5309	6
Filter No. 9 Effluent Valve	Position	AO	SC-5309	6
Filter No. 9 Effluent Valve	Position	AI	SI-5312	6
Filter No. 9 Backwash Supply Valve	Remote	DI	YN-5289	6
Filter No. 9 Backwash Supply Valve	Open	DO	HSA-5289	6
Filter No. 9 Backwash Supply Valve	Close	DO	HSB-5289	6

Service Description	State/Span	Type	Field Tag Number	RTU
Filter No. 9 Backwash Supply Valve	Opened	DI	ZIO-5289	6
Filter No. 9 Backwash Supply Valve	Closed	DI	ZIC-5289	6
Filter No. 9 Backwash Waste Valve	Remote	DI	YN-5229	6
Filter No. 9 Backwash Waste Valve	Open	DO	HSA-5229	6
Filter No. 9 Backwash Waste Valve	Close	DO	HSB-5229	6
Filter No. 9 Backwash Waste Valve	Opened	DI	ZIO-5229	6
Filter No. 9 Backwash Waste Valve	Closed	DI	ZIC-5229	6
Filter No. 9 Rewash Valve	Remote	DI	YN-5269	6
Filter No. 9 Rewash Valve	Open	DO	HSA-5269	6
Filter No. 9 Rewash Valve	Close	DO	HSB-5269	6
Filter No. 9 Rewash Valve	Opened	DI	ZIO-5269	6
Filter No. 9 Rewash Valve	Closed	DI	ZIC-5269	6
Filter No. 9 Surface Wash	Energize	DO	HS-5249	6
Filter No. 10	Level	AI	LI-5410	6
Filter No. 10	Loss-of Head	AI	PDIT-5410	6
Filter No. 10	Effluent Turbidity	AI	AI-5450	6
Filter No. 10	Effluent Flow Rate	AI	FI-5430	6
Filter No. 10 Influent Valve	Remote	DI	YN-5210	6
Filter No. 10 Influent Valve	Open	DO	HSA-5210	6
Filter No. 10 Influent Valve	Close	DO	HSB-5210	6
Filter No. 10 Influent Valve	Opened	DI	ZIO-5210	6
Filter No. 10 Influent Valve	Closed	DI	ZIC-5210	6
Filter No. 10 Effluent Valve	Remote	DI	YN-5310	6
Filter No. 10 Effluent Valve	Position	AO	SC-5310	6
Filter No. 10 Effluent Valve	Position	AI	SI-5312	6
Filter No. 10 Backwash Supply Valve	Remote	DI	YN-5290	6
Filter No. 10 Backwash Supply Valve	Open	DO	HSA-5290	6
Filter No. 10 Backwash Supply Valve	Close	DO	HSB-5290	6
Filter No. 10 Backwash Supply Valve	Opened	DI	ZIO-5290	6
Filter No. 10 Backwash Supply Valve	Closed	DI	ZIC-5290	6
Filter No. 10 Backwash Waste Valve	Remote	DI	YN-5230	6
Filter No. 10 Backwash Waste Valve	Open	DO	HSA-5230	6
Filter No. 10 Backwash Waste Valve	Close	DO	HSB-5230	6
Filter No. 10 Backwash Waste Valve	Opened	DI	ZIO-5230	6
Filter No. 10 Backwash Waste Valve	Closed	DI	ZIC-5230	6
Filter No. 10 Rewash Valve	Remote	DI	YN-5270	6
Filter No. 10 Rewash Valve	Open	DO	HSA-5270	6
Filter No. 10 Rewash Valve	Close	DO	HSB-5270	6
Filter No. 10 Rewash Valve	Opened	DI	ZIO-5270	6
Filter No. 10 Rewash Valve	Closed	DI	ZIC-5270	6
Filter No. 10 Surface Wash	Energize	DO	HS-5250	6
Filter No. 11	Level	AI	LI-5411	6
Filter No. 11	Loss-of Head	AI	PDIT-5411	6
Filter No. 11	Effluent Turbidity	AI	AI-5451	6
Filter No. 11	Effluent Flow Rate	AI	FI-5431	6
Filter No. 11 Influent Valve	Remote	DI	YN-5211	6
Filter No. 11 Influent Valve	Open	DO	HSA-5211	6
Filter No. 11 Influent Valve	Close	DO	HSB-5211	6
Filter No. 11 Influent Valve	Opened	DI	ZIO-5211	6
Filter No. 11 Influent Valve	Closed	DI	ZIC-5211	6
Filter No. 11 Effluent Valve	Remote	DI	YN-5311	6
Filter No. 11 Effluent Valve	Position	AO	SC-5311	6
Filter No. 11 Effluent Valve	Position	AI	SI-5312	6
Filter No. 11 Backwash Supply Valve	Remote	DI	YN-5291	6
Filter No. 11 Backwash Supply Valve	Open	DO	HSA-5291	6
Filter No. 11 Backwash Supply Valve	Close	DO	HSB-5291	6
Filter No. 11 Backwash Supply Valve	Opened	DI	ZIO-5291	6
Filter No. 11 Backwash Supply Valve	Closed	DI	ZIC-5291	6
Filter No. 11 Backwash Waste Valve	Remote	DI	YN-5231	6
Filter No. 11 Backwash Waste Valve	Open	DO	HSA-5231	6
Filter No. 11 Backwash Waste Valve	Close	DO	HSB-5231	6
Filter No. 11 Backwash Waste Valve	Opened	DI	ZIO-5231	6
Filter No. 11 Backwash Waste Valve	Closed	DI	ZIC-5231	6
Filter No. 11 Rewash Valve	Remote	DI	YN-5271	6
Filter No. 11 Rewash Valve	Open	DO	HSA-5271	6
Filter No. 11 Rewash Valve	Close	DO	HSB-5271	6
Filter No. 11 Rewash Valve	Opened	DI	ZIO-5271	6
Filter No. 11 Rewash Valve	Closed	DI	ZIC-5271	6
Filter No. 11 Surface Wash	Energize	DO	HS-5251	6
Filter No. 12	Level	AI	LI-5412	6
Filter No. 12	Loss-of Head	AI	PDIT-5412	6
Filter No. 12	Effluent Turbidity	AI	AI-5452	6
Filter No. 12	Effluent Flow Rate	AI	FI-5432	6

Service Description	State/Span	Type	Field Tag Number	RTU
Filter No. 12 Influent Valve	Remote	DI	YN-5212	6
Filter No. 12 Influent Valve	Open	DO	HSA-5212	6
Filter No. 12 Influent Valve	Close	DO	HSB-5212	6
Filter No. 12 Influent Valve	Opened	DI	ZIO-5212	6
Filter No. 12 Influent Valve	Closed	DI	ZIC-5212	6
Filter No. 12 Effluent Valve	Remote	DI	YN-5312	6
Filter No. 12 Effluent Valve	Position	AO	SC-5312	6
Filter No. 12 Effluent Valve	Position	AI	SI-5312	6
Filter No. 12 Backwash Supply Valve	Remote	DI	YN-5292	6
Filter No. 12 Backwash Supply Valve	Open	DO	HSA-5292	6
Filter No. 12 Backwash Supply Valve	Close	DO	HSB-5292	6
Filter No. 12 Backwash Supply Valve	Opened	DI	ZIO-5292	6
Filter No. 12 Backwash Supply Valve	Closed	DI	ZIC-5292	6
Filter No. 12 Backwash Waste Valve	Remote	DI	YN-5232	6
Filter No. 12 Backwash Waste Valve	Open	DO	HSA-5232	6
Filter No. 12 Backwash Waste Valve	Close	DO	HSB-5232	6
Filter No. 12 Backwash Waste Valve	Opened	DI	ZIO-5232	6
Filter No. 12 Backwash Waste Valve	Closed	DI	ZIC-5232	6
Filter No. 12 Rewash Valve	Remote	DI	YN-5272	6
Filter No. 12 Rewash Valve	Open	DO	HSA-5272	6
Filter No. 12 Rewash Valve	Close	DO	HSB-5272	6
Filter No. 12 Rewash Valve	Opened	DI	ZIO-5272	6
Filter No. 12 Rewash Valve	Closed	DI	ZIC-5272	6
Filter No. 12 Surface Wash	Energize	DO	HS-5252	6
RTU Intrusion Alarm		DI		6
Emergency Eyewash/Shower Station - Caustic Room	Activated	DI		2
Emergency Eyewash/Shower Station - Caustic Room	Activated	DI		2
Emergency Eyewash/Shower Station - Ferric Room	Activated	DI		2
Emergency Eyewash/Shower Station - Fluoride Room	Activated	DI		2
Emergency Eyewash/Shower Station - Fluoride Room (Exterior)	Activated	DI		2
Emergency Eyewash/Shower Station - Bulk Storage Tank Room	Activated	DI		2
Emergency Eyewash/Shower Station - Hypo Pump Room	Activated	DI		2
Emergency Eyewash/Shower Station - Hypo Storage Tank Room	Activated	DI		2
Emergency Eyewash/Shower Station - Hypo Storage (Fill Station)	Activated	DI		2
Emergency Eyewash/Shower Station - Ammonia Bldg	Activated	DI		3

P. O. HOFFER WTP (ALTERNATE BID)

Service Description	State/Span	Type	Field Tag Number	RTU
North 36" Raw Water Flow		AI	FI-10401	See Note 1
South 36" Raw Water Flow		AI	FI-10402	See Note 1
Air Compressor No. 1	Run	DI		See Note 1
Air Compressor No. 1	Fail	DI		See Note 1
Air Compressor No. 2	Run	DI		See Note 1
Air Compressor No. 2	Fail	DI		See Note 1
Carbon Slurry Tank No. 1 Dilution Water Flow		AI	FI-51400	RTU-15
Carbon Slurry Tank Mixer MXR-51001	Auto	DI	YNA-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001	Run	DI	YNB-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001	General Fail	DI	YA-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001	Start/Stop	DO	HS-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001 E-Stop	Activated	DI	YA-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001 Speed Control	0 - 100%	AO	SC-51001	RTU-15
Carbon Slurry Tank Mixer MXR-51001 Speed Feedback	0 - 100%	AI	SI-51001	RTU-15
Carbon Slurry Tank No. 1 Level		AI	LI-51401	RTU-15
Carbon Slurry Tank No. 1 Level Alarm	High	DI	LSH-51401	RTU-15
Carbon Slurry Tank Mixer MXR-51002	Auto	DI	YNA-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002	Run	DI	YNB-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002	General Fail	DI	YA-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002	Start/Stop	DO	HS-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002 E-Stop	Activated	DI	YA-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002 Speed Control	0 - 100%	AO	SC-51002	RTU-15
Carbon Slurry Tank Mixer MXR-51002 Speed Feedback	0 - 100%	AI	SI-51002	RTU-15

Service Description	State/Span	Type	Field Tag Number	RTU
Carbon Slurry Tank No. 2 Level		AI	LI-51402	RTU-15
Carbon Slurry Tank No. 2 Level Alarm	High	DI	LSH-51402	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Run	DI	YNA-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	In Remote	DI	YNB-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Drive Fault	DI	YA-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Start/Stop	DO	HS-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Speed	AO	SC-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Speed Feedback	AI	SI-51010	RTU-15
Carbon Metering Pump No. 1 (PACMP-1)	Hose Failed	DI	YAH-51010	RTU-15
Carbon Metering Pump No. 1 High Discharge Pressure	High	DI	PAH-51010	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	Run	DI	YNA-51020	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	In Remote	DI	YNB-51020	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	Drive Fault	DI	YA-51020	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	Start/Stop	DO	HS-51020	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	Speed	AO	SC-51020	RTU-15
Carbon Metering Pump No. 1 (PACMP-2)	Speed Feedback	DI	YAH-51020	RTU-15
Carbon Metering Pump No. 2 (PACMP-2)	Hose Failed	AI	SI-51020	RTU-15
Carbon Metering Pump No. 2 High Discharge Pressure	High	DI	PAH-51020	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	Run	DI	YNA-51030	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	In Remote	DI	YNB-51030	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	Drive Fault	DI	YA-51030	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	Start/Stop	DO	HS-51030	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	Speed	AO	SC-51030	RTU-15
Carbon Metering Pump No. 1 (PACMP-3)	Speed Feedback	DI	YAH-51030	RTU-15
Carbon Metering Pump No. 3 (PACMP-3)	Hose Failed	AI	SI-51030	RTU-15
Carbon Metering Pump No. 3 High Discharge Pressure	High	DI	PAH-51030	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	Run	DI	YNA-51040	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	In Remote	DI	YNB-51040	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	Drive Fault	DI	YA-51040	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	Start/Stop	DO	HS-51040	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	Speed	AO	SC-51040	RTU-15
Carbon Metering Pump No. 1 (PACMP-4)	Speed Feedback	DI	YAH-51040	RTU-15
Carbon Metering Pump No. 4 (PACMP-4)	Hose Failed	AI	SI-51040	RTU-15
Carbon Metering Pump No. 4 High Discharge Pressure	High	DI	PAH-51040	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	Run	DI	YNA-51050	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	In Remote	DI	YNB-51050	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	Drive Fault	DI	YA-51050	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	Start/Stop	DO	HS-51050	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	Speed	AO	SC-51050	RTU-15
Carbon Metering Pump No. 1 (PACMP-5)	Speed Feedback	DI	YAH-51050	RTU-15
Carbon Metering Pump No. 5 (PACMP-5)	Hose Failed	AI	SI-51050	RTU-15
Carbon Metering Pump No. 5 High Discharge Pressure	High	DI	PAH-51050	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	Run	DI	YNA-51060	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	In Remote	DI	YNB-51060	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	Drive Fault	DI	YA-51060	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	Start/Stop	DO	HS-51060	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	Speed	AO	SC-51060	RTU-15
Carbon Metering Pump No. 1 (PACMP-6)	Speed Feedback	DI	YAH-51060	RTU-15
Carbon Metering Pump No. 6 (PACMP-6)	Hose Failed	AI	SI-51060	RTU-15
Carbon Metering Pump No. 6 High Discharge Pressure	High	DI	PAH-51060	RTU-15
Carbon Room Emergency Eyewash/shower Activated	Alarm	DI	FAH-51411	RTU-15
Carbon Fill Station Emergency Eyewash/shower Activated	Alarm	DI	FAH-51412	RTU-15
PAC Chemical Injection Manhole Level Alarm	High	DI	LAH-51409	RTU-15
Carbon Containment Area Sump Level Alarm	High	DI	LAH-51408	RTU-15

P. O. HOFFER WTP (BASE BID)

Filtered Water Mixing Vault Sump Level	High	DI	LAH-43401	RTU-10
FW Mixing Vault 54" Valve To Clearwell 1	Auto	DI	YN-43201	RTU-10
FW Mixing Vault 54" Valve To Clearwell 1	Closed	DI	ZIC-43201	RTU-10
FW Mixing Vault 54" Valve To Clearwell 1	Opened	DI	ZIO-43201	RTU-10
FW Mixing Vault 54" Valve To Clearwell 1	Close	DO	ZSC-43201	RTU-10
FW Mixing Vault 54" Valve To Clearwell 1	Open	DO	ZSO-43201	RTU-10

Service Description	State/Span	Type	Field Tag Number	RTU
FW Mixing Vault 54" Valve To Clearwell 2	Auto	DI	YN-43202	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2	Closed	DI	ZIC-43202	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2	Opened	DI	ZIO-43202	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2	Close	DO	ZSC-43202	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2	Open	DO	ZSO-43202	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2 & 12 MG Clearwell	Auto	DI	YN-43203	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2 & 12 MG Clearwell	Closed	DI	ZIC-43203	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2 & 12 MG Clearwell	Opened	DI	ZIO-43203	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2 & 12 MG Clearwell	Close	DO	ZSC-43203	RTU-10
FW Mixing Vault 54" Valve To Clearwell 2 & 12 MG Clearwell	Open	DO	ZSO-43203	RTU-10
Filter Water Mixing Vault Mixer MXR-43001	Auto	DI	YNA-43001	RTU-10
Filter Water Mixing Vault Mixer MXR-43001	Run	DI	YNB-43001	RTU-10
Filter Water Mixing Vault Mixer MXR-43001	Fail	DI	YA-43001	RTU-10
Filter Water Mixing Vault Mixer MXR-43001	Start/Stop	DO	HS-43001	RTU-10
Filter Water Mixing Vault Mixer MXR-43002	Auto	DI	YNA-43002	RTU-10
Filter Water Mixing Vault Mixer MXR-43002	Run	DI	YNB-43002	RTU-10
Filter Water Mixing Vault Mixer MXR-43002	Fail	DI	YA-43002	RTU-10
Filter Water Mixing Vault Mixer MXR-43002	Start/Stop	DO	HS-43002	RTU-10
Existing High Service Pump No. 1	Auto	DI		RTU-17
Existing High Service Pump No. 1	Run	DI		RTU-17
Existing High Service Pump No. 1	General Fail	DI		RTU-17
Existing High Service Pump No. 1 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 1 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 1 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 1 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 1 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 2	Auto	DI		RTU-17
Existing High Service Pump No. 2	Run	DI		RTU-17
Existing High Service Pump No. 2	General Fail	DI		RTU-17
Existing High Service Pump No. 2 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 2 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 2 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 2 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 2 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 3	Auto	DI		RTU-17
Existing High Service Pump No. 3	Run	DI		RTU-17
Existing High Service Pump No. 3	General Fail	DI		RTU-17
Existing High Service Pump No. 3 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 3 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 3 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 3 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 3 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 4	Auto	DI		RTU-17
Existing High Service Pump No. 4	Run	DI		RTU-17
Existing High Service Pump No. 4	General Fail	DI		RTU-17
Existing High Service Pump No. 4 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 4 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 4 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 4 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 4 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 5	Auto	DI		RTU-17
Existing High Service Pump No. 5	Run	DI		RTU-17
Existing High Service Pump No. 5	General Fail	DI		RTU-17
Existing High Service Pump No. 5 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 5 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 5 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 5 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 5 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 6 (VFD)	Auto	DI		RTU-17
Existing High Service Pump No. 6 (VFD)	Run	DI		RTU-17
Existing High Service Pump No. 6 (VFD)	General Fail	DI		RTU-17

Service Description	State/Span	Type	Field Tag Number	RTU
Existing High Service Pump No. 6 (VFD)	VFD Fault	DI		RTU-17
Existing High Service Pump No. 6 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 6 Speed Feedback (VFD)	0 - 100%	AI		RTU-17
Existing High Service Pump No. 6 Speed Control (VFD)	0 - 100%	AO		RTU-17
Existing High Service Pump No. 6 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 6 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 6 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 6 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 7	Auto	DI		RTU-17
Existing High Service Pump No. 7	Run	DI		RTU-17
Existing High Service Pump No. 7	General Fail	DI		RTU-17
Existing High Service Pump No. 7 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 7 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 7 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 7 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 7 - Cone Valve Status	Closed	DI		RTU-17
Existing High Service Pump No. 8 (VFD)	Auto	DI		RTU-17
Existing High Service Pump No. 8 (VFD)	Run	DI		RTU-17
Existing High Service Pump No. 8 (VFD)	Fail	DI		RTU-17
Existing High Service Pump No. 8 (VFD)	VFD Fault	DI		RTU-17
Existing High Service Pump No. 8 Control	Start/Stop	DO		RTU-17
Existing High Service Pump No. 8 Speed Feedback (VFD)	0 - 100%	AI		RTU-17
Existing High Service Pump No. 8 Speed Control (VFD)	0 - 100%	AO		RTU-17
Existing High Service Pump No. 8 Motor Protection Relay	MPR Tripped	DI		RTU-17
Existing High Service Pump No. 8 Emergency Stop	Activated	DI		RTU-17
Existing High Service Pump No. 8 - Cone Valve Status	Open	DI		RTU-17
Existing High Service Pump No. 8 - Cone Valve Status	Closed	DI		RTU-17
Filter Backwash Supply Pump	Auto	DI		RTU-17
Filter Backwash Supply Pump	Run	DI		RTU-17
Filter Backwash Supply Pump	General Fail	DI		RTU-17
Filter Backwash Supply Pump Motor Protection Relay	MPR Tripped	DI		RTU-17
Filter Backwash Supply Pump Control	Start/Stop	DO		RTU-17
Filter Backwash Supply Pump Emergency Stop	Activated	DI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 1 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 2 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Phase B Voltage	NAI		RTU-17

Service Description	State/Span	Type	Field Tag Number	RTU
Finished Water Pump No. 3 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 3 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 4 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 5 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 6 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17

Service Description	State/Span	Type	Field Tag Number	RTU
Finished Water Pump No. 7 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 7 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	kW	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Power Factor	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase A Current	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase B Current	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Phase C Current	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Vibration	NDI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Pump Bearing Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Finished Water Pump No. 8 Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Backwash Pump Motor Protection Relay	kW	NAI		RTU-17
Backwash Pump Motor Protection Relay	Power Factor	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase A Voltage	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase B Voltage	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase C Voltage	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase A Current	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase B Current	NAI		RTU-17
Backwash Pump Motor Protection Relay	Phase C Current	NAI		RTU-17
Backwash Pump Motor Protection Relay	Motor Vibration	NDI		RTU-17
Backwash Pump Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Backwash Pump Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
Backwash Pump Motor Protection Relay	Motor Winding Temp.	NAI		RTU-17
THE FOLLOWING ALARM I/O POINTS SHALL BE PROVIDED IN ALL PLC ENCLOSURE UNDER THIS CONTRACT				
PLC Panel Intrusion Alarm	On	DI	YA-XXXXX	Note 2
PLC Enclosure Internal Temperature Alarm	High	DI	TAH-XXXXX	Note 2
Utility Power Alarm	Failed	DI	JA-XXXXX	Note 2
PLC Panel UPS Alarm	Loss of Power	DI	UPS-XXXXX	Note 2
PLC Panel UPS Battery Alarm	Low	DI	BAT-XXXXX	Note 2
PLC Panel 24 VDC P.S. Alarm	Failed	DI	PWR-XXXXX	Notes 2,3

NOTES:

1. Signals shall be connected to the exisitng "RAW WATER MONITORING PANEL" located in the Raw Water Pump Station at P.O. Hoffer WTP. Existing PLC is WAGO PLC.

2. Replace "-XXXX" with PLC designation listed above..

3. Power supply failure alarm shall be provided for each power supply in PLC (i.e., P.S. for loop-powered instruments and P.S. for discrete signals as appropriate).

4. RTU-10 is existing RTU and located at the Ammonia Building as shown on Contract Drawing E10.

SECTION 17950

FUNCTIONAL CONTROL DESCRIPTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FURNISHING COMPLETE FUNCTIONING SYSTEMS AS DESCRIBED HEREIN.

B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.

C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.

D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Contractor through individual equipment suppliers.

E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the Contractor under Division 16. The Contractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01520 – Maintenance of Utility Operations During Construction

B. Section 17910 – Instrument Schedule

C. Section 17920 – Control System Input/Output Schedule

PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

2.01 DEFINITIONS

A. RUNNING status signals shall be from auxiliary contacts provided with the motor control

equipment (i.e., starter, VFD, SCR, etc.).

B. AUTO status signals shall be defined as HAND-OFF-AUTO switch in the AUTO position or process control system in AUTO (versus MANUAL).

C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.

D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

2.02 CONVENTIONS

A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:

Condition	Color
Running/On/Open	Green
Auto/Ready	White
Stopped/Off/Closed	Red
Fail/Alarm	Amber
Generic Status	Blue or White

2.03 PROCESS CONTROL

A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.

B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:

1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.

3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).

4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.

C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control

constants shall be accessible and alterable from the existing operator workstations (OWS).

D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.

E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.

F. Equipment failure shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.

G. Instrument failure shall be generated via the operator work stations for any instrument which is generating a signal which is less than 4 mA or greater than 20 mA.

H. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.

I. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the existing operator workstations.

PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS (**GLENVILLE LAKE WTP**)

PART 3 – TABLE OF CONTENTS	
3.01	FILTERS – NORMAL FILTRATION AND BACKWASH
3.02	EXISTING PLC PROGRAMS – RTU-1, RTU-2, AND RTU-3

3.01 FILTRATION

A. Process Overview

1. Twelve existing conventional dual media filters at the Glenville Lake Water Treatment Facility are currently operated in manual via existing filter consoles located on the filter gallery. Existing filter valves are currently equipped with electric actuators. Under this Contract, all filters shall be controlled by new PLC's, designated as RTU-4, -5, and -6. One RTU shall provide control for every four filters. For control interface with the RTUs, a new SCADA HMI workstation shall be provided in the filter gallery area to allow plant operator with access to the control system to perform filter backwash for each filter.

2. Existing filter effluent Venturi flow meter, filter effluent turbidity meter, and filter loss-of-head differential pressure transmitter are currently provided for each existing filter. One (1) new ultrasonic level sensor and transmitter shall be added

under this Contract for each filter. Existing filter effluent rate-of-flow control valve shall also be controlled automatically by new PLC to maintain constant filter rate setpoints as entered by the plant operator.

B. Control Equipment

1. Existing motorized OPEN/CLOSE valves are:

   a. Filter Influent

   b. Backwash Supply

   c. Backwash Drain

   d. Rewash valve

2. Existing modulating valves are provided for each filter:

   a. Filter Effluent

   The butterfly valves serving this application shall be replaced under this Contract as specified in Division 15. The existing electric actuators shall be reused (see Contract Drawings for details).

3. The following existing open/close valve shall be opened or closed by energizing the existing solenoid on each valve:

   a. Surface Wash

4. One existing constant speed filter backwash pump (WSW pump 7001), an existing backwash supply venturi flow meter (FI-7406) and an existing modulating flow control valve (MOV-7206) shall be reused.

5. One new ultrasonic level sensor and transmitter shall be provided for each new filter.

6. Two new ultrasonic level sensors and transmitters, LE/LIT -4401A and LE/LIT – 4401B (one primary and one standby) shall be provided for the sedimentation basin effluent channel to replace the existing level capacitance probe.

C. Control Operations

1. The RTU shall monitor and display the following at the SCADA OWS and HMI tablet for each filter:

   a. The status of each filter (normal filtration mode, backwash mode, rewash mode, filter out-of-service)

b. Position of all filter valves – Open/Close status of O/C valves and % open for Filter Effluent Valve

c. Filter effluent flow (in MGD), filter water level (in feet), loss-of-head differential pressure (in feet), and filter effluent turbidity (in NTU).

d. Sedimentation basin effluent channel level (in feet).

e. Actual filter run (in service) time (in hours) and total time between backwashes (in hours).

f. Total backwash water volume (in gallons).

3.01.1 NORMAL FILTRATION

A. Process Overview

1. The RTU shall allow each filter to be operated either manually or semi-automatically during normal filtration from the HMI, OIU, or tablet.

B. Control Operations

1. During normal filtration, the filter valve position shall be as follows:

a. Filter Influent – opened

b. Backwash Supply – closed

c. Backwash Waste – closed

d. Surface Wash – solenoid energized (closed)

e. Rewash – closed

f. Filter effluent – open (modulating)

2. During normal filtration, the RTU shall control the flow through the filters that are in-service uniformly by modulating the filter effluent rate-of-flow control valves to maintain a common flow setpoint through all filters. In addition, the filter effluent rate-of-flow controls shall respond to the master level controller in order to maintain a level setpoint in the sedimentation basin effluent channel. The operator shall input this adjustable level setpoint at the HMI or OIU. Cascade control shall be used in which the level control (primary loop) shall be the master controller and the individual flow loops (secondary loops) shall be the slave controllers. The common flow setpoint for the filter effluent rate-of-flow controls shall be derived by taking the total plant raw water flow divided by the numbers of filter in-service.

3. During normal filter operation, the differential pressure transmitter provided at each filter shall transmit an analog signal proportional to filter head loss to the RTU. If the filter loss of head reaches the “high” loss of head alarm setpoint (initially set at

5 feet) operations shall receive an alarm at the HMI, OIU, and tablet. As the head loss increases to a “high-high” alarm setpoint (initially set at 6 feet) or the filter effluent valve has reached 100% open, operations shall be notified that a filter backwash is immediately required and the specified filter shall be placed at the head of the queue. Loss-of-head setpoint shall be adjustable from the HMI and the OIU.

4. During normal filter operation, the filter effluent turbidity analyzer shall transmit an analog signal proportional to the filter effluent turbidity (to two decimal places) to the RTU. If the turbidity reaches the “high” alarm setpoint (initially set at 0.10 NTU) operations shall receive an alarm at the HMI and OIU. As the turbidity increases to a “high-high” alarm setpoint (initially set at 0.20 NTU), operations shall be notified that a backwash is immediately required and the specified filter shall be placed at the head of the queue. The filter effluent turbidity setpoint shall be adjustable from the SCADA HMI and the OIU.

5. During normal filter operation, the filter run time for each filter shall be continuously displayed at the HMI, OIU, and tablet. Upon the filter approaching 95% of the operator entered maximum allowable filter run time, operations shall receive an alarm at the HMI and OIU. Upon the filter reaching 100% of the maximum allowable filter run time, operations shall be notified that a backwash is immediately required and the specified filter shall be placed at the head of the queue. Maximum allowable filter runtime shall be adjustable from the HMI and the OIU.

6. When Operations places a filter “out-of-service”, the RTU shall place all of the filter valves on the filter taken out of service into the closed position. Each time a filter is taken “out-of-service”, the remaining filters shall evenly share the filter influent flow normally handled by the filter taken out of service.

3.01.2 FILTER BACKWASH

A. Process Overview

1. Filter controls shall allow each filter to be backwashed through the HMI, OIU, or tablet either manually or semi-automatically during normal filtration. The RTU shall allow only one filter to be backwashed at a time. The RTU shall allow a filter to backwash when up to two (2) filters are in the Rewash cycle.

B. Control Operations

1. Filter backwashes in either the manual or semi-automatic mode shall be initiated by the operator at the HMI, OIU, or tablet. Manual backwash mode shall require the operator to step through the backwashing steps manually. Semi-automatic mode shall require the operator to initialize the backwash sequence via a “Start Backwash” button associated with each filter. The operator shall be able to view the filter backwash queue in order to know which filter will be backwashed.

2. Prior to initiating a filter backwash, the RTU shall determine if there is adequate volume in the Washwater/Sludge Equalization Tank (EQ tank) to receive the volume of washwater generated from both a backwash and rewash cycle of a filter.

This calculation shall be based on the current water level in the EQ tank using an existing ultrasonic level sensor (LI-9401) and the volume of water required to perform both a filter backwash and a filter rewash. The volume of filter backwash water shall be calculated as the sum of the individual backwash step wash rates (in gpm) multiplied by the duration of the individual backwash steps (in min). The volume of the filter rewash shall be calculated as the prevailing individual filtration rate (in gpm) multiplied by the rewash duration (in min). If the calculated water level in the EQ tank following a backwash and rewash cycle is anticipated to exceed an operator-entered maximum water level setpoint, then the RTU shall generate an alarm condition, but shall not prevent the operator from initiating a backwash.

3. The operators shall enter the following backwash parameters at the HMI and OIU:

   a. Surface Wash duration

   b. Simultaneous surface wash/low backwash 1 rate/duration

   c. Low backwash 2 rate/duration

   d. High backwash rate/duration

   e. Low backwash 3 rate/duration

   f. Rewash cycle duration (minimum rewash time, turbidity setpoint to terminate rewash, and time duration that the turbidity value stays at setpoint before rewash cycle can be terminated)

   g. Maximum allowable filter runtime

   h. Maximum loss of head (“high” and “high-high” setpoints)

   i. Maximum turbidity (“high” and “high-high” setpoints)

   All backwash parameters, flow rates, durations and alarm setpoints shall be password protected and fully adjustable.

4. Once a backwash is initiated, the filter rate-of-flow controller shall no longer respond to the sedimentation basin effluent channel level controller setpoint flow rate. The remaining filters in service shall adjust their filter effluent flow rate accordingly to maintain the sedimentation basin effluent channel level and distribute the flow evenly among the remaining filters in service.

5. In the following backwash sequence, the RTU shall not continue to the next step in the sequence unless confirmation of the appropriate opened or closed limit switch of the valve has been received by the RTU.

6. In the following backwash sequence, a “Pause” feature shall be available to the operator to select at any point in the sequence to maintain the operations of the current backwash step. Operator shall be asked to confirm “Pause” selection prior to RTU pausing at the current step in the backwash sequence. At this time, the

elapsed time of the current step in the backwash sequence shall also be “paused” temporarily. The RTU shall not continue forward with the backwash sequence until the “Pause” function is released by the operator. Upon release of the “Pause” selection, the RTU shall likewise release the “pause” of the elapsed time of the current step allowing the step to complete its prescribed duration. The duration of the “Pause” and the backwash volume used during this operation shall be recorded and reflected in backwash duration and volume use calculations and trends described below.

7. In the following backwash sequence, a “Skip” feature shall be available to the operator at any point over the duration of the sequence to end the active step of the sequence and begin the next step. Operator shall be asked to confirm “Skip” selection prior to RTU moving forward to the next step in the backwash sequence. Impacts to backwash duration and volume use as a result of initiating the “Skip” feature shall be reflected accordingly in the backwash trends described below.

8. Backwash Sequence (Semi-Automatic Mode)

   a. The filter backwash sequence shall begin with the closing of the filter influent valve. Closing the filter influent valve shall also stop the run (filter in service) clock for the filter run time. The filter shall continue to process water (filter effluent valve shall remain in its previous position) until the level is drawn down to approximately 6 inches above the top of the filter media as measured by the ultrasonic level sensor. While an alarm shall occur if the minimum filter level is not obtained within 10 minutes (initial setting), the backwash sequence shall continue. At this point, the filter rate-of-flow controller setpoint shall be reset by the control system to zero flow, which shall close the filter effluent valve. The backwash drain valve shall then open. The surface wash valve shall open and surface wash water shall be provided to the filter for 3 minutes (initial setting).

   b. At the end of the initial surface wash, the surface wash shall remain energized and the backwash supply pump shall be started against a closed backwash supply valve. After a time delay of 15 seconds (initial setting), the backwash supply valve shall then open, and the first low wash cycle shall begin. Simultaneously, the RTU shall modulate the backwash flow control valve up to the low backwash 1 rate, 5 gpm/sf = 1,800 gpm (initial setting). Surface wash and low backwash shall operate concurrently for a pre-set time duration of 3 minutes (initial setting). At the end of this cycle the surface wash valve shall close.

   c. After the surface wash valve has de-energized, the second low wash cycle shall begin. The RTU shall slowly modulate the backwash flow control valve as necessary to achieve the low backwash 2 rate, 5 gpm/sf = 1,800 gpm (initial setting) for 5 minutes (initial setting).

   e. After the second low wash, the backwash control valve shall slowly open further to maintain a high wash rate of 15 gpm/sf = 5,400 gpm (initial setting) for 15 minutes (initial settings). After the high wash, the backwash control valve shall close to allow a third low backwash rate of 5 gpm/sf =

1,800 gpm (initial setting) for 5 minutes (initial settings). At the end of the third low wash cycle, the backwash supply valve shall close. The backwash pump shall stop and the backwash drain valve shall close.

f. At the end of the backwash cycle, the filter influent valve shall open with the filter effluent valve remaining closed. The filter shall fill to its normal operating level as measured by new ultrasonic level sensors. Once the normal level is reached, the Rewash Cycle (Filter-to-Waste) shall be automatically initiated by opening the Rewash valve.

g. When the Rewash cycle begins, the common flow setpoint for the filter effluent rate-of-flow controls shall be derived by taking the total plant raw water flow divided by the numbers of filter in-service and in rewash.

h. The Rewash cycle shall continue for 20 minutes (initial setting). The filter effluent turbidity shall be monitored continuously throughout the rewash cycle duration. At the end of the Rewash cycle, the RTU shall determine if the filter effluent turbidity has been maintained at 0.1 NTU (initial setting) and has remained at or below this turbidity setpoint for a duration of 3 minutes (initial setting). If the filter effluent turbidity has been at or below the turbidity setpoint for the prescribed duration, then the RTU shall alert operations at the HMI, OIU and tablet that the filter is ready to be placed back into service. The operator shall then place the filter back into service. If the turbidity setpoint is not obtained after the Rewash cycle duration (minimum rewash time setpoint), an alarm shall be displayed at the HMI, OIU, and tablet. The operator shall then choose to either: 1.) continue the Rewash cycle until an acceptable turbidity level is achieved, 2.)initialize a full backwash sequence, or 3.)take the filter out-of-service. In the event that the Rewash cycle continues, the operator shall be prompted at the HMI, OIU, and tablet once the acceptable turbidity level has been achieved and maintained for the prescribed duration. The operator shall then be prompted to place the filter back in service.

i. When placing the filter back in service, the RTU shall be programmed to activate a prompt to the operator to manually enter a starting position (in % valve opening) for the filter effluent rate-of-flow control valve. The valve shall then move to that position. Once the operator is satisfied with the current starting position of the filter effluent valve, the operator shall be required to acknowledge and return the valve to its normal filtration control strategy.

j. Upon placing the filter back into service from the HMI, OIU, or tablet, the rewash valve shall close simultaneously with the opening of the filter effluent valve. Once the filter rate of flow setpoint is achieved, the filter run (in-service) clock shall reset and begin recording filter run time. The RTU shall calculate and record the volume of wash water used.

k. When a filter is in the semi-automatic backwash mode, any disruption in the backwash cycle such as a valve position failure or power failure shall cause the RTU to abort the backwash sequence and take the filter out-of-

service, closing all filter valves. The filter shall remain out-of-service until the operator determines the reason for the disruption in the backwash cycle. After the reason for the disruption has been addressed, the filter shall be put into the top of backwash queue or shall be manually re-initiated by the operator to restart the filter backwash sequence. The following conditions shall activate a “Backwash Fail” alarm at the HMI, OIU, and tablet and shall cause the filter to be taken out-of-service:

i. Backwash pump fails to start
ii. Backwash pump fails
iii. No filter level signal is available
vi. “High-High” filter level is exceeded
v. Any filter valve fails to open or close, or fails to reach its setpoint position in the allotted time
vi. Plant power failure during backwash

9. Filter Backwash Priority Queue

a. A filter backwash priority queue shall be programmed in the RTU that shall prioritize filters that have met the operational criteria for a backwash. The Filter Backwash Priority Queue shall be programmed in each of the filter RTUs. The Queue can be used to schedule and prioritize backwash requests from all filters. Filters residing in the Queue shall continue operating in filtration mode until the backwash is initiated.

b. The operator shall be capable of performing the following actions at the Queue screen:

i. The operator shall be able to select a prioritization method for the Queue. Filters shall be capable of prioritization in order by the following criteria: filter effluent turbidity, filter media loss-of-head, or by current filter run time.

ii. All filters in-service and those removed-from-service shall be included in the Queue.

iii. Filters shall normally be prioritized in the Queue based on current filter run time where the filter with the longest run-time is placed at the top of the Queue – first in line for the next filter backwash. In this mode of operation, when the filter effluent turbidity high-high setpoint is exceeded for a specific filter, then that filter shall automatically be moved to the top of the Queue for the next available backwash. When the filter effluent valve is at 100% open and the filter loss-of-head high-high setpoint is exceeded, then that filter should be moved to the top of the Queue.

iv. An alarm shall be presented in the Filter Backwash Priority Queue when the high setpoint value is exceeded for: filter run time, filter effluent turbidity, filter media loss-of-head, and Filter Effluent valve % open.

v. The operator shall be able to manually add a previously off-line filter to the Queue by entering the filter number and the desired insertion position.

vi. The operator shall be able to manually remove a filter from the Queue by entering the filter number.

vii. Operations shall be able to revise the priority of any filter in the Queue set by the RTU, thereby overriding the priority set by the RTU except for a filter currently in a backwash or in a rewash cycle.

3.01.3 GRAPHIC DISPLAYS, TRENDS, AND REPORTS

A. Provide a Filter Overview screen configured as follows:

1. Show the entire filter facility (all filters), sedimentation basin effluent channel level, EQ tank level, high service pump station wet well level, and backwash pump status

2. This screen shall provide the operating status of all filters and the associated equipment as stated above, as well as the priority list in the filter backwash Queue as described above.

3. Provide direct navigation links from the Filter Overview screen to:

i. Individual Filter screens
ii. Filter Backwash Priority Queue screen
iii. Active Filter Backwash screen
iv. Backwash Pump screen
v. EQ Tank screen
vi. Filter Setpoints screen

B. Provide Individual Filter screens configured as follows:

1. Screens shall show all filter modes of operation (in-service, out-of-service, backwashing, and rewash cycle) and include the following information:

i. Operating valve positions and status (opened/closed status, percentage open on Filter Effluent modulating valves, remote/local setting on filter valves)
ii. Filter level measured by ultrasonic level sensors
iii. Filter effluent flow rate
iv. Filter run time (number of hours from when the filter is placed into service)
v. Filter effluent turbidity
vi. Filter head loss

2. Provide direct navigational links to the Filter Overview screen.

C. Provide Filter Backwash Priority Queue screen configured as follows:

1. The Queue shall be displayed in a table with vertical orientation and with columns as indicated below. Rows shall be organized in a top-down format with the filter currently under backwash at the top, the next in line for backwash directly below, etc. Columns shall be arranged in a left-right fashion with the column head and contents arranged as listed below. The Filter Backwash Queue shall consist of the following columns for each filter as a minimum:

    i. Queue Position
    ii. Filter Number
    iii. Filter Status (Washing, Rewash, In-Service, Removed-from Service)
    iv. Current Filter Run Time (hours)
    v. Current Filter Effluent Turbidity (NTU)
    vi. Current Headloss Across Filter Media(feet)
    vii. Current Filter Effluent Control Valve Position (% Open)

2. The current Step in the backwash sequence shall be displayed at the bottom on the Filter Backwash Queue table.

3. Provide direct navigational links to the Filter Overview and Active Filter Wash Sequence screens as well as the Individual Filter screens for all filters currently residing in the Queue.

D. Provide an Active Filter Backwash Sequence screen configured as follows:

1. Provide a display showing the current backwash sequence in a vertical, top-down, tabular format. The table shall be set up with various steps with each step clearly identified with descriptions and confirming status.

2. Display the filter currently being backwashed and all steps associated with the wash type. Each step status (Done, Active, Fail, or N/A) shall be displayed on the screen.

3. Display the following data associated with the active wash sequence in progress as a minimum:

    i. Backwash Water Flow
    ii. Backwash Sequence Duration (Elapsed)
    iii. Backwash Current Step Duration (Elapsed)
    iv. Surface Wash Duration
    v. Simultaneous Surface Wash/Backwash Rate and Duration
    vi. Low 1 and 2 Backwash Flow Rates and Durations
    vii. High Backwash Flow Rate and Duration
    viii. Water Level Above Media
    ix. Filter Rewash Duration

4. Provide a direct navigational link to the Filter Setpoints screen.

E. Provide an EQ Tank screen configured as follows:

1. Display shall include EQ tank level, calculated filter backwash and rewash total volume, available EQ tank volume, and status of both pumps.

2. Provide a direct navigational link to the Filter Overview screen.

F. Provide a Backwash Pump screen configured as follows:

1. Display shall include pump status, current backwash pump flow, active backwash step, individual backwash step flow setpoints, and % open of backwash flow control valve.

2. Provide a direct navigational link to the Filter Overview screen.

G. Setpoints Screens

1. Provide a display for all filters for changing filter setpoints. Filter backwash setpoints shall be unique for each filter.

2. Setpoint modifications shall be password-protected with appropriate password-controlled access per Owner direction.

3. Provide a direct navigational link to the Filter Overview and Active Filter Wash screens.

H. Trends shall include filter effluent flow, filter run times, filter effluent turbidity, backwash water usage, filter head loss, and sedimentation basin effluent channel level.

I. Filter Performance Reports and Trends

1. Trends shall be monitored and recorded for graphical presentation in the plant SCADA system.

2. A filter status report with time log shall be provided with the following records as a minimum:

i. Filter in-service with associated starting time and stopping time
ii. Totalized filter run time
iii. Filter out-of-service with associated starting time and stopping time
iv. Filter washing with associated starting time and stopping time
v. Totalized filter backwash water volume used

3. The following trends shall be provided for each filter as a minimum:

i. Filter Run Time
ii. Filter Run Time vs. Average Run Time (for all filters)
iii. Filter Run Time (weekly, monthly, and yearly)
iv. Filter Turbidity vs. Filter Run Time/Rewash Time
v. Filter Headloss vs. Filter Run Time

vi. Filter Rewash Time

4. Additional reports and trends shall be provided as requested by the Owner and/or Engineer.

3.02 EXISTING PLC PROGRAMS – RTU-1, RTU-2, AND RTU-3

A. OVERVIEW

1. Existing PLC programs related to the existing facilities at the WTP shall be re-written under new Allen-Bradley PLC platform. All existing control strategies related to the existing facilities shall not be modified and shall remain the same, except as may be required to provide the proper, specified interface with the new SCADA/HMI software application.

2. The existing graphic displays shall be used by the instrumentation subcontractors as information only. These displays shall be used as guidelines and show general arrangement of the existing equipment, piping interconnections, etc. The instrumentation subcontractor shall be responsible for furnishing new graphic displays that capture the information shown but also shall conform to the new graphic displays specifications under Section 17240 – Control System Software Suite. It is not the intent that the existing graphic displays be replicated in the new SCADA/HMI application. In other words, new graphic layouts and symbols, new pop-ups, new menu bar, etc. shall be provided as required to conform to the requirements specified in Section 17240 rather than using the existing conventions.

3. Existing PLC programs shall be available for use by the instrumentation subcontractors and shall be furnished by the Owner. With the existing PLC programs and the control system input/output schedule provided under Section 17920 of this Division, the instrumentation subcontractors shall develop scope and pricing for integration services under this Contract. The functional control descriptions associated with existing RTU-1, RTU-2, and RTU-3 describing the required operation, monitoring, and control of these existing facilities shall not be provided under this Section 17950. The processes and equipment in these facilities will not be modified as part of this Contract. However, since the existing SCADA/HMI software package shall be replaced entirely with a new software package, the Contractor shall provide new SCADA/HMI system configuration to meet the requirements specified under Section 17240 of the Specifications for these facilities.

PART 4 -- FUNCTIONAL CONTROL DESCRIPTIONS (**P.O. HOFFER WTP**)

PART 4 – TABLE OF CONTENTS	
4.01	FILTERED WATER MIXING VAULT
4.02	POWDER ACTIVATED CARBON SYSTEM (ALTERNATE BID)

4.03	HIGH SERVICE PUMPS 1- 8 AND FILTER WASH WATER PUMP

4.01 FILTERED WATER MIXING VAULT

A. Process Overview

1. Three (3) motor operated open/close valves shall be provided under Division 15 (MOV-43201, 43202, and 43203). Two constant speed mixers shall be furnished by the Owner. One sump float level switch shall be provided under Division17.

B. Control Operations

1. The control system shall monitor the status of each motor operated valve. Each valve shall accept an open/close signal from the control system that shall be operator initiated from the SCADA OWS. There shall be no automatic control of the valves from the PLC.

2. The control system shall monitor the status of each mixer. Each mixer shall accept a start/stop initiated from the SCADA OWS.

C. Graphic Displays

1. A new screen shall be developed to show the motor operated valves, mixers, sump level switch and mixing vault. Screen shall display the operation and alarm status of each motor operated valve, each mixer, and the sump float.

4.02 POWDER ACTIVATED CARBON SYSTEM (ALTERNATE BID)

A. Process Overview

1. A new powder activated carbon storage and feed system shall be provided under this Contract. The Powder Activated Carbon (PAC) shall be in slurry mixture and shall be stored in two separate mixing tanks. Each mixing tank shall be equipped with a variable speed/vertical turbine mixer, a radar level instrument, and a high level sensing probe.

2. The PAC slurry mixture in the storage tanks shall be mixed with additional make-up water. Make-up water supply line shall be provided with an automatic feed system that consists of a turbine flow meter, a water solenoid valve, and a batch controller.

3. PAC slurry shall be fed to the process using six positive displacement, peristaltic hose-type metering pumps. Five PAC metering pumps shall be assigned as duty pumps and one PAC metering pumps shall be the standby pump as shown on the Drawings. PAC feed points shall be as follows:

a. North 36” Raw Water line in the Raw Water Pump Station
b. South 36” Raw Water line in the Raw Water Pump Station

c. Glenville Lake WTF Raw Water

4. PAC slurry feed pipelines shall be provided with NPW carrier water assembly on each line. Each carrier water assembly shall be equipped with a rotameter and a single pressure reducing valve and pressure gauges installed on the common water supply line as shown on the Drawings.

B. Control Equipment

1. A PAC slurry tank fill panel shall be provided under Division 17 as shown on the Drawings and shall include the following:

a. Tank level indicator (one per tank)
b. Tank “full” level alarm indicating light (one per tank)
c. Tank high-high level alarm contact to PLC (one per tank)
d. One (1) digital batch controller
e. Tank low level indicating light (one per tank)
f. Alarm horn
e. Alarm silence pushbutton
f. Sump high level alarm indicating light
g. Tank mixer run status indicating lights

2. A variable speed mixer shall be provided for each carbon slurry tank. The mixer electric motor shall be equipped with motor winding temperature switch. The VFD for each mixer shall be provided under Division 16 shall include the following:

a. RUN Indicating light
b. SPEED indicator
c. VFD FAIL indication light
d. MOTOR FAIL indication light
e. ALARM RESET pushbutton
f. Run Time Meter
g. VFD interface unit (keypad controller)

3. A local control panel located at each mixer motor shall be provided under Division 16 and shall include the following:

a. START and STOP pushbuttons
b. E-Stop pushbutton

4. Six metering pumps shall be provided with motor-mounted VFDs under Division 11 to include the following:

a. REMOTE/LOCAL control mode settings
b. Manual local speed adjustment
c. Output contacts to indicate remote/local setting, run status, hose leak, and general alarm, and 4-20 mA speed feedback signal
d. Remote start/stop and 4-20mA remote speed control signals

5. Two (2) radar level transmitters shall be provided for the slurry tanks.

6. A high level probe shall be provided in each tank.

7. A pressure switch shall be provided downstream of each metering pump.

8. Emergency eyewash/shower assemblies shall be provided at the Fill Station and in the Pump Room as shown on the Drawings. The assembly shall be equipped with a flow switch on the supply water line. When the assembly is in use, an alarm shall be activated in the SCADA system.

9. A float switch shall be provided in the sump in the PAC feed manhole to detect high sump level conditions in the SCADA.

C. Control Operations

1. PAC slurry tank continuous level shall be indicated at the PAC Slurry Tank Fill Control Panel (in Feet). When tank level reaches the high-high level set point, the alarm indicating light on the panel shall be illuminated and alarm horn shall sound. The silence pushbutton shall deactivate the horn but the alarm light shall remain on until the alarm condition is off. When the level in the tank reaches a pre-set full level setting, the Tank Full indicating light shall be on.

2. Make-up water supply to each PAC slurry tank shall be controlled by the batch controller when PAC slurry is being delivered to each tank. Prior to each start of each batching process via the batch controller, the plant operator shall select a slurry tank to receive the water supply by opening an inlet water supply isolation valve. Plant operator shall enter a water volume (in US Gallon) in the batch controller. When the batch controller is turned on, the batch controller shall start measuring and totalizing the water flow rate as seen from the turbine flow meter and at the same time open the water supply solenoid valve. When water volume has reached the pre-set value, the batch controller shall automatically close the solenoid valve and the batching process is ended. The batch controller shall be configured to display the accumulated total water flow and instantaneous water flow rate during batching. Totalized water flow shall be reset to zero after each batch by the operator.

3. Slurry tank mixers shall shut down and send alarm signal to the PLC when the level in the PAC slurry tank falls to a pre-set low-low level setting as seen from the radar level instrument. Under this condition, the PLC shall activate the low-low alarm signal and the signal shall be sent to the mixer for shutdown interlock.

4. The following duty and standby metering pumps shall be used to deliver PAC slurry to the application points:

    a. PACMP-1 and 2: North 36” Raw Water line in the Raw Water Pump Station
    b. PACMP-4 and 5: South 36” Raw Water line in the Raw Water Pump Station
    c. PACMP-6: Glenville Lake Raw Water Supply Line
    d. PACMP-3: Standby Pump

NOTE: New chemical injection manhole for the Glenville Lake Raw Water pipeline at P.O. Hoffer shall be as shown on the Drawings. Glenville Lake raw water flow meter is existing and located in an existing meter vault along existing 36" raw water main from Glenville Lake Raw Water Pumping Station.

5. The above duty pumps shall be started and stopped based on the required Dosage entered by the operator or by the high plant flow rate. The duty pumps shall be controlled by the PLC as lead-lag control sequence. Pump lead-lag sequence shall be alternated automatically to equalize run time or set to a sequence manually selected by the plant operator. In the automatic alternation mode, the lead-lag sequence shall be reordered when the lead pump has operated continuously for an adjustable numbers of hours, the next pump shall be started as lead pump, and the old lead pump shall be stopped when the new lead pump reaches its operating speed.

   The following requirements for starting the lag pump shall be as follows:

   a. The pump currently running is at maximum speed (maximum pump capacity)
   b. A time delay has elapsed

   The following requirements for stopping a pump when two pumps are running shall be as follows:

   a. The pumps currently running is at a pre-select, adjustable minimum speed
   b. A time delay has elapsed

6. When a metering pump is in REMOTE mode, the lead pump shall be started and stopped, and pump speed shall be controlled by the PLC. The feed rate in gallons per hour (gph) shall either be entered directly by the operator from the OWS, or the pump shall be controlled automatically in flow pace mode by the PLC. The two control modes shall be operator selectable from each individual chemical feed application point from the PAC System Graphic Display at the OWS. When flow pace mode is selected, the feed rate of metering pumps PACMP-1 and 2 shall be flow paced based on North 36" Raw Water flow (FIT-10401), metering pumps PACMP-4 and 5 shall be flow paced based on South 36" Raw Water flow (FIT-10402), and metering pump PACMP-6 shall be flow paced based on Glenville Lake Raw Water flow. Metering Pump PACMP-3 shall serve as a standby/backup pump for all duty metering pumps. The operator shall input the desired chemical dosage (in mg/l) and the PAC solution concentration (lbs of active carbon per gallon of slurry solution) at the OWS, and the PLC shall calculate required chemical feed rate (in gph) and yield a 4-20 mA output signal to the duty metering pump. PACMP-1 and 2 shall both be required to operate to meet maximum demand in the North Raw Water line, and PACMP-4 and 5 shall both be required to operate to meet maximum demand in the South Raw Water line. Chemical feed rate shall be calculated as follows:

$$Feed\ Rate, gph = \frac{Dose, \frac{mg}{L} * Flow, mgd * 8.34}{Effective\ Density, \frac{lb}{gal} * 24}$$

Where:

Plant operator enters lbs of Carbon per gallon of slurry at OWS.

7. PAC slurry metering pumps shall stop when high pump discharge pressure is activated as seen from the pressure switch. The pressure switch output signal shall be hardwired to the pump control circuit for shutdown interlock. High pressure alarm shall be sent to the PLC.

8. A backup high-high level probe shall be installed in each PAC slurry tank. High level alarm shall be monitored by the PLC.

D. Graphic Displays

1. Continuous level and calculated liquid volume in each PAC slurry tank shall be displayed at the OWS, as well as high, high-high, low (level just above elevation of lower mixer impeller), and low-low tank level alarm conditions.

2. PAC slurry tank mixer run and fail status shall be indicated at the OWS.

3. PAC slurry makeup water flow shall be indicated at the OWS.

4. Metering pump remote/local status, run status, hose leak, general alarm, and 4-20 mA speed feedback shall be displayed at the OWS. Metering pump control from the OWS shall be as described above. High metering pump discharge pressure condition shall be indicated at the OWS.

5. Emergency eyewash/shower operation shall be indicated at the OWS.

6. Raw water flow rate through the two RW lines to the Hoffer WTP shall be indicated at the OWS.

4.03 HIGH SERVICE PUMPS 1-8 AND FILTER WASH WATER PUMP

A. Process Overview

4. A new electrical equipment building shall be provided under this project at P.O. Hoffer WTP and it shall be called Treatment Facility Electrical Building. The new MCC-TF in this building shall be designed to operate the existing High Service Pumps 1, 2, 3, 4, 5, and 7 and the existing Wash Water Pump via new reduced voltage solid state motor control units as shown on the Electrical Contract Drawings. New variable frequency drives shall be provided in the building for the existing High Service Pumps 6 and 8.

5. A new RTU control panel shall be provided in the Treatment Facility Electrical Building designated as RTU-17. The new RTU-17 shall be provided under this Division by the Instrumentation Supplier to provide for monitoring and control functions for the pumps.

B. Control Equipment

1. For the existing High Service Pumps 1-5, 7, and the existing Filter Wash Water Pump, the new RVSS unit shall include the following devices:

   a. Pump “Run” indicating light

   b. Pump “Off” indicating light

   c. Pump discharge “Low” pressure indicating light

   d. Pump “Fail” indicating light

   e. Motor protection relay unit

   f. The following devices shall be provided on a local control station located at the pump:

      i. HAND/OFF/AUTO selector switch

      ii. Pump START and STOP pushbuttons

      iii. E-Stop PB

   g. The following devices associated with each pump shall remain the same on the existing pumps and shall be reconnected to the new RVSS unit:

      i. Motor vibration monitors

      ii. Pump discharge cone valve control and monitoring functions

      iii. Pump discharge pressure switch

2. For the existing High Service Pumps 6, and 8, the new VFD shall include the following devices:

   a. Pump “Run” indicating light

   b. Pump “Off” indicating light

   c. Pump discharge “Low” pressure indicating light

   d. Pump “Fail” indicating light

   e. Motor protection relay unit

   f. VFD control interface unit

g. The following devices shall be provided on a local control station located at the pump:

i. HAND/OFF/AUTO selector switch

ii. Pump START and STOP pushbuttons

iii. E-Stop PB

h. The following devices associated with each pump shall remain the same on the existing pumps and shall be reconnected to the new RVSS unit:

i. Motor vibration monitors

ii. Pump discharge cone valve control and monitoring functions

iii. Pump discharge pressure switch

3. A new Emergency Stop Pushbutton Station shall be provided and installed at the filter gallery as shown on the Drawing. The station shall include eight (8) E-Stop PB's (one per pump) to shut down the pump immediately regardless of its control mode.

C. Control Operations

1. When the H-O-A selector switch is in the OFF position, the pump shall not operate under any condition.

2. When the H-O-A selector switch is in the LOCAL position, the pump shall be operated from the start and stop on the Local Control Station.

3. When the H-O-A selector switch is in the AUTO position, the existing High Service Pumps shall be operated from RTU 17 as follows:

a. Remote manual run/stop from SCADA Operator Workstations.

b. Remote manual speed control from SCADA Operator Workstation for pumps 6 and 8.

4. When the H-O-A selector switch is in the AUTO position, the existing Filter Wash Water Pump shall be operated from the new RTU 17. Existing start/stop control program for the wash water pump shall remain the same.

D. Graphic Displays

1. A new graphic display for the High Service Pump Station shall be created by the Instrumentation Supplier under this Contract. The following existing process variables associated with the High Service Pump Station shall be shown (real-time values, real-time and historical trends):

a. High pressure zone A flow (in MGD)

b. High pressure zone B flow (in MGD)

c. Low pressure zone flow (in MGD)

d. Total flow (in MGD)

e. High pressure systems pressure (in psi)

f. Low pressure systems pressure (in psi)

g. Settled turbidity #1 through #3

h. Finished water chlorine residual

i. Clearwell level

j. Pump well flow

2. Pump control and monitoring functions:

a. Start/Stop control for each pump

b. Speed control for pumps 6 and 8

c. Pump status

d. Pump alarms

3.

- END OF SECTION -

APPENDIX A

GEOTECHNICAL SUBSURFACE INVESTIGATION

GeoTechnologies, Inc.
Geotechnical and Construction Materials Testing Services

October 17, 2018

Mr. Patrick Thiedman, P.E.
HAZEN & SAWYER
4011 WestChase Boulevard, Suite 500
Raleigh, NC 27607

Re: Subsurface Investigation
PO Hoffer Additions
Fayetteville, North Carolina
GeoTechnologies Project No. 1-18-0565-EA

Gentlemen:

GeoTechnologies, Inc. has completed the authorized investigation to evaluate subsurface soil conditions for the proposed additions to PO Hoffer waste water treatment facility in Fayetteville, NC. These additions will include a new chemical storage building, new chemical feed building, new filtered water mixing vault, new carbon slurry facility, new electrical building, new paved roads, and an expansion to the existing treatment facility complex involving new filters.

Subsurface conditions at the site were investigated by drilling fifteen borings advanced with an ATV-mounted drill rig using standard penetration test (SPT) techniques. In the vicinity of the proposed Electrical Building (B-12), an additional boring was advanced using hand operated equipment with the soil consistency evaluated using a Sowers dynamic cone penetrometer (DCP). The borings performed were located at approximate coordinates shown on the attached Table 1 and at locations approximately shown on the attached Figure 1. The borings were located in the field with a Trimble Geo7X GPS unit which typically has an accuracy of about 5 to 7 feet. The borings were advanced to termination depths of approximately 4 to 30 feet below existing site grade. The standard penetration testing was performed with a conventional drop hammer rather than with an automatic hammer and therefore no correction to the SPT data is required.

Preliminary foundation loading and bearing pressures have been provided to by Hazen and Sawyer. The existing site grades were obtained from surveys provided by Hazen and Sawyer and from topographical maps from the Cumberland County GIS website. Existing site grades should be considered approximate. This report presents the findings of the investigation and our preliminary recommendations regarding site development and foundation support.

SITE AND PROJECT INFORMATION

The proposed addition to the waste water treatment plant consists of new paved roads and structures supported primarily by mat foundations, but may include slabs-on-grade, wall footings and column footings. The site is a functioning waste water treatment plant with additions being proposed near existing site facilities. It is worth noting that a large portion of the proposed paved roads are currently gravel roads in use on-site. Specific cuts and fills within the roads have not been provided at this time, but we assume they will bear close to existing grade. The Table below summarizes the project information as currently understood by GeoTechnologies.

Structure	Anticipated Foundation Type	Assumed Approx. Dimensions (ft)	Anticipated Loading	Assumed Bearing Below Existing Grade (ft)	Boring Numbers (Figure 1)
Chemical Storage Building	Mat Foundation	50 x 200	2700 PSF	5	B-1, B-2, B-3
Chemical Feed Building	Mat Foundation	60 x 35	2700 PSF	6 to 8	B-4, B-5
Filters	Mat Foundation	50 x 160	3000 PSF	5 to 8	B-6, B-7
Treatment Facility Expansion	Mat Foundation	65 x 140	2700*/2200** PSF	5 to 8	B-8, B-9
Filter Water Mixing Unit	Mat Foundation	12 x 28	1400 PSF	11	B-10
Carbon Slurry Facility	Mat Foundation	40 x 40	2000 PSF	1	B-11
Electrical Building	Mat Foundation	35 x 40	2000 PSF	2	B-12
New Paved Roads	N/A	N/A	N/A	Approximately at Existing Grade	A-1, A-2, A-3, A-4

**Base Bid; **Alternate Bid*

SUBSURFACE CONDITIONS

Generalized subsurface profiles prepared from the test boring data are attached to this report as Figure 2A, 2B, and 2C to graphically illustrate subsurface conditions encountered at this site. More detailed descriptions of the conditions encountered at the individual test boring locations are then presented on the attached test boring records.

The subsurface profile on this site was found to generally consist of a near surface layer of fill typically extending to a depth of 0 to 8 feet below existing site grade. The near surface fill typically consisted of silty to clayey sands and sandy low to high plasticity clays exhibiting penetration resistances in the range of 5 to 40 blows per foot (bpf) indicating marginal to good compaction. Many of the fill soils contained organic material such as wood particles. The fill soils did not appear to contain organic material exceeding 5% by weight, based on the split spoon samples. However, split spoon samples are not always indicative of the total amount of organic material within soils, and it is possible to encounter fill soils with higher amounts of organic material. Beneath the near surface fill, the virgin soils encountered consisted of loose to very dense clean, silty, and clayey sands and firm to very hard sandy clays and silts exhibiting penetration resistances in the range of 6 to 100 bpf.

Groundwater was present in the boreholes at the time of boring at depths of about 2.5 to 27 feet below grade. Groundwater was measured 24 hours after the time of boring in 3 borings and ranged from 0 to 7 ft below existing elevation. The groundwater measurements taken 24 hours after boring were significantly more shallow than the depth measured at the time of boring. Caving of the borings was encountered in borings B-2 and B-6 at 6 ft and 0 ft below existing grade, respectively. It should be noted that groundwater levels will vary with seasonal and climatic changes and could be higher at other times of the year. The subsurface profile is also conducive to the development of perched groundwater in the near surface soils.

LABORATORY TESTING

Laboratory testing included standard Proctor compaction (ASTM D-698), laboratory soaked CBR tests (ASTM D-1883), and grain size analysis (ASTM D-1140). Representative bulk samples were collected from the upper 3 feet in

borings A-1 through A-4. One bulk sample was generated by material combined from borings A-1 and A-2, and a second bulk sample from A-3 and A-4.

Standard Proctor maximum dry densities were between 116.0 and 119.4 pounds per cubic foot with optimum moisture contents of 12.5 and 11.3 percent. The percent passing the #200 sieve ranged from 1.0 to 16.7 percent. Unified Soil Classifications based on the laboratory classification tests were SM for borings B-6, B-7 and B-2, and SP for borings B-4. Laboratory soaked CBR samples produced CBR values ranging from 7.1 to 7.2 percent at 0.1 inches of penetration and 7.0 to 7.7 percent at 0.2 inches of penetration with swell ranging from 0.6 to 0.7 percent. The laboratory results are summarized in the attached Table 2.

RECOMMENDATIONS

The following recommendations are made based upon a review of the attached test boring data, our understanding of the proposed construction, and experience with similar projects and subsurface conditions. Preliminary structure bearing elevations and foundation loading pressures have been provided to GeoTechnologies, Inc. Once finalized construction plans become available, they should be provided to GeoTechnologies so that the following recommendations can be confirmed or modified.

Site Grading Considerations. The following section provides a general discussion regarding site grading and preparation. Expected subgrade repairs for the individual structures are discussed later in this report.

Site grading should begin with clearing and stripping of topsoil and organic material. We recommend that those areas at grade or designated to receive fill be proofrolled with a partially loaded dump truck or similar piece of rubber tired equipment to identify areas necessitating repair. Hand auger borings and/or test pits may be needed for further evaluation in areas where old fill exists. Repairs will depend on soil conditions and the type of foundation support being used and the planned grade of the structure. Repairs should be performed as directed by the geotechnical engineer.

Repairs will typically consist of undercut and replacement as directed, or discing, drying, and recompacting in those areas where the depth of soft soil does not exceed about 8 to 12 inches. Drying and recompacting will be most effective if the contractor provides an appropriate disc, and if the repair is implemented during a period of warm and dry weather typical of the months from April into early October. Greater volumes of undercut will be generated if the site is prepared during a period of cool and/or wet weather, or if the contractor is not prepared to moisture condition the soils.

Most soils requiring repair should be contained within the top 1 to 2 feet of existing grade. However, some borings (B-3, B-6 and B-8) encountered marginally compacted fill as deep as 5 to 8 feet below existing grade. These areas will require repairs deeper than the upper few feet if the bearing depth of the structure is not below this marginally compacted fill. Repair options for these areas will be outlined later in the report. All repairs should be performed as directed by the geotechnical engineer. We recommend that a fair unit price for undercut of unsuitable material be established in the contract documents.

Highly plastic clay fill soil was encountered in two of the borings (B-8 and B-12). Beneath any conventional slabs or mat foundations any highly plastic clay that remains within 3.0 feet of exterior grade elevation will need to be removed and replaced with a lower plasticity material to prevent problems associated with shrinkage and swelling of those materials. High plasticity soil encountered within 3.0 feet of exterior grade elevation within shallow foundations can be over-excavated and replaced with flowable fill or additional concrete. Highly plastic soil may be encountered, but will likely be isolated and not widespread.

The area in proximity to borings B-8 and B-9 was holding water above the ground surface at the time of the investigation. This standing water will need to be diverted from the proposed structure footprints prior to beginning proper grading. If these areas are graded to drain or have features such as drainage ditches or French drains installed to lower the water level, it is possible that the amount of undercut required to properly prepare the building pads will decrease.

Borrow Materials/Placement. The on-site soils, excluding topsoil and any unsuitable old fill (highly plastic or excessively organic soils) will be suitable for reuse as structural fill if the material can be brought to within about 2% of the optimum moisture content with wetting or drying as required. The contractor should be prepared to disk and dry or to use a water truck to add moisture as necessary to maintain moisture within the suggested range during compaction.

Off-site borrow should consist of silty and clayey sands or low plasticity silts and clays having Unified Soil Classifications of SM, SC, ML, or CL. Fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness, except where smaller equipment is needed to backfill trenches or below grade walls. For these cases, the loose lift thickness should not exceed 4 to 6 inches. All fill materials should be compacted to not less than 95% of the standard Proctor maximum dry density except in the final foot where this requirement should be increased to 98% of the standard Proctor maximum. It is recommended that quality control testing be performed to verify that the proper soil density specifications are being met and to confirm that fill placement is being performed in a controlled manner.

Difficult Excavation Considerations. Above the planned bearing elevation of the structures, the borings did not encounter material which would classify as difficult excavation for an appropriate excavator such as a CAT 330 or 345 equipped with a narrow rock bucket and rock teeth. For reference purposes, our experience has been that an appropriate excavator can remove material in the range of 50 blows per 4 to 6 inches of penetration with some effort. One boring (B-3) encountered an approximately 1 foot thick layer of material 8 feet below existing grade which would typically classify as difficult excavation material. Although this material was encountered below bearing elevation, it may be indicative of material this hard elsewhere on the site. Additionally, it is possible that harder and shallower material may be present intermediate of the borings.

If difficult excavation material is encountered, the most common technique to remove confined rock which cannot be removed with conventional rock excavation equipment is blasting; however, we expect that consideration will also be given to removing these materials with equipment such as a ram-hoe. Blasting will likely be restricted due to the vibrations it would impart to the nearby structures. Removal means and methods should be left to the discretion of the contractor, with appropriate consideration being given to vibrations and their impact on adjacent structures.

If the project will be bid on a classified basis, we recommend establishing a fair unit price for difficult excavation, with payable quantities based on in-place surveyed measurements. Additionally, we recommend that project specifications clearly indicate what equipment should be used to demonstrate difficult excavation.

Dewatering Considerations. Dewatering is ultimately the responsivity of the contractor performing the construction. Some structures such as the Electrical Building and the Carbon Slurry Faculty are planned to bear approximately 1 to 2 feet below existing grade. Groundwater infiltrating these more shallow excavations can likely be addressed by over-excavation a minimum of 12 inches and replacement with uniformly graded washed stone. Once washed stone is placed, sump pumps can be utilized to drain any infiltrating water.

Structures such as the Treatment Facility Expansion, the Filters, the Chemical Feed Building, the Chemical Storage Building, and the Filter Water Mixing Unit are planned to require excavations of 5 to 11 feet. These deeper excavations are all likely to encounter clean to relatively clean sands below the water table within the excavations. It is worth noting that the Filter Water Mixing Unit did not encounter the water table in the boring, but clean sands are present at shallow depth which could easily develop groundwater with seasonal changes or the development of a

perched condition. Clean sands below the water table typically create unstable excavations in which water permeates the excavation at a high rate, thus dewatering methods (beyond use of sump pumps) may be required in these structures.

There are several options which the contractor can employ to control water and make the necessary excavation. One option would be to install well points surrounding the excavation area. Another option would be to try to lay slopes back from the limits of the excavation. If the contractor elects to try and lay the slopes back, it is possible that groundwater could be controlled by trenching in a sock drain and attaching it to a vacuum pump around the perimeter of the excavation. Another approach would be to drive standard sheet piling around the perimeter of the area to be excavated.

If side slopes are used and the excavation is dewatered in advance of excavation, it appears that cuts of up to 20 feet can be designed as OSHA type "B" soils for undisturbed soils and type “C” for old fill soils. We recommend that all sloped excavations be observed and evaluated by qualified personnel at the time of excavation to verify compliance with OSHA regulations. Modifications to the excavation geometry should be performed as necessary. If slopes are used, they should be observed daily by qualified personnel. Excavations deeper than 20 feet should be designed on a case-by-case basis by a qualified engineer. We recommend that all below grade slopes be covered with plastic to help maintain dry slopes and to promote surficial stability.

Uplift Considerations. Excessive hydrostatic uplift can be resisted by increasing the size of the foundation to engage additional soil if desired. Alternatively, micro-piles, soil anchors, or helical piers can be used to provide additional resistance. If these elements are used to provide additional resistance to uplift loads, we recommend that load testing be performed to 2.5 times the design capacity for verification, unless otherwise directed by the geotechnical engineer.

Below Grade Walls. Below grade walls may be designed using the soil parameters indicated in the table below. Material placed within 4 feet of walls should be compacted with hand held rather than with heavy mechanized equipment. Backfill should be compacted to at least 95% of the standard Proctor maximum dry density, with 98% being achieved within the upper 12 inches of grade in any pavement areas. The values assume level grade behind or in front of the wall and should be modified for sloping grades. Appropriate safety factors should be applied to design calculations.

At-rest EFP Above Water	At-rest EFP Below Water	Active EFP Above Water	Active EFP Below Water	Passive EFP	Base Friction
55 pcf	90 pcf	40 pcf	80 pcf	300 pcf	0.30

Pavement Design. Pavement subgrades should be moisture conditioned to within 2% of optimum and recompacted to not less than 98% of the standard Proctor maximum dry density immediately prior to placement of base course stone. The subgrades should also be proofrolled for stability with repairs made as recommended by the geotechnical engineer. Site grades should be detailed to promote drainage away from the pavement areas, and underdrains or ditches should be provided along the high side of all pavements due to the potential for perched groundwater conditions to develop.

Two bulk samples were obtained in the field for the proposed paved roads. The results are displayed in the attached Laboratory Data section of this report and on Table 2. Based on the results of the testing on the bulk samples collected, properly prepared subgrades should exhibit a design subgrade CBR value about 7%, or a subgrade modulus value of 125 pci. We can provide flexible or rigid pavement designs if provided with traffic volumes and loadings.

Seismic Design. Based on the results of the test borings and past deeper borings in the surrounding area, the site profile seismic class is a "D". Geophysical Testing may allow for an improved seismic site class.

FOUNDATION SUPPORT (GENERAL RECOMMENDATIONS)

Foundation design recommendations for the individual structures are discussed in the next section of this report. This section is intended to provide general design recommendations for support alternatives.

Shallow Foundations. Unless otherwise indicated, shallow foundations may be designed for an allowable soil bearing pressure of 3,000 psf or a subgrade modulus of 125 pci (for a 1 foot by 1-foot area). All foundations should bear at least 12 inches below grade for frost protection and all subgrades should be evaluated by the geotechnical engineer to determine if repairs are warranted. Where settlement estimates are provided, they should be considered preliminary if foundation details are modified from those provided. Settlement estimates should be updated as additional foundation design details become available. All settlement estimates should be reviewed by the structural engineer.

Slab-on-Grades. We recommend placing at least 4 inches of compacted (98% modified Proctor) CABC stone below slab-on-grades. Clean #57 or #67 stone may also be considered; however, it has been our experience that compacted CABC stone provides better protection for the subgrade prior to concrete placement. The design engineer should include a vapor barrier detail where appropriate.

FOUNDATION SUPPORT & EXPECTED REPAIRS (INDIVIDUAL STRUCUTRES)

Chemical Storage Building. The Chemical Storage Building is assumed to bear 5 to 8 feet below existing grade with an assumed bearing pressure of 2700 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate 0 to 5 feet of unsuitable and/or marginally compacted fill soils will generally be present within the footprint of this structure. The majority of the soils requiring repair will likely be concentrated near boring B-3. Unsuitable and/or marginally compacted fill soils should be removed down to firm bearing soil and replaced with properly compacted fill soils, uniformly graded washed stone, or additional concrete. The excavations are deep enough that shallow groundwater and unstable sands will likely be issues during excavation and will need to be addressed utilizing one of the dewatering methods previously mentioned in this report.

Chemical Feed Building. The Chemical Feed Building is assumed to bear 6 to 8 feet below existing grade with an assumed bearing pressure of 2700 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate that soils requiring repair will generally be isolated and minimal within the footprint of this structure. The excavations are deep enough that shallow groundwater and unstable sands will likely be issues during excavation and will need to be addressed utilizing one of the dewatering methods previously mentioned in this report.

Treatment Facility Expansion. The Treatment Facility Expansion is assumed to bear 5 to 8 feet below existing grade with an assumed bearing pressure of 2200 to 2700 PSF (base and alternate bid respectively). Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate 0 to 2 feet of unsuitable and/or marginally compacted fill soils will generally be present within the footprint of this structure. Unsuitable and/or marginally compacted fill soils should be removed down to firm bearing soil and replaced with properly compacted fill soils, uniformly graded washed stone, or additional concrete. The excavations are deep enough that shallow groundwater and unstable sands will likely be issues during excavation and will need to be addressed utilizing one of the dewatering methods previously mentioned in this report.

Filters. The Filters adjacent to the Treatment Facility Expansion is assumed to bear 5 to 8 feet below existing grade with an assumed bearing pressure of 3000 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate 0 to 2 feet of unsuitable and/or marginally compacted fill soils will generally be present within the footprint of this structure. Unsuitable and/or marginally compacted fill soils should be removed down to firm bearing soil and replaced with properly compacted fill soils, uniformly graded washed stone, or additional concrete. The excavations are deep enough that shallow groundwater and unstable sands will likely be issues during excavation and will need to be addressed utilizing one of the dewatering methods previously mentioned in this report.

Filter Water Mixing Unit. The Filter Water Mixing Unit is assumed to bear 11 feet below existing grade with an assumed bearing pressure of 1400 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We do not anticipate any repairs will be necessary within the footprint of this structure. The excavations are deep enough that shallow groundwater and unstable sands will likely be issues during excavation and will need to be addressed utilizing one of the dewatering methods previously mentioned in this report.

Carbon Slurry Facility. The Carbon Slurry Facility is assumed to bear approximately 1 to 2 feet below existing grade with an assumed bearing pressure of 2000 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate that soils requiring repair will generally be isolated and minimal within the footprint of this structure. The excavations are shallow enough that major dewatering approaches are not anticipated to be necessary. Groundwater infiltrating excavations can likely be addressed by over-excavation and replacement with washed stone then using sump pumps to drain the infiltrating water. However, if excavations become sufficiently deep, dewatering will need to be handled utilizing one of the methods previously mentioned in this report.

Electrical Building. The Electrical Building is assumed to bear approximately 2 foot below existing grade with an assumed bearing pressure of 2000 PSF. Assuming the appropriate shallow repairs are made as recommended by a geotechnical engineer, the anticipated settlement of this structure is less than 1 inch. Differential settlements are likely to be on the order of half of the total settlement. We anticipate approximately 2 to 3 feet of unsuitable and/or marginally compacted fill soils will generally be present within the footprint of this structure. Unsuitable and/or marginally compacted fill soils should be removed down to firm bearing soil and replaced with properly compacted fill soils, uniformly graded washed stone, or additional concrete. The excavations are shallow enough that major dewatering approaches are not anticipated to be necessary. Groundwater infiltrating excavations can likely be addressed by over-excavation and replacement with washed stone then using sump pumps to drain the infiltrating water. However, if excavations become sufficiently deep, dewatering will need to be handled utilizing one of the methods previously mentioned in this report.

SUMMARY

In summary, the undisturbed soils on-site are suitable to support the proposed structures with shallow spread foundations. However, 0 to 8 feet of well to marginally compacted fill soils (some containing excessively organic or highly plastic material) are present throughout the site. The majority of the fill soils encountered below bearing elevation of the structures will require repairs in order to properly prepare the foundations. Different amounts of repairs are anticipated based on the structure. Additionally, clean to relatively clean sands are present below the water table throughout the site. Dewatering will be necessary where excavations extend into the water table.

Some difficult excavation material (N=100+ using SPT methods) was encountered on-site. No difficult excavation material was encountered above planned bearing elevation of the structures. However, difficult excavation material was encountered within a few feet of bearing elevation for some structures, and the hardness and depth of difficult excavation material is likely to vary intermediate of the borings. Therefore, use of a large excavator with rock teeth and/or a ram-hoe may be necessary to address difficult excavation material in some isolated areas. Blasting is probably not feasible due to the vibrations it would induce upon nearby structures.

The table below summarizes conditions and specific recommendations for each structure.

Structure	Assumed Bearing Below Existing Grade (ft)	Boring #'s	N=100+ Material Encountered Above Bearing Elevation?	Shallow Foundation Support Possible?	Repairs required below bearing elevation?	Will excavations be unstable from groundwater?
Chemical Storage Building	3 to 5	B-1, B-2, B-3	No	Yes	Yes, 0 to 5 ft.	Yes
Chemical Feed Building	6 to 8	B-4, B-5	No	Yes	No	Yes
Filters	5 to 8	B-6, B-7	No	Yes	Yes, 0 to 2 ft	Yes
Treatment Facility Expansion	5 to 8	B-8, B-9	No	Yes	Yes, 0 to 2 ft.	Yes
Filter Water Mixing Unit	11	B-10	No	Yes	No	Yes*
Carbon Slurry Facility	1 to 2	B-11	No	Yes	No	No**
Electrical Building	1 to 2	B-12	No	Yes	Yes, 0 to 2 ft.	No**

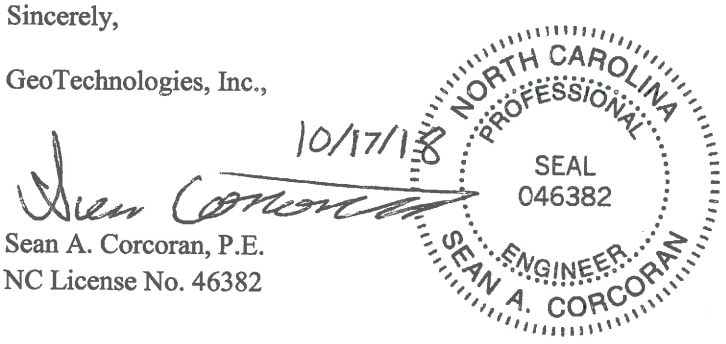
**Water table was not encountered but if the water table varies seasonally or a perched condition arises, the excavations will become unstable*
***Groundwater can likely be handled with over-excavation and replacement with washed stone then use of sump pumps.*

We appreciate the opportunity to have provided you with our services during this phase of the project. Please contact us if you have questions regarding this report or if we may be of further assistance currently.

Sincerely,

GeoTechnologies, Inc.,

10/17/18



Sean A. Corcoran, P.E.
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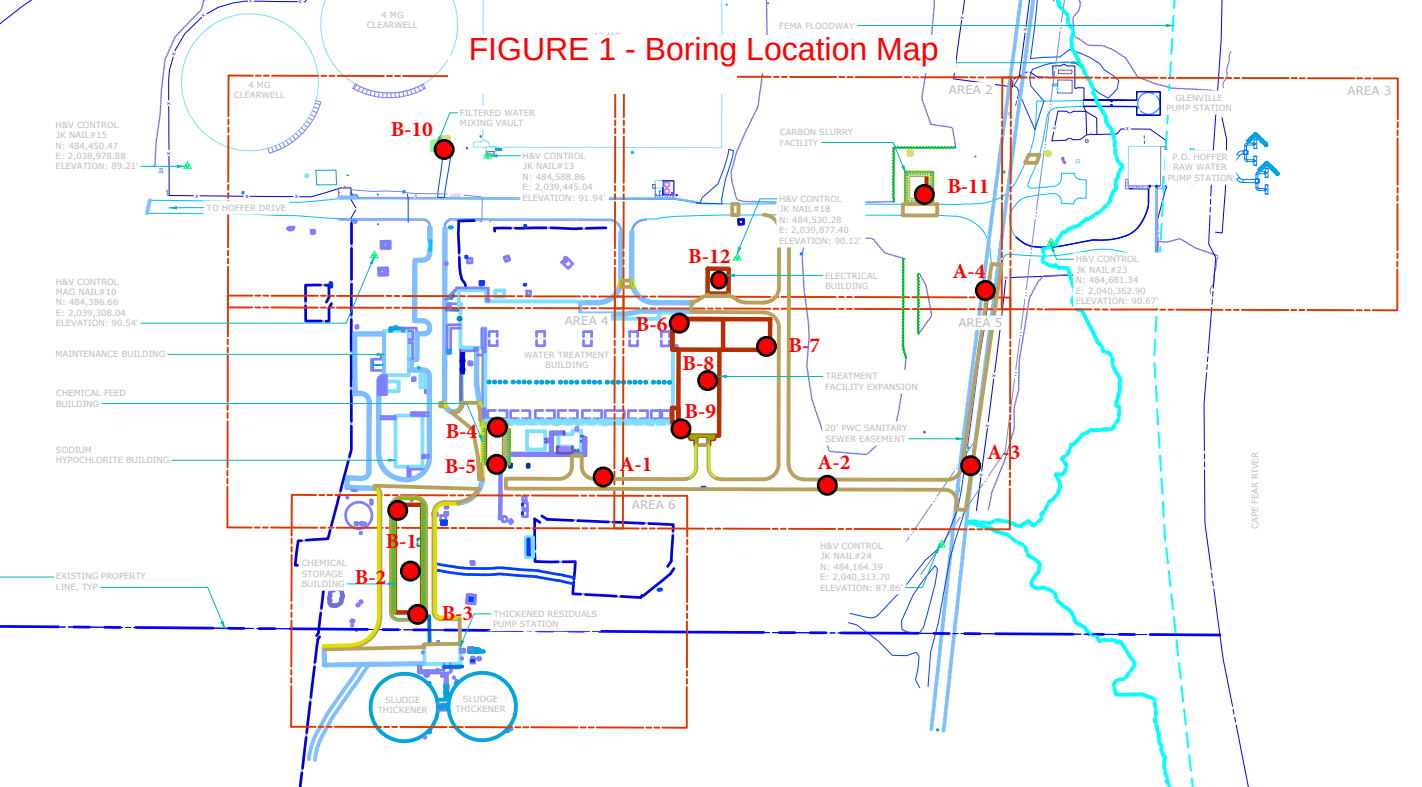
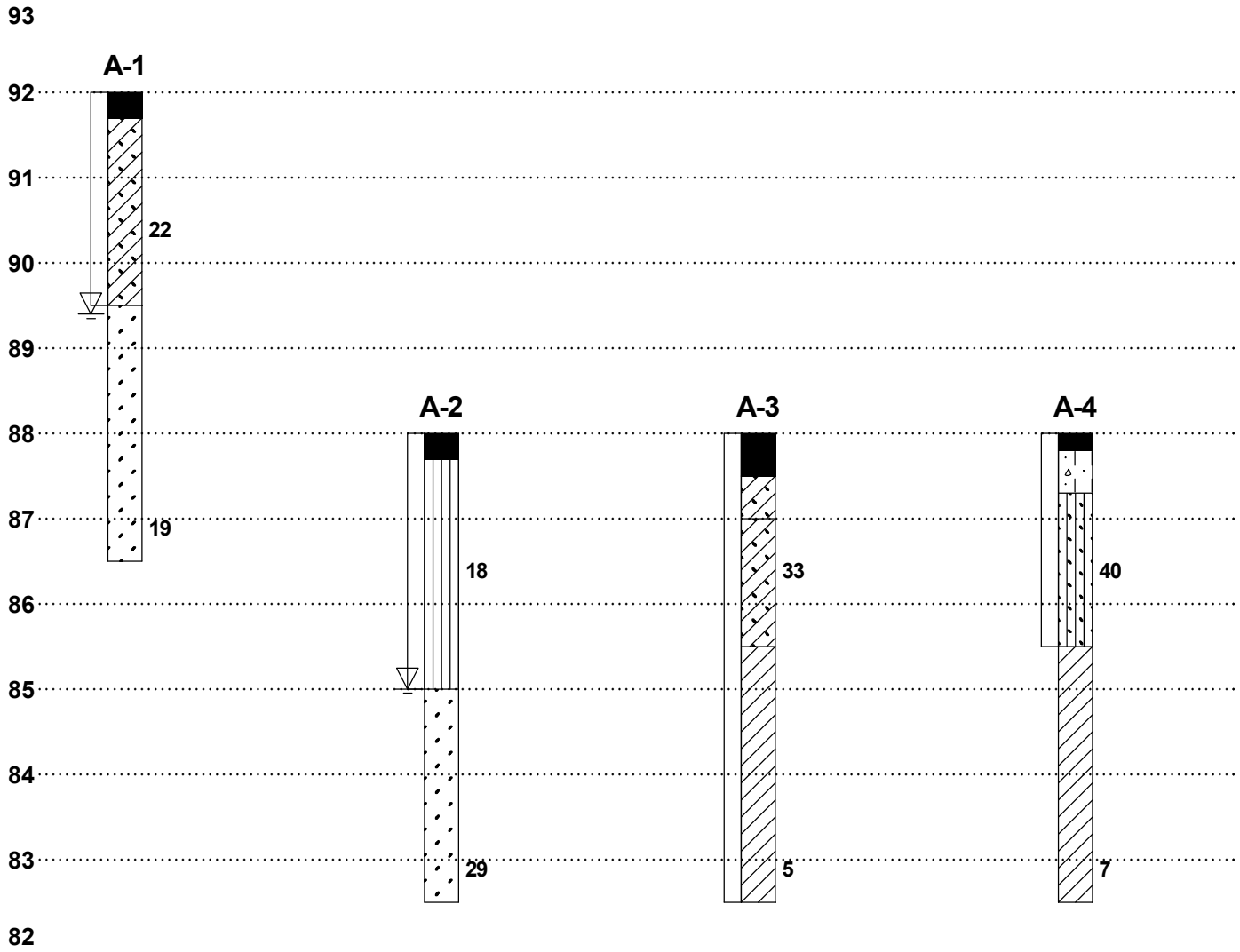
SAC/pr-els

FIGURE 1 - Boring Location Map



GENERALIZED SUBSURFACE PROFILE



LEGEND

- Topsoil
- Clayey Sand
- Poorly-graded Sand
- Low Plasticity Silt
- Low Plasticity Clay
- Soil/Gravel
- Silty Sand
- Fill
- Standard Penetration Resistance
- Groundwater at Time of Boring
- Groundwater after Time of Boring
- Auger Refusal
- Cave Depth

PROJECT:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

GeoTechnologies, Inc.

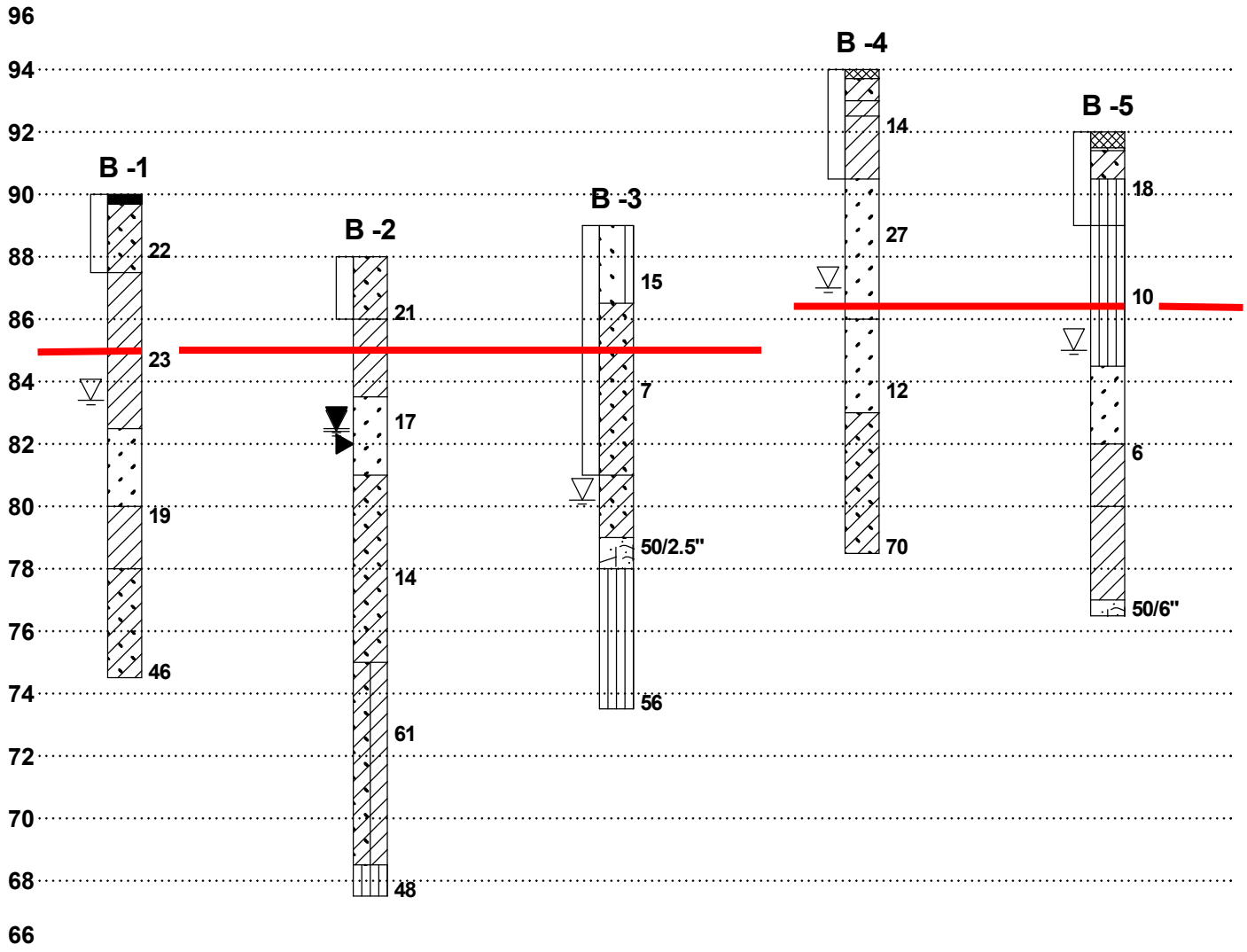
SCALE: As Shown

JOB No:1-18-0565-EA

FIGURE No:2A

Elevation (Feet)

GENERALIZED SUBSURFACE PROFILE



LEGEND

- Topsoil
- Clayey Sand
- Low Plasticity Clay
- Poorly-graded Sand
- Clayey Sand - Sandy Clay
- Low Plasticity Silt
- Low Plasticity Silt to Silty Sand
- Cemented Sand
- Asphalt
- Soil/Gravel
- Fill
- Standard Penetration Resistance
- Groundwater at Time of Boring
- Groundwater after Time of Boring
- Auger Refusal
- Cave Depth
- = Proposed Grade

PROJECT:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

GeoTechnologies, Inc.

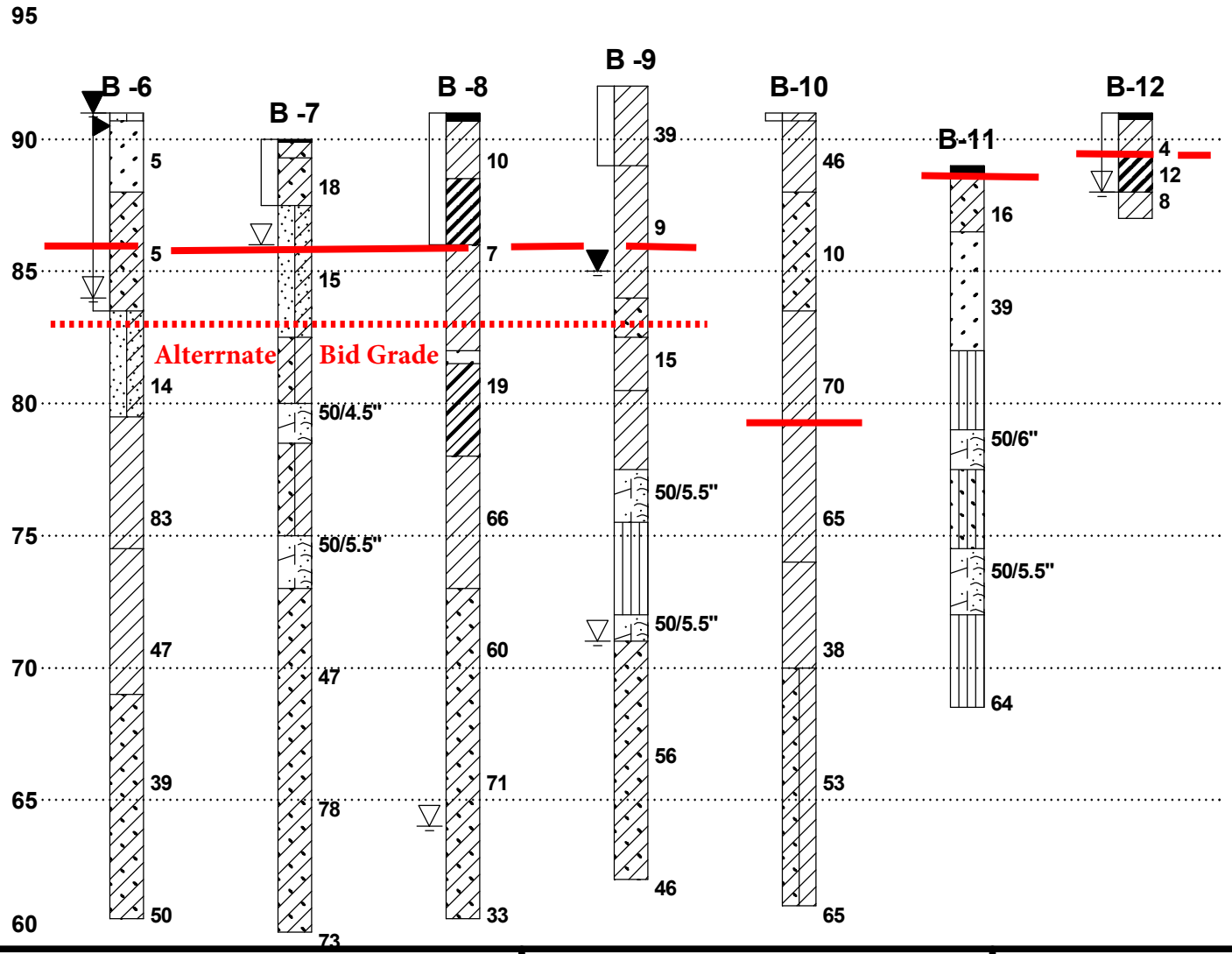
SCALE: As Shown

JOB No:1-18-0565-EA

FIGURE No:2B

Elevation (Feet)

GENERALIZED SUBSURFACE PROFILE



LEGEND

- Soil/Gravel
- Poorly-graded Sand
- Clayey Sand
- Poorly-graded Sand with Clay
- Low Plasticity Clay
- Topsoil
- Clayey Sand - Sandy Clay
- Cemented Sand
- High Plasticity Clay
- Moderate Plasticity Clay
- Low Plasticity Silt
- Silty Sand
- Fill
- Standard Penetration Resistance
- * Dynamic Cone Penetration
- Groundwater at Time of Boring
- Groundwater after Time of Boring
- Auger Refusal
- Cave Depth
- = Proposed Grade

PROJECT:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

GeoTechnologies, Inc.

SCALE: As Shown

JOB No:1-18-0565-EA

FIGURE No:2C

TABLE 1
Boring Coordinates

1-18-0565EA - PO Hoffer

	N (f)	E (ft)
B-1	483,949	2,039,480
B-2	483,868	2,039,522
B-3	483,797	2,039,566
B-4	484,110	2,039,593
B-5	484,067	2,039,614
B-6	484,353	2,039,846
B-7	484,361	2,039,999
B-8	484,264	2,039,937
B-9	484,177	2,039,898
B-10	484,533	2,039,407
B-11	484,650	2,040,192
B-12	484,432	2,039,894
A-1	484,067	2,039,788
A-2	484,161	2,040,150
A-3	484,242	2,040,360
A-4	484,487	2,040,333

TABLE 2

LABORATORY TEST SUMMARY

PO Hoffer Additions
Fayettville, North Carolina
GeoTechnologies Project No. 1-18-0565-EA

#	Boring	Depth (ft.)	Natural Moisture (%)	Passing #200 Sieve (%)	Unified Soil Class.	CBR @ 0.1"	CBR @ 0.2"	Swell (%)	Max. Dry Density (pcf)	Optimum Moisture (%)
1	A-1, A-2	Subgrade-3	11.4		SM	7.2	7.7	0.7	116.0	12.5
2	A-3, A-4	Subgrade-3	10.1		SM	7.5	7.0	0.6	119.4	11.3
3	B-10	4		16.7	SM					
4	B-4	9		1.0	SP					
3	B-6	9		7.7	SM					
4	B-7	4		7.3	SM					

Laboratory Data

GeoTechnologies, Inc. CBR DATA SHEET ASTM D-1883

JOB #: 1-18-0565-EA JOB NAME: Po Hoffer Additions

DATE: 9/17/2018 SAMPLE I.D.: A-1, A-2 Depth: 0.0-3.0'

NOTES: PROCTOR DATA: TEST PROCEDURE: ASTM D-698

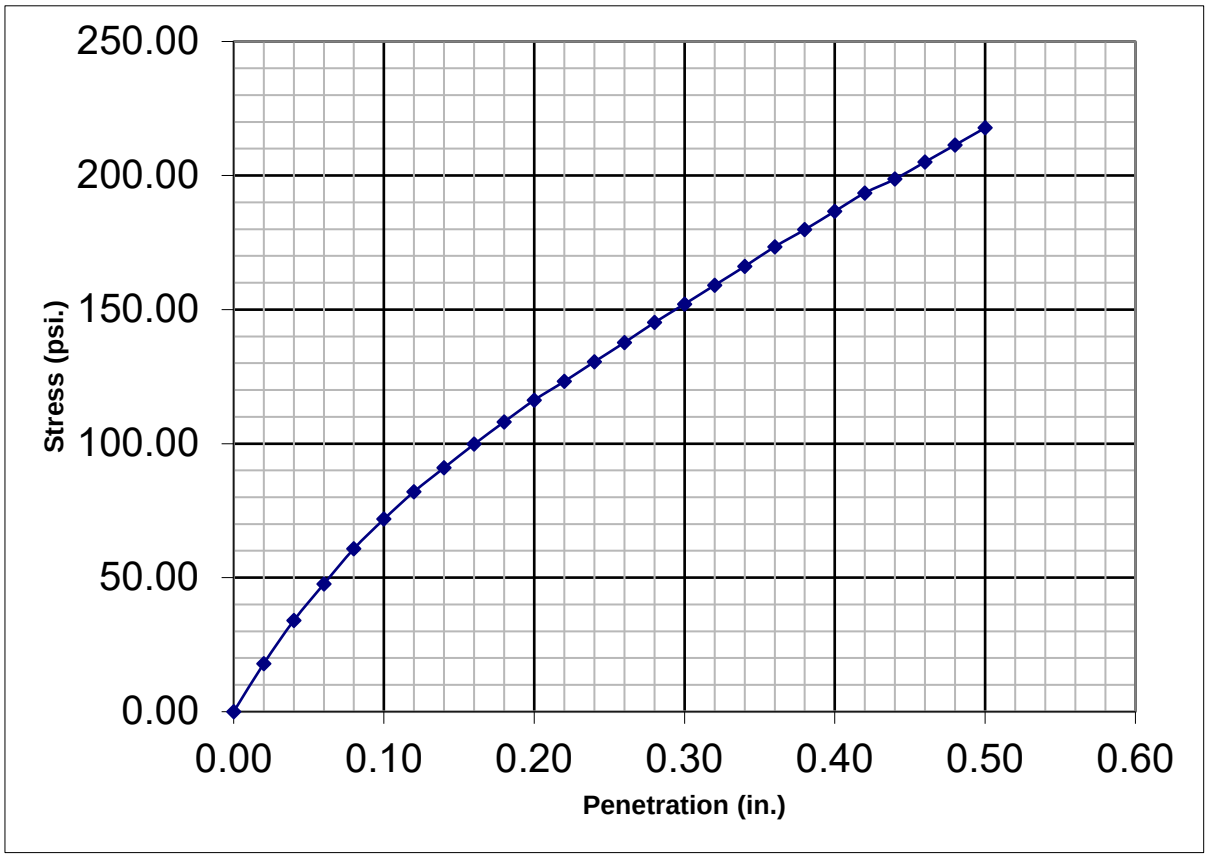
Opt. Moisture = 12.5% Max. Dry Density = 116.0 PCF

SOIL DESCRIPTION: Brown Silty Sand

CBR SPECIMEN DATA		Swell Data	
MOISTURE CONTENT	11.4%	Initial Reading	0.470
WET DENSITY	128.9 lbs./cu.ft.	Final Reading	0.500
DRY DENSITY	115.7 lbs./cu.ft.	Mold Height	4.570
% COMPACTION	99.7 %	% Swell	0.66

LOAD CELL 5000 LB. RATE OF DEFORMATION .05 in./min.

SURCHARGE USED 10 lbs.



CBR @ 0.1"	7.2
CBR @ 0.2"	7.7
% SWELL	0.7

GeoTechnologies, Inc. CBR DATA SHEET ASTM D-1883

JOB #: 1-18-0565-EA JOB NAME: Po Hoffer Additions

DATE: 9/17/2018 SAMPLE I.D.: A-3, A-4 Depth: 0.0-3.0'

NOTES: PROCTOR DATA: TEST PROCEDURE: ASTM D-698

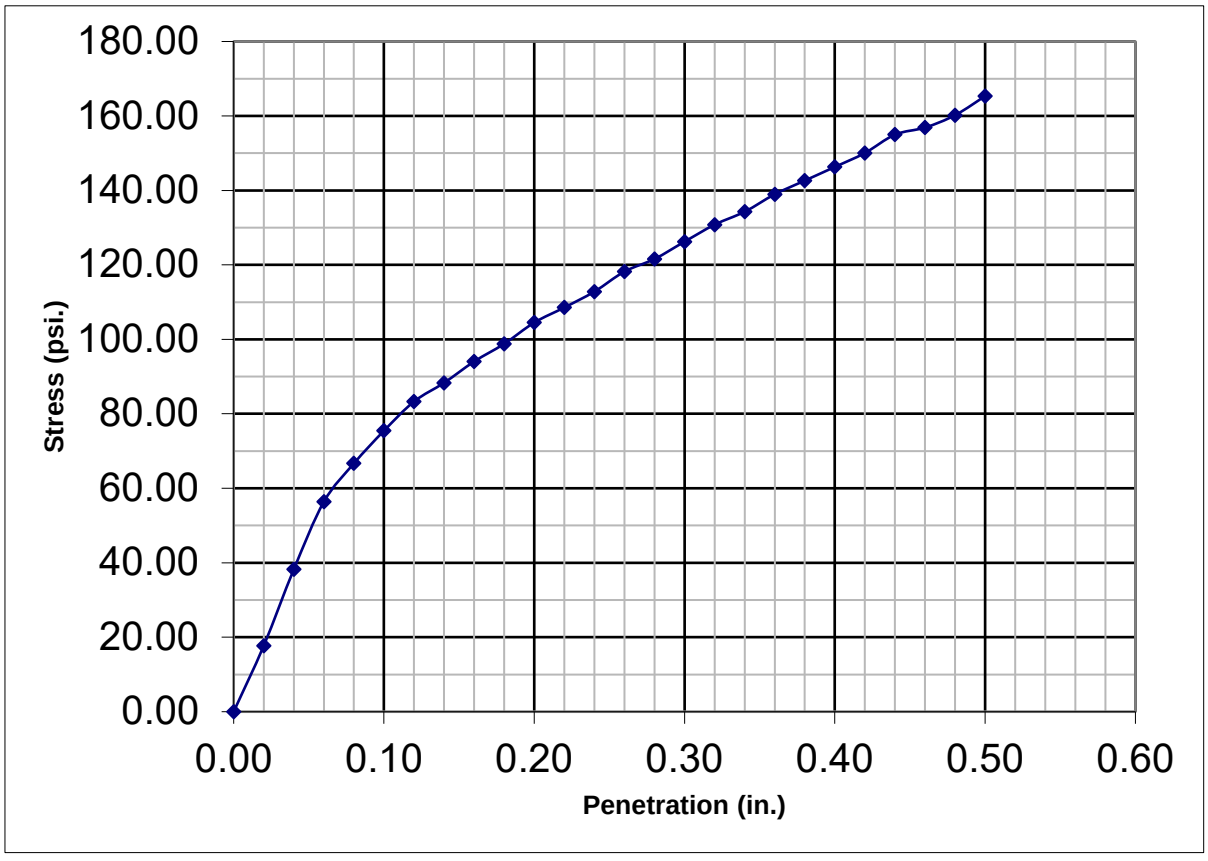
Opt. Moisture = 11.3% Max. Dry Density = 119.4 PCF

SOIL DESCRIPTION: Brown Silty Sand

CBR SPECIMEN DATA		Swell Data	
MOISTURE CONTENT	10.1%	Initial Reading	0.469
WET DENSITY	130.3 lbs./cu.ft.	Final Reading	0.495
DRY DENSITY	118.3 lbs./cu.ft.	Mold Height	4.593
% COMPACTION	99.1 %	% Swell	0.57

LOAD CELL 5000 LB. RATE OF DEFORMATION .05 in./min.

SURCHARGE USED 10 lbs.



CBR @ 0.1"	7.5
CBR @ 0.2"	7.0
% SWELL	0.6

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-10 S-2	4.0'					Brown Silty Course to Fine Sand

Project:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

Job No.: 1-18-0565-EA

Date: 9/17/18

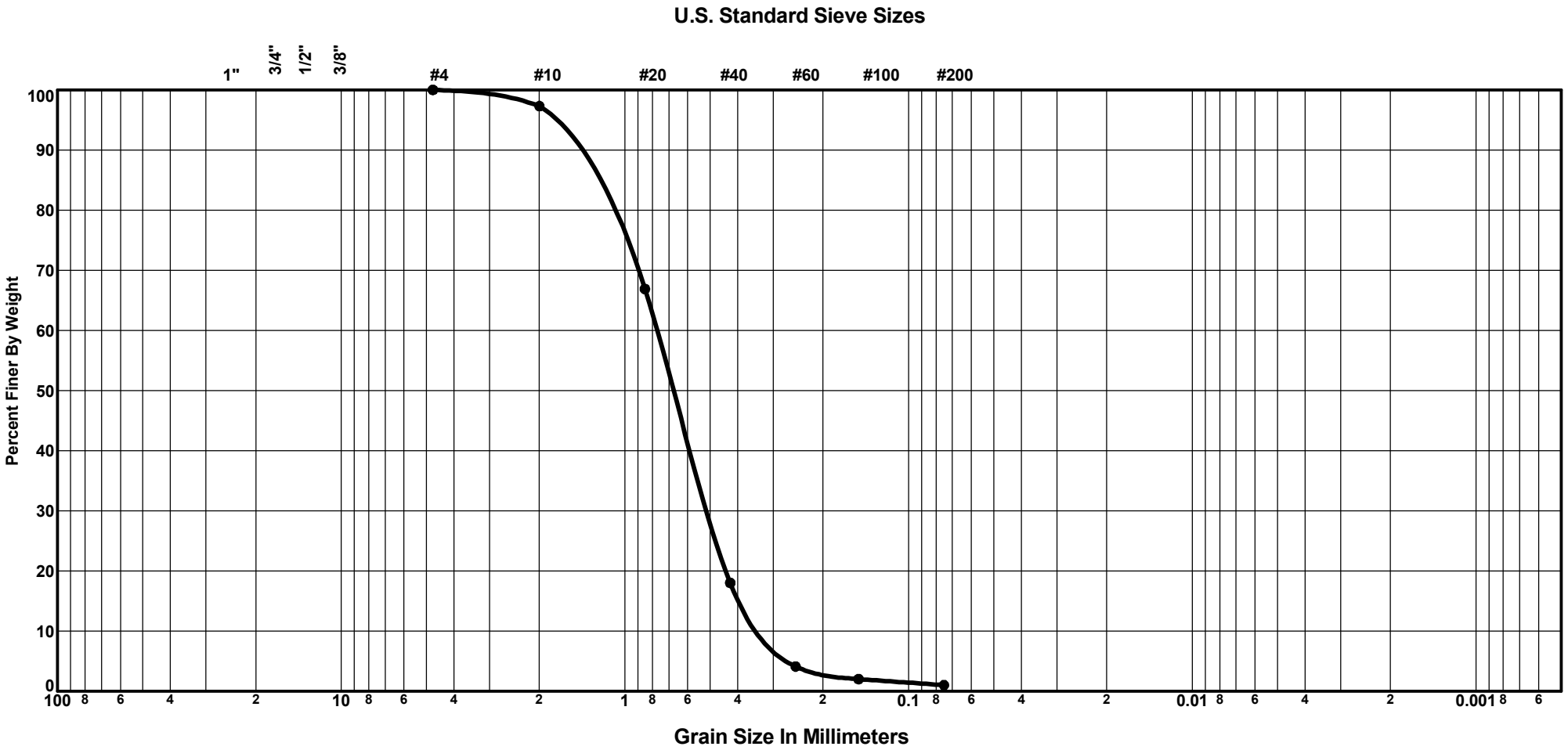
Date Recieved: 8/27/2018

Dates Tested: 8/27-9/4/2018

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.

3200 Wellington Court, Ste 108
Raleigh, NC 27615



GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-4 S-3	9.0'					Brown Fine to Medium Sand

Project:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

Job No.: 1-18-0565-EA

Date: 9/17/18

Date Recieved: 9/4/2018

Dates Tested: 9/4-9/10/2018

GRAIN SIZE DISTRIBUTION

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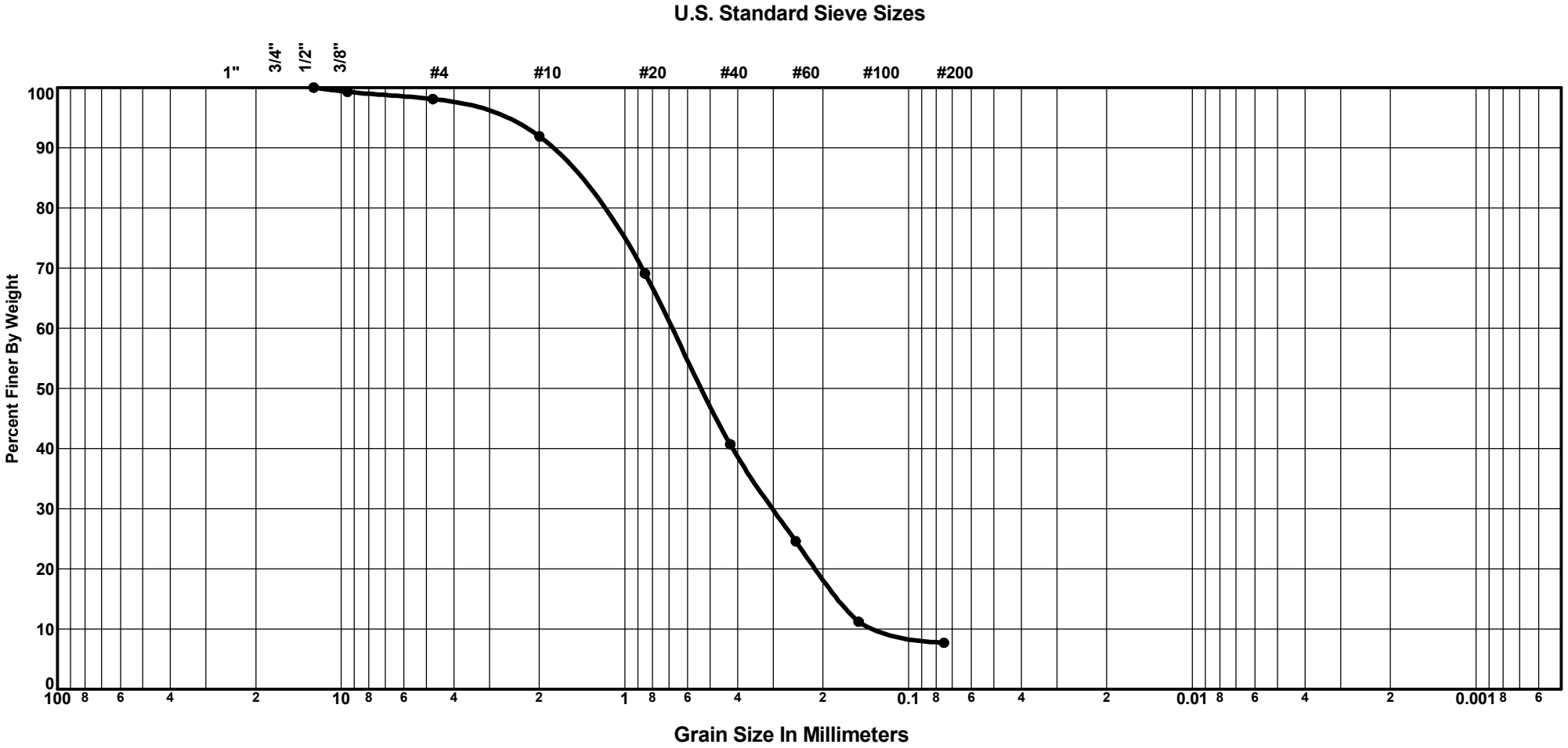

GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-6 S-3	9.0'					Brown Slightly Silty Fine to Medium Sand

Project:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

Job No.: 1-18-0565-EA

Date: 9/17/18

Date Recieved: 8/27/2018

Dates Tested: 8/27-9/4/2018

GRAIN SIZE DISTRIBUTION

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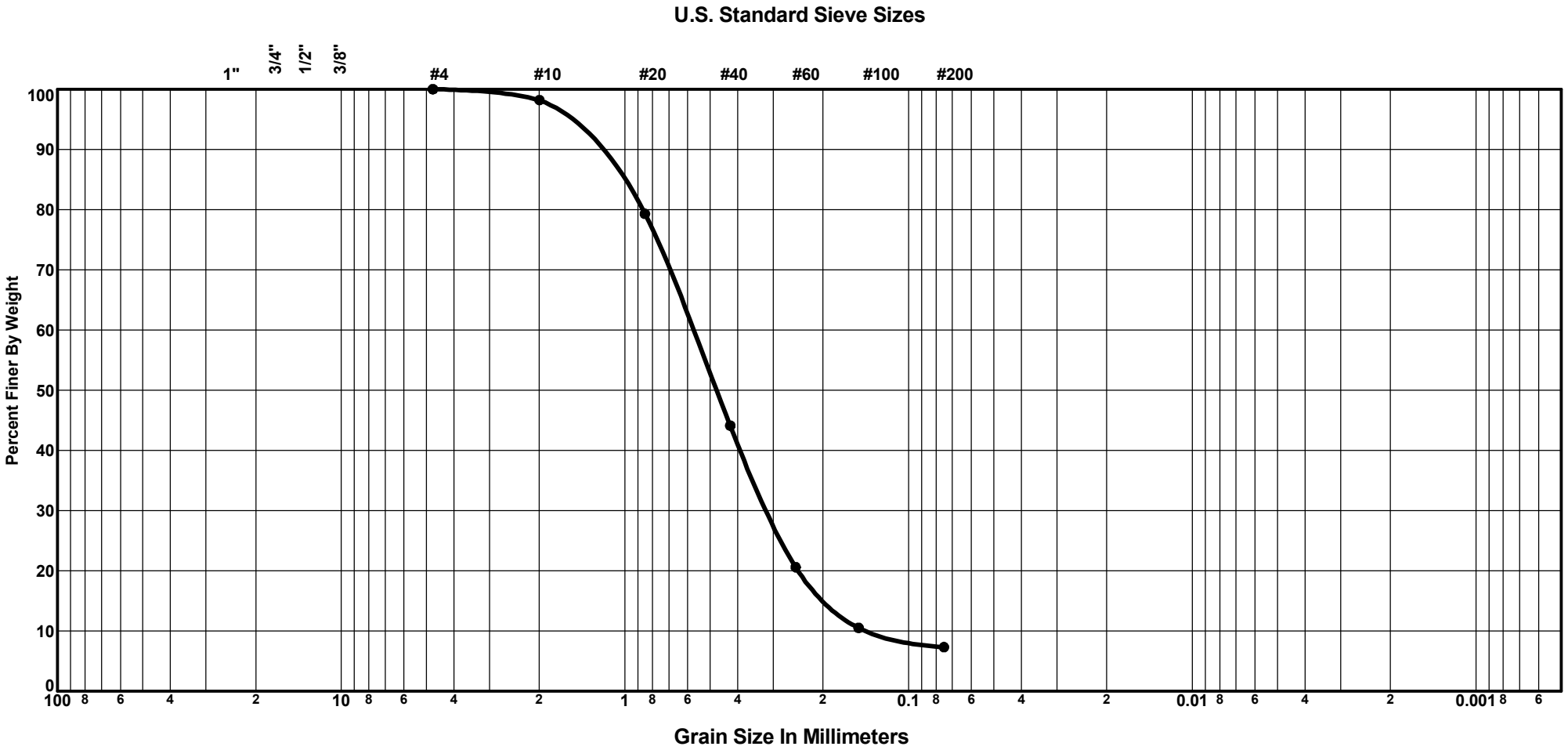


GRAVEL		SAND			FINES	
COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

Boring No.	Elev./Depth	Nat. W.C.	L.L.	P.L.	P.I.	Soil Description or Classification
B-7 S-2	4.0'					Brown Slightly Silty Fine to Medium Sand

Project:

PO Hoffer Water Plant Additions
Fayetteville, North Carolina

Job No.: 1-18-0565-EA

Date: 9/17/18

Date Recieved: 8/27/2018

Dates Tested: 8/27-9/4/2018

GRAIN SIZE DISTRIBUTION

GeoTechnologies, Inc.
3200 Wellington Court, Ste 108
Raleigh, NC 27615

GeoTechnologies, Inc.

Job No: 1-18-0565-EA Date: 9/17/18

Job Name: PO Hoffer Water Plant Additions

Job Location: Fayetteville, North Carolina

Boring No: A-1, A-2

Sample No:

Depth: 0.0-3.0'

TEST RESULTS

Method of Test: ASTM D 698

Maximum Dry Density: 116.0 PCF

Optimum Moisture Content: 12.5%

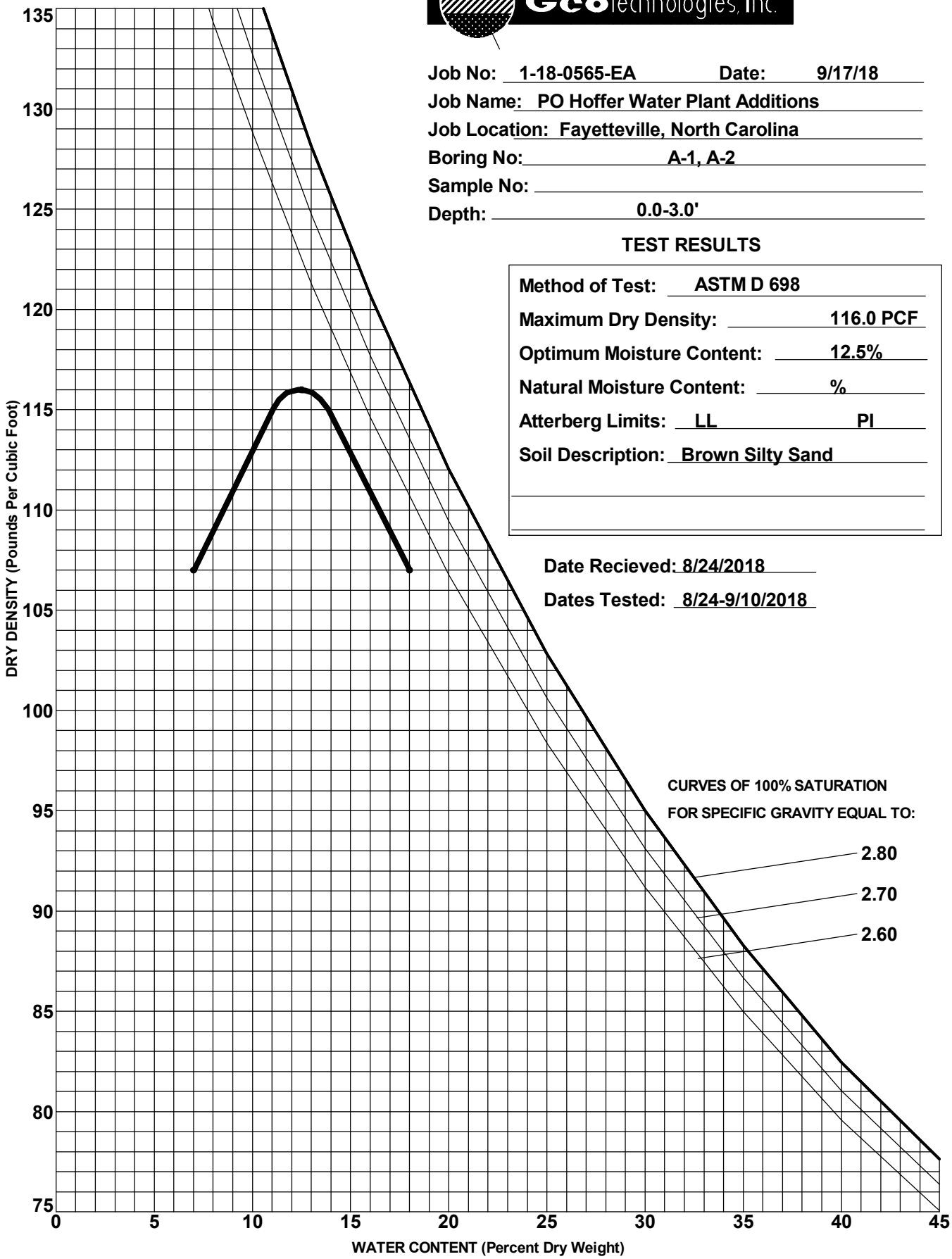
Natural Moisture Content: %

Atterberg Limits: LL PI

Soil Description: Brown Silty Sand

Date Recieved: 8/24/2018

Dates Tested: 8/24-9/10/2018



MOISTURE-DENSITY RELATIONSHIP

3200 Wellington Court, Ste 108
Raleigh, NC 27615

GeoTechnologies, Inc.

Job No: 1-18-0565-EA Date: 9/17/18

Job Name: PO Hoffer Water Plant Additions

Job Location: Fayetteville, North Carolina

Boring No: A-3, A-4

Sample No:

Depth: 0.0-3.0'

TEST RESULTS

Method of Test: ASTM D 698

Maximum Dry Density: 119.4 PCF

Optimum Moisture Content: 11.3%

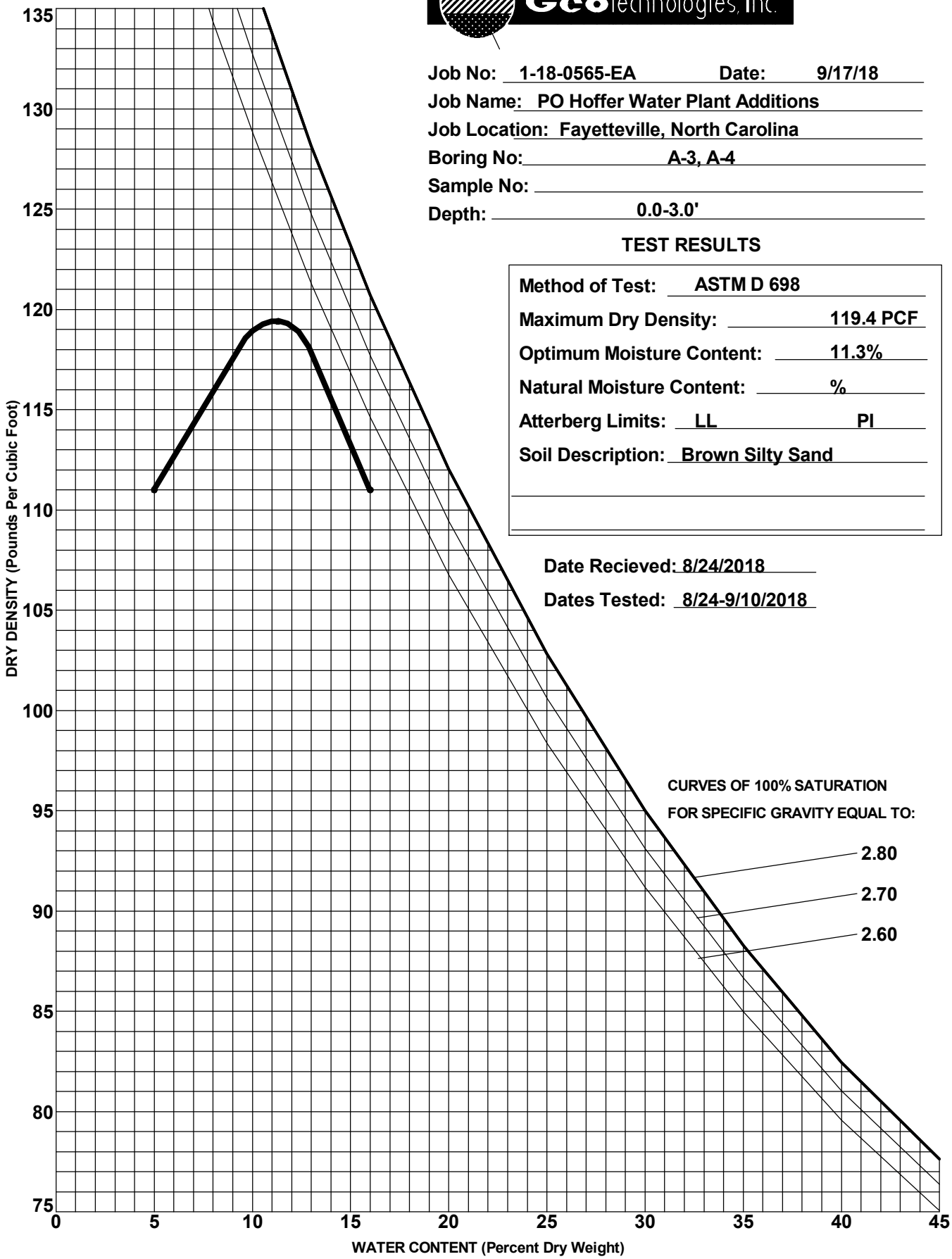
Natural Moisture Content: %

Atterberg Limits: LL PI

Soil Description: Brown Silty Sand

Date Recieved: 8/24/2018

Dates Tested: 8/24-9/10/2018



MOISTURE-DENSITY RELATIONSHIP

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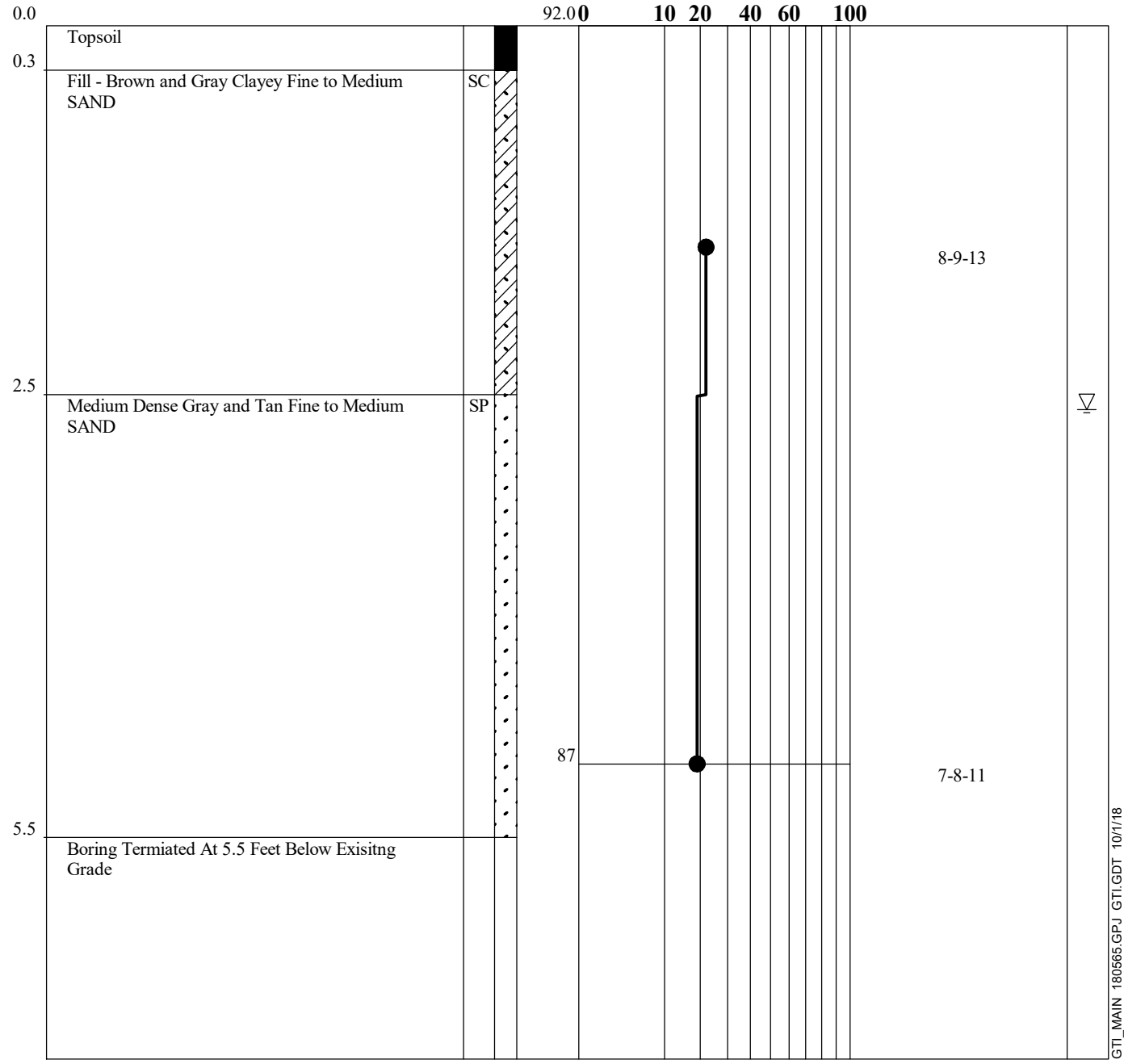
Boring Logs

TEST BORING RECORD



Groundwater Encountered At 2.6 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER A-1
DATE 8-30-18

PAGE 1 OF 1

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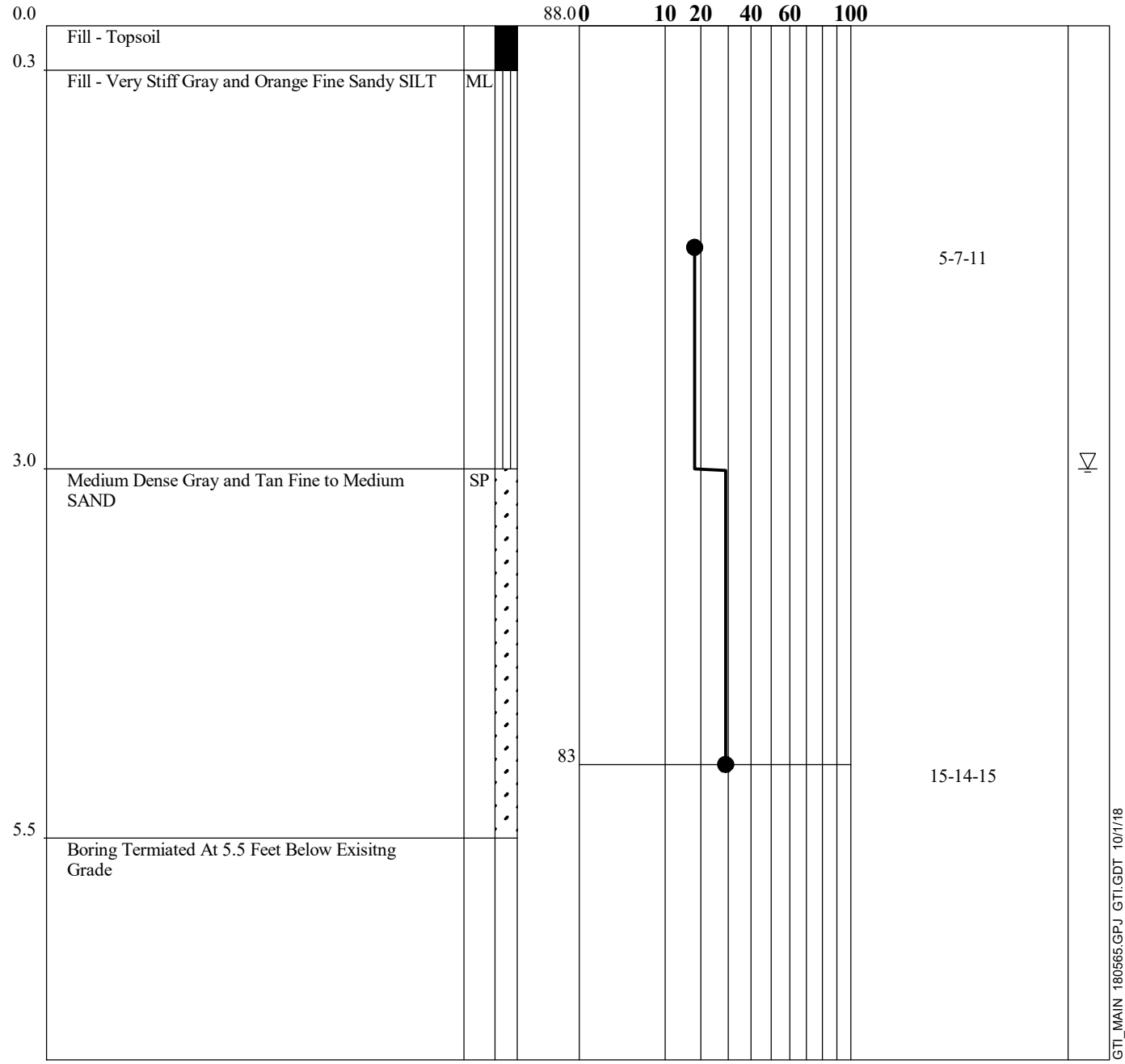
3200 Wellington Court, Ste 108
Raleigh, NC 27615

TEST BORING RECORD



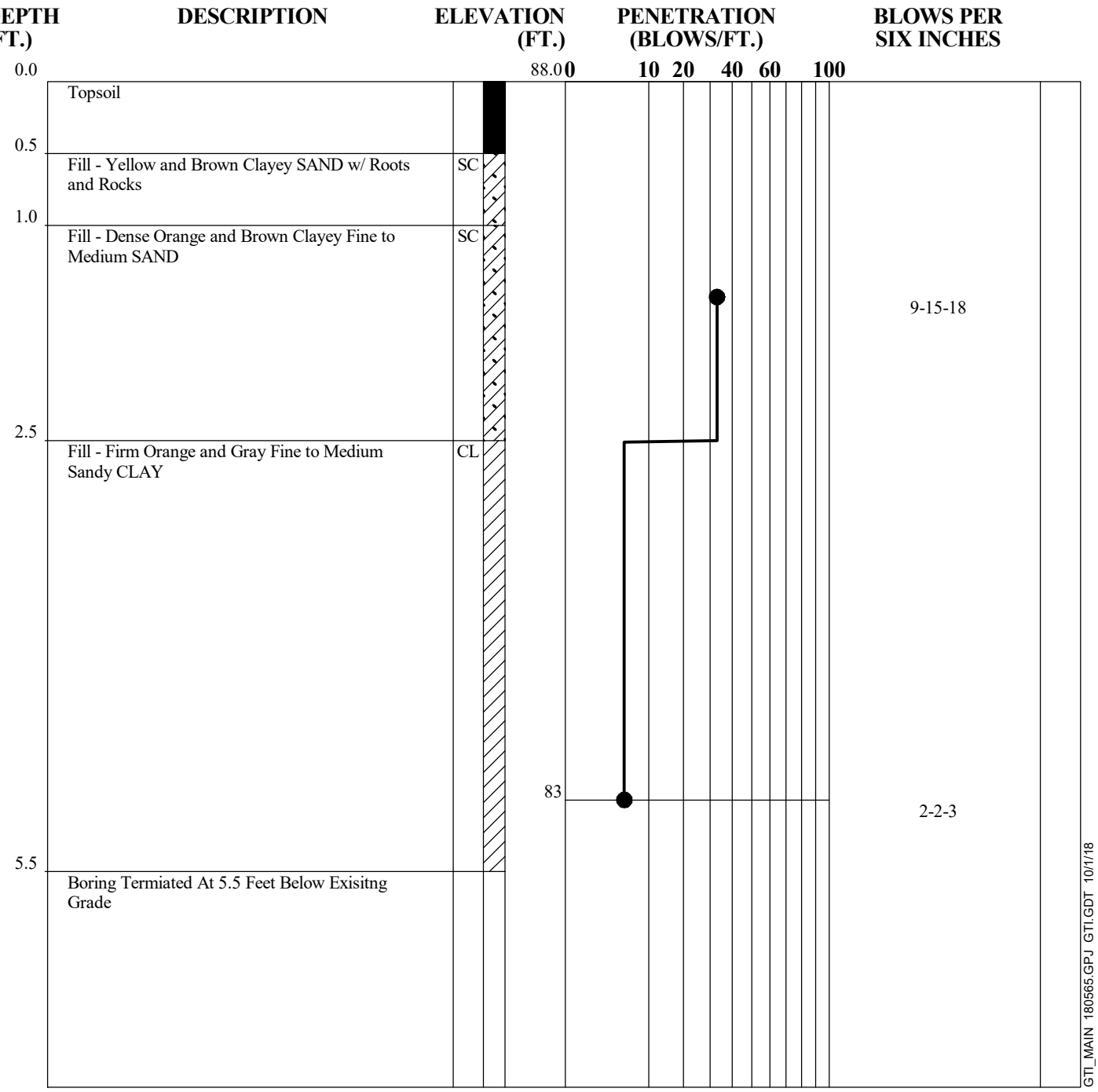
Groundwater Encountered At 3.0 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER A-2
DATE 8-30-18

PAGE 1 OF 1

GeoTechnologies, Inc.
3200 Wellington Court, Ste 108
Raleigh, NC 27615

TEST BORING RECORD



Dry At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER A-3
DATE 8-30-18

PAGE 1 OF 1

GeoTechnologies, Inc.
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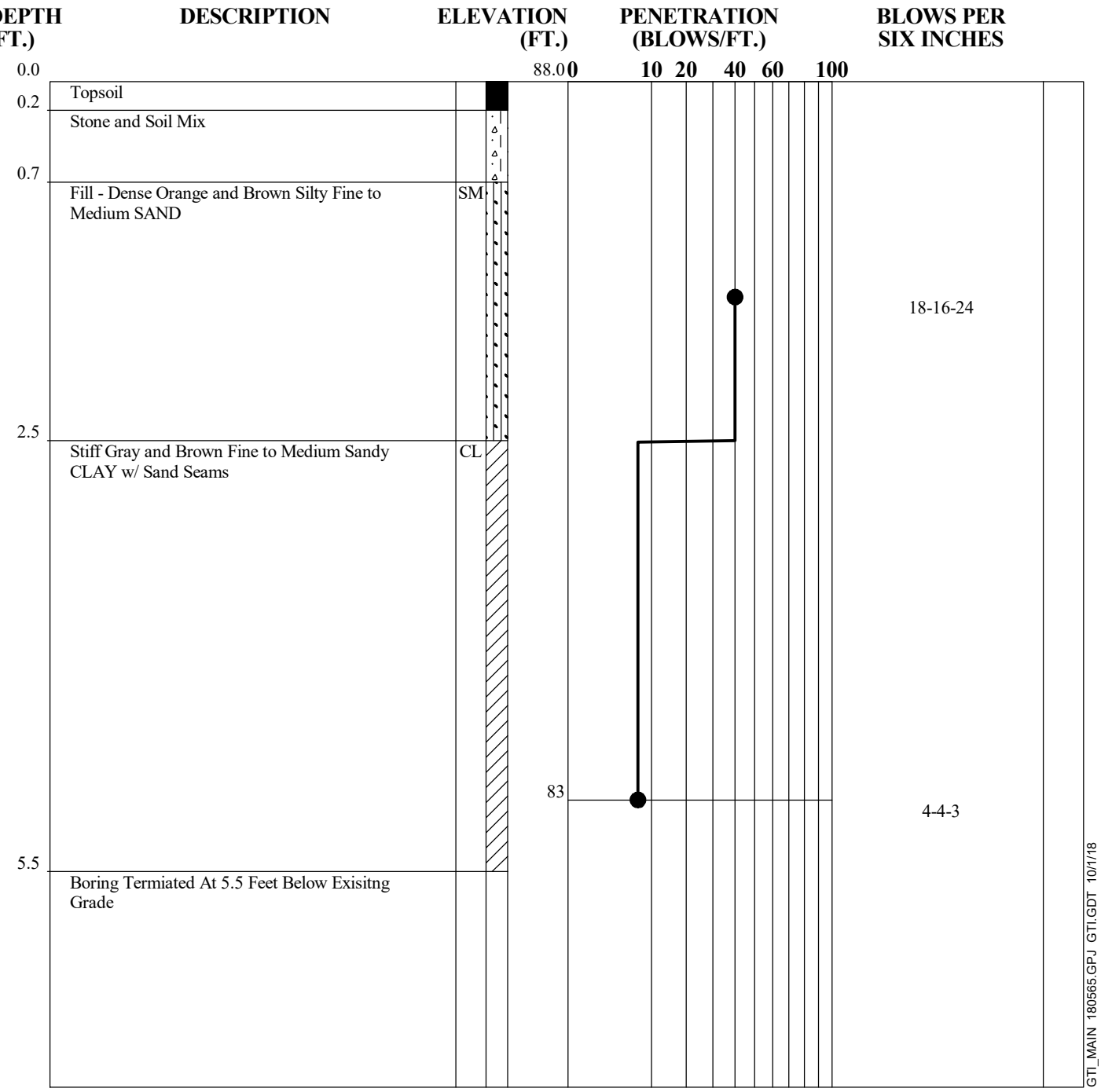
TEST BORING RECORD



Dry At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER A-4
DATE 8-30-18

PAGE 1 OF 1

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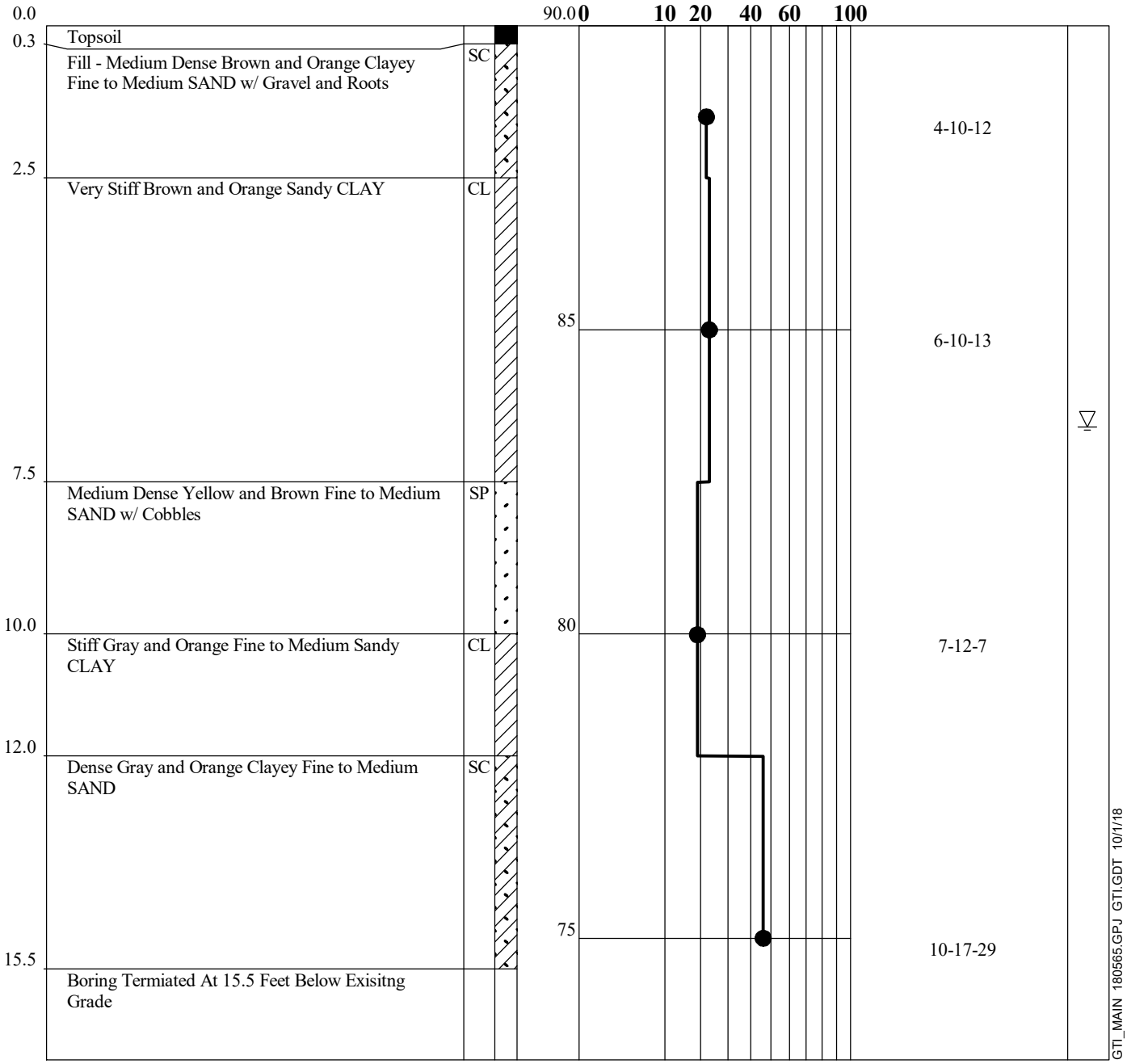
TEST BORING RECORD



Groundwater Encountered At 6.6 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -1
DATE 8-30-18

PAGE 1 OF 1

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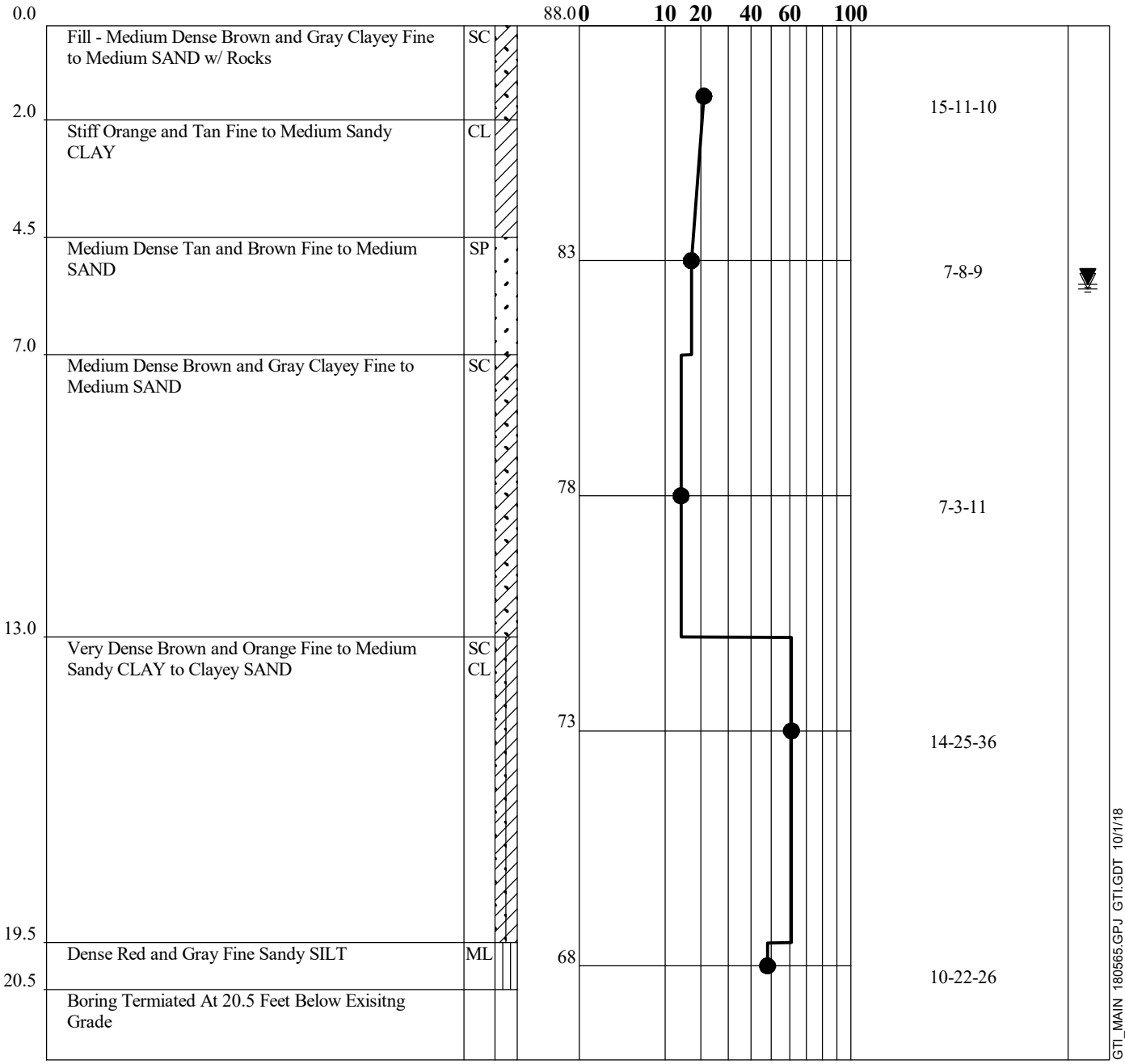
TEST BORING RECORD

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	PENETRATION (BLOWS/FT.)	BLOWS PER SIX INCHES
0.0	Fill - Medium Dense Brown and Gray Clayey Fine to Medium SAND w/ Rocks (SC)	88.0		15-11-10
2.0	Stiff Orange and Tan Fine to Medium Sandy CLAY (CL)			
4.5	Medium Dense Tan and Brown Fine to Medium SAND (SP)	83		7-8-9
7.0	Medium Dense Brown and Gray Clayey Fine to Medium SAND (SC)	78		7-3-11
13.0	Very Dense Brown and Orange Fine to Medium Sandy CLAY to Clayey SAND (SC/CL)	73		14-25-36
19.5	Dense Red and Gray Fine Sandy SILT (ML)	68		10-22-26
20.5	Boring Termiated At 20.5 Feet Below Exisitng Grade			



Groundwater Encountered At 5.6 Feet Below Existing Grade At Time of Boring. Groundwater Encountered At 5.5 Feet Below Exisitng Grade 24 hours After Boring. Caving At 6 feet Below Exisitng Grade.

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -2
DATE 8-30-18

PAGE 1 OF 1

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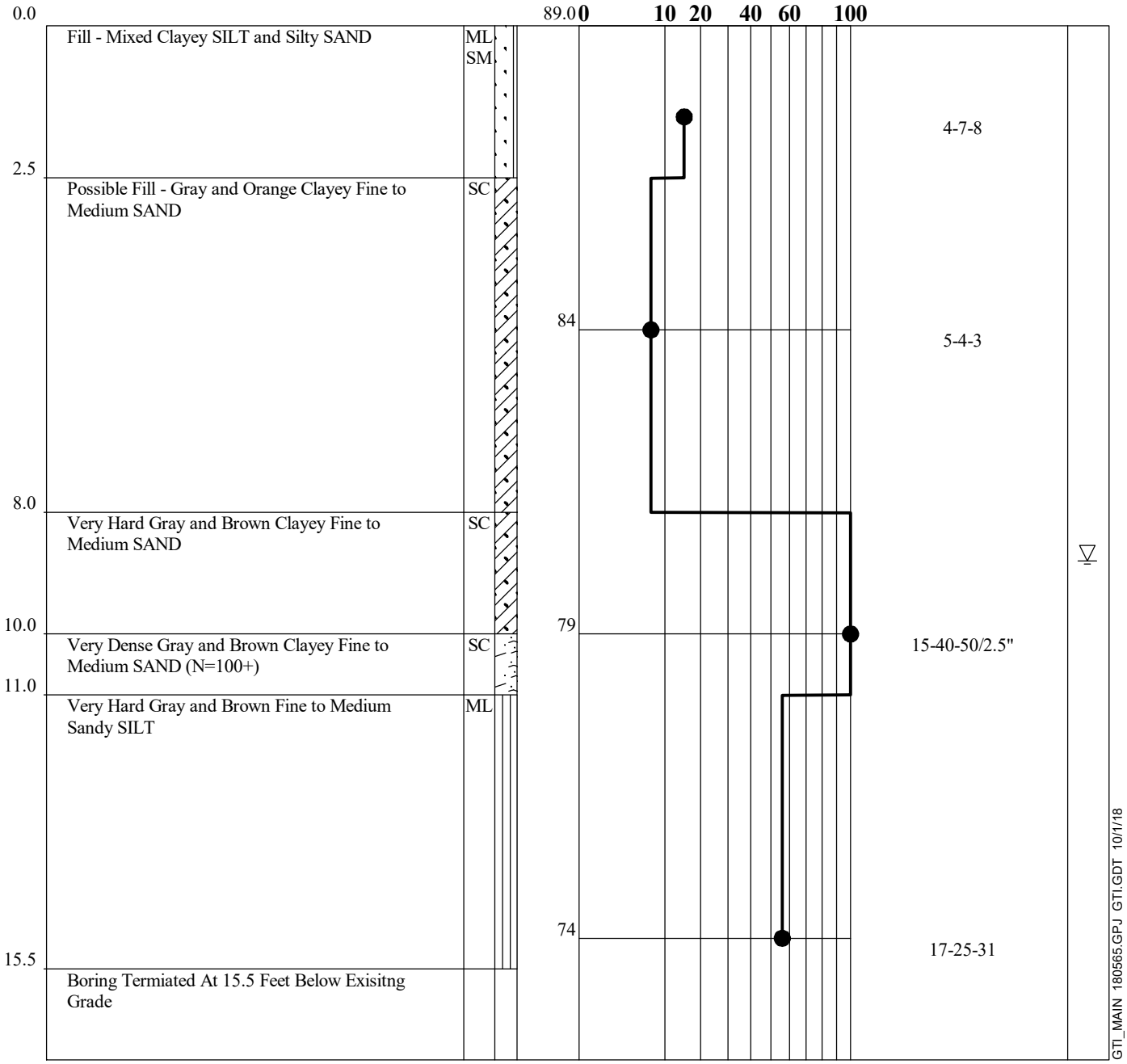
TEST BORING RECORD



Groundwater Encountered At 8.8 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -3
DATE 8-30-18

PAGE 1 OF 1

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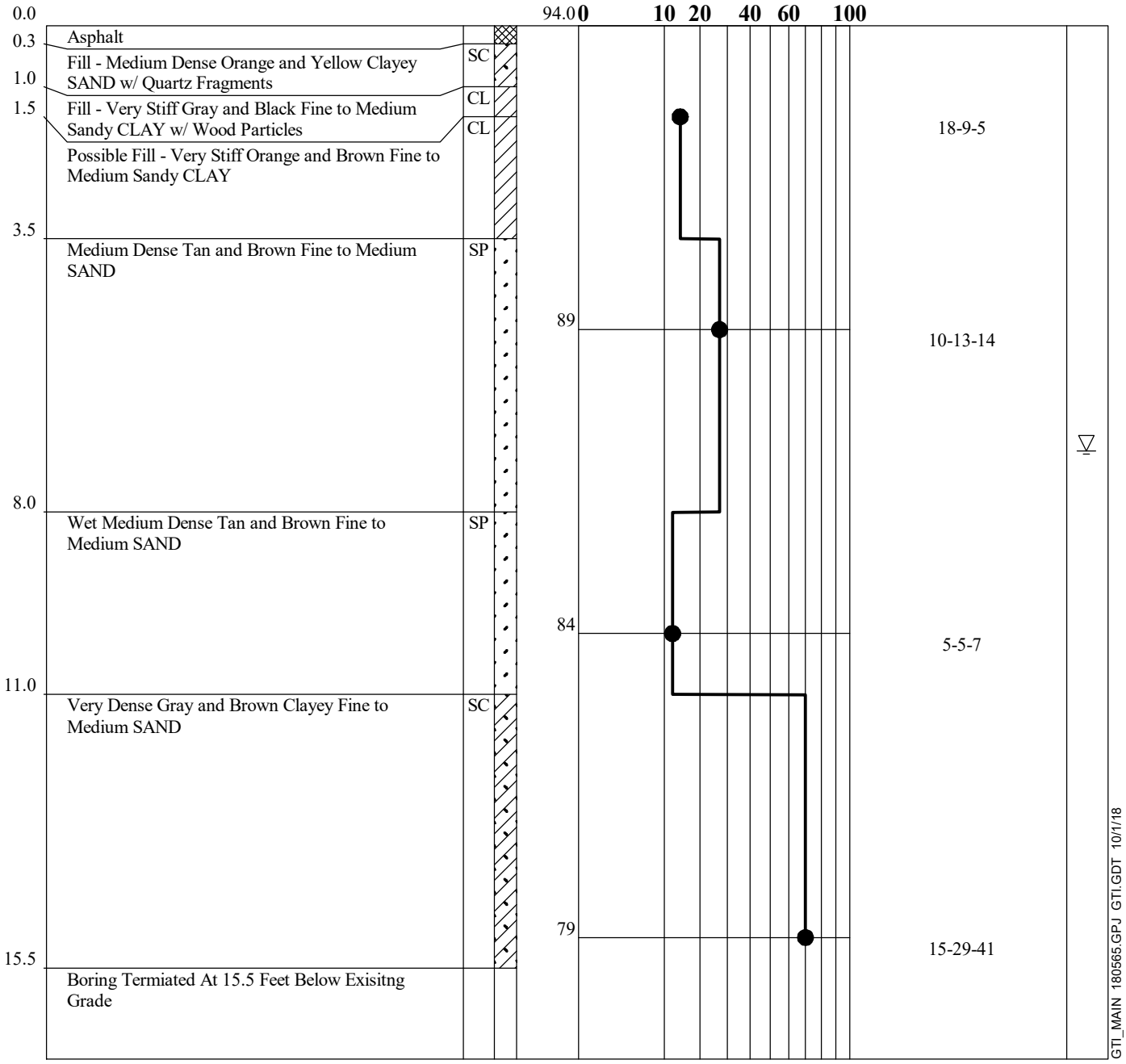
TEST BORING RECORD



Groundwater Encountered At 7 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -4
DATE 8-30-18

PAGE 1 OF 1

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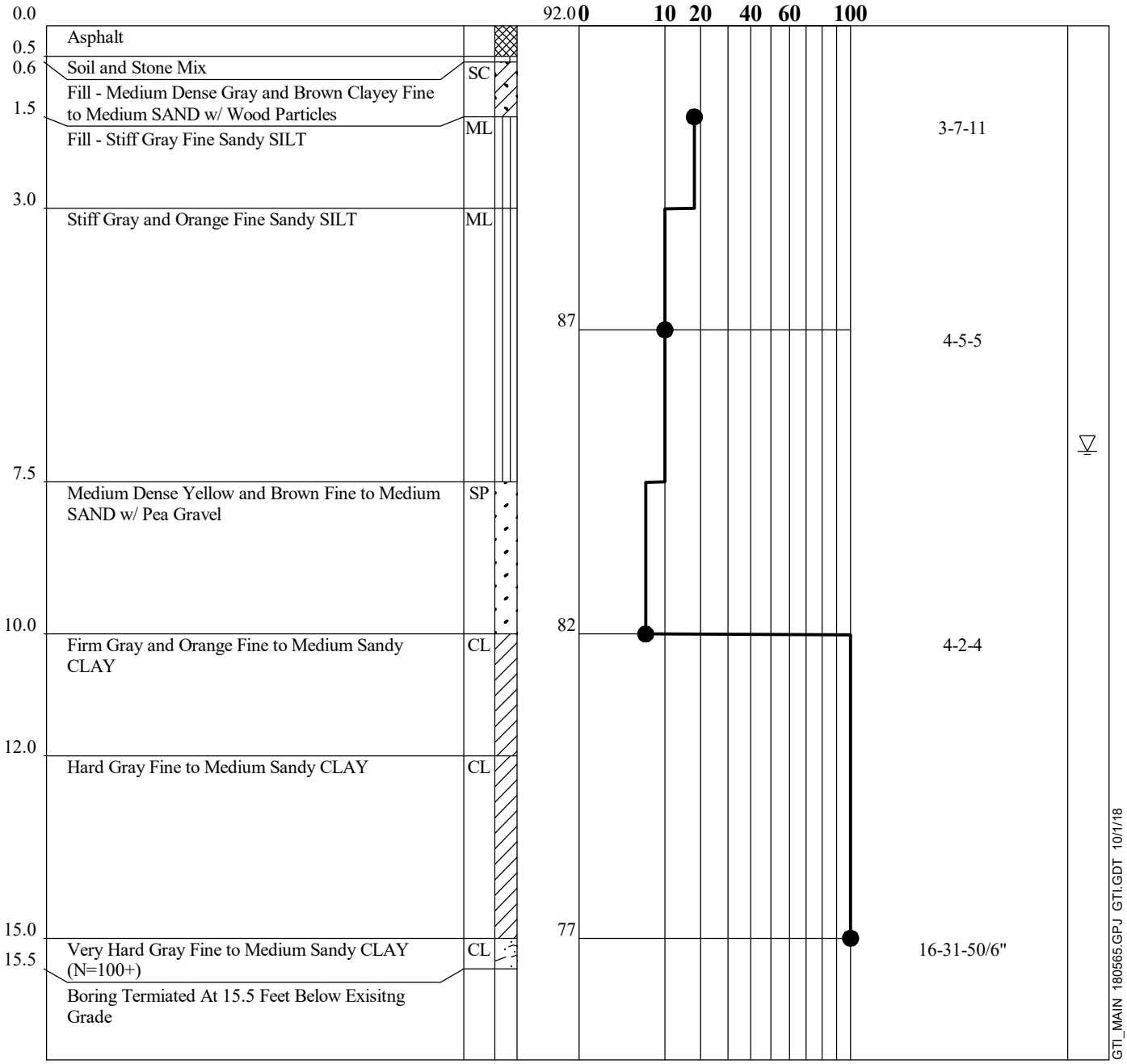
TEST BORING RECORD



Groundwater Encountered At 7 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -5
DATE 8-30-18

PAGE 1 OF 1

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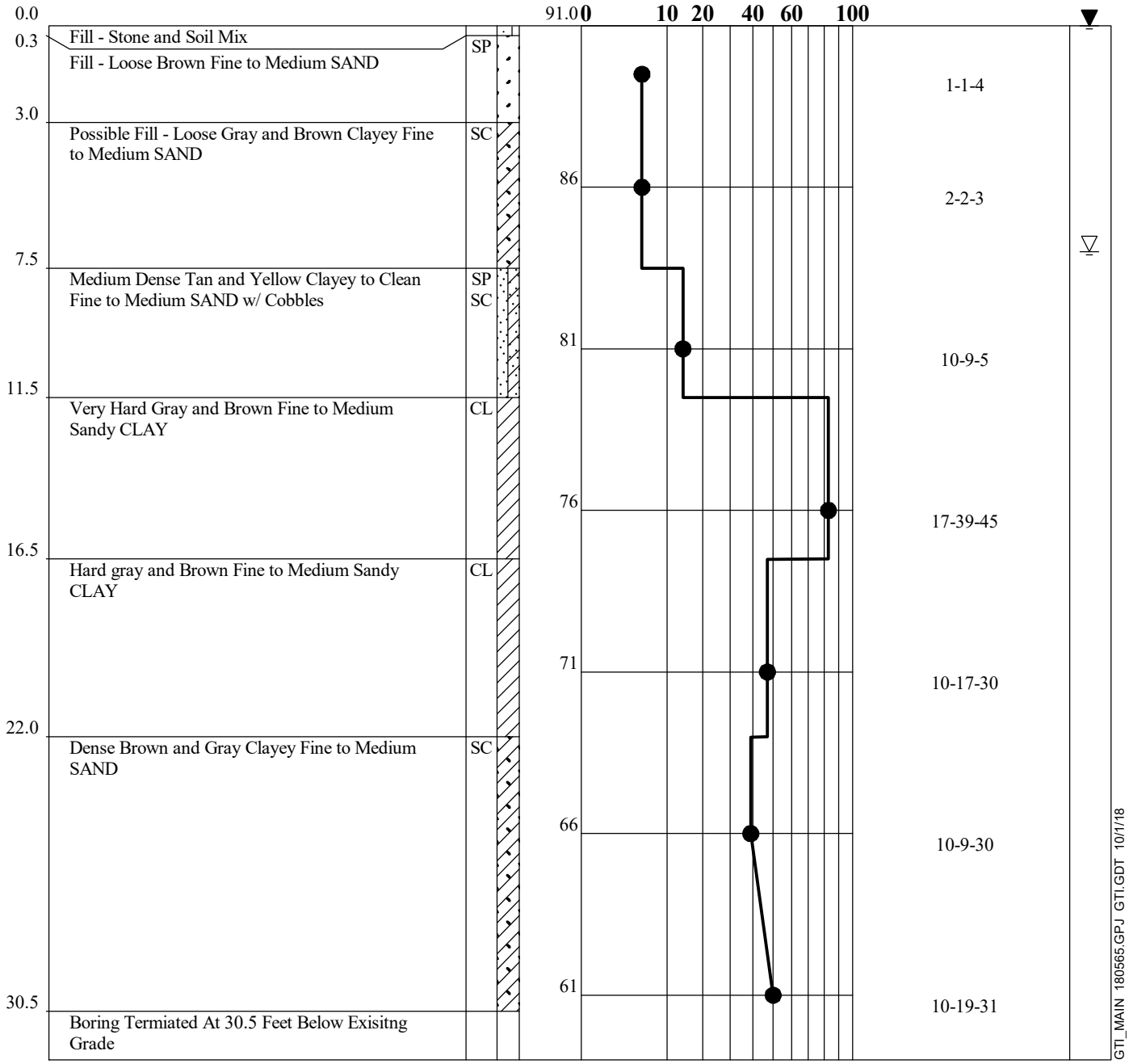
TEST BORING RECORD



Groundwater Encountered At 7 Feet Below Existing Grade At Time of Boring. Groundwater Encountered At 0 Feet Below Exisitng Grade 24 hours After Boring. Caving At 6 Feet Below Existing Grade.

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -6
DATE 8-30-18

PAGE 1 OF 1

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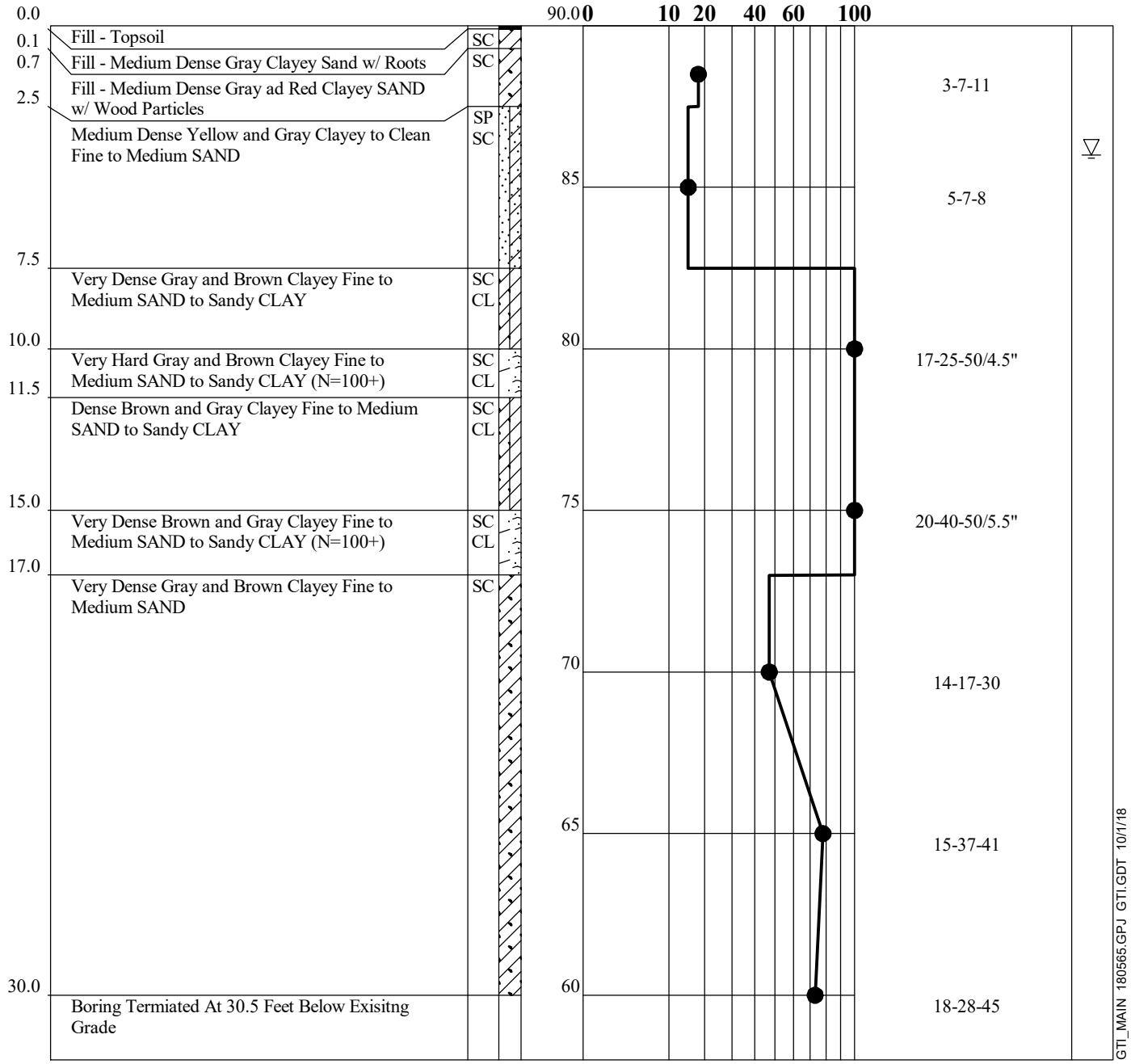
TEST BORING RECORD



Groundwater Encountered At 4 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -7
DATE 8-30-18

PAGE 1 OF 1

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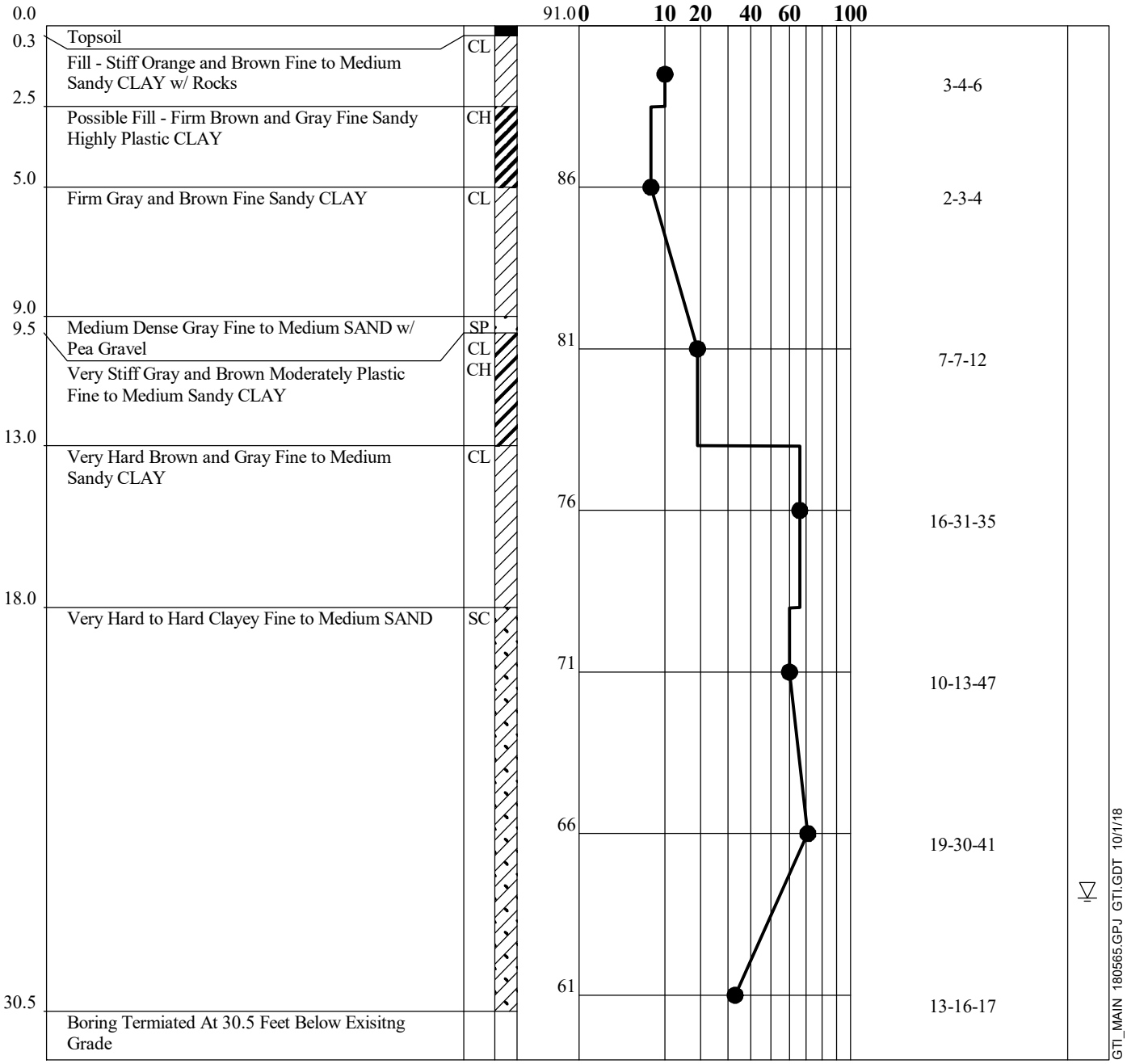
TEST BORING RECORD



Groundwater Encountered At 27 Feet Below Existing Grade At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -8
DATE 8-30-18

PAGE 1 OF 1

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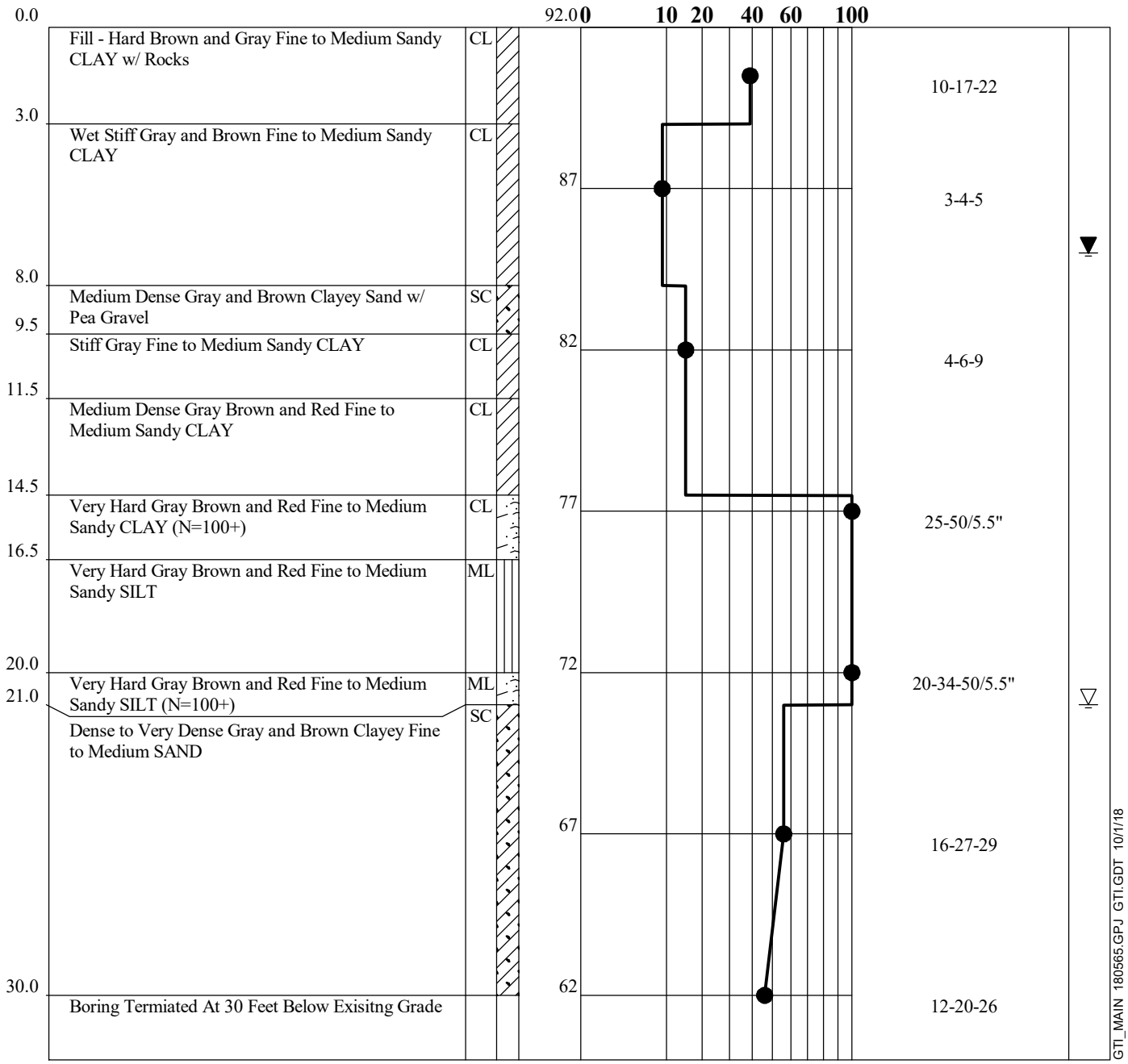
TEST BORING RECORD



Groundwater Encountered At 21 Feet Below Existing Grade At Time of Boring. Groundwater Encountered At 7 Feet Below Exisitng Grade 24 hours After Boring.

JOB NUMBER 1-18-0565-EA
BORING NUMBER B -9
DATE 8-30-18

PAGE 1 OF 1

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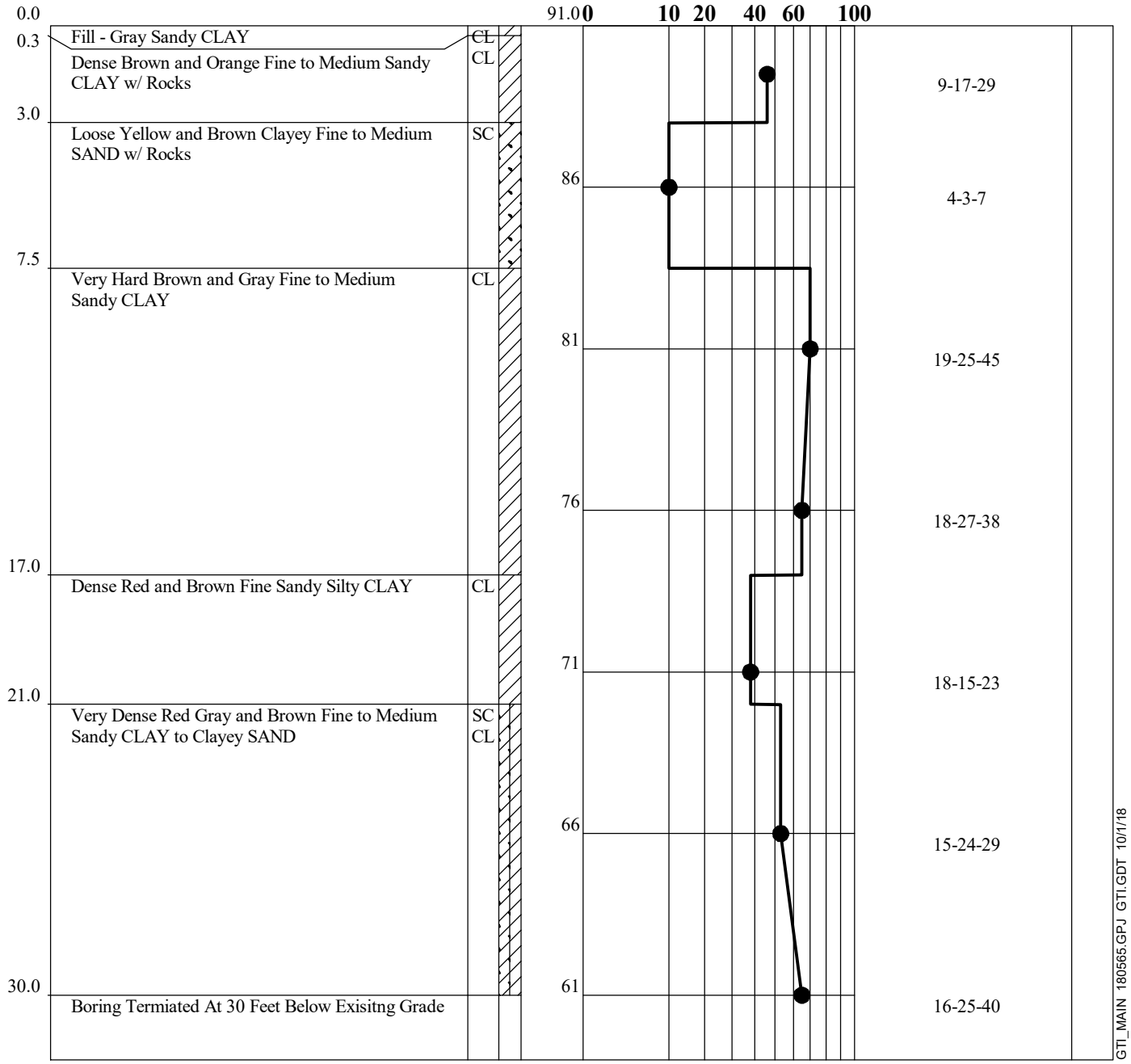
TEST BORING RECORD



Dry At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B-10
DATE 8-30-18

PAGE 1 OF 1

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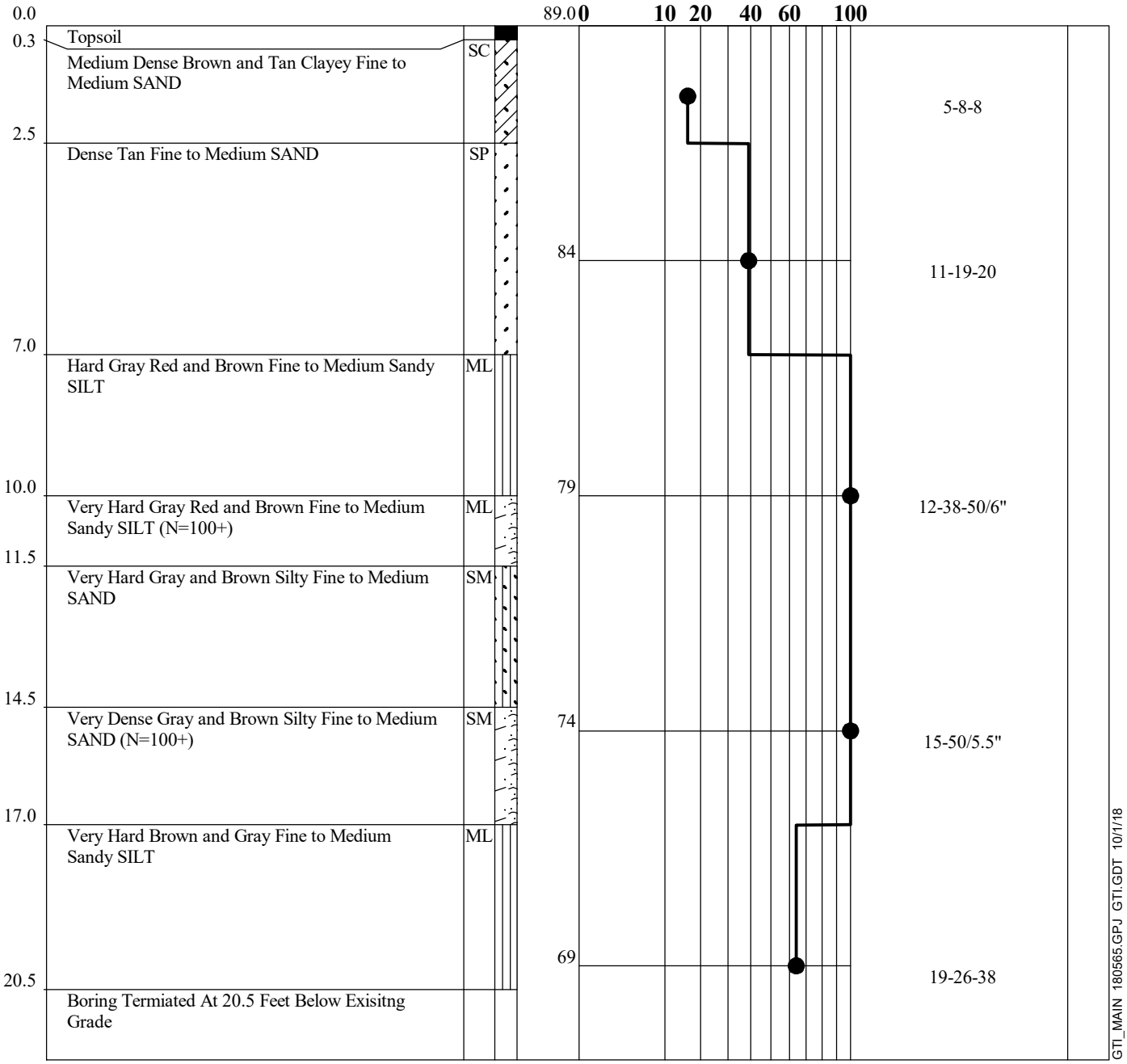
TEST BORING RECORD



Dry At Time of Boring

JOB NUMBER 1-18-0565-EA
BORING NUMBER B-11
DATE 8-30-18

GeoTechnologies, Inc.
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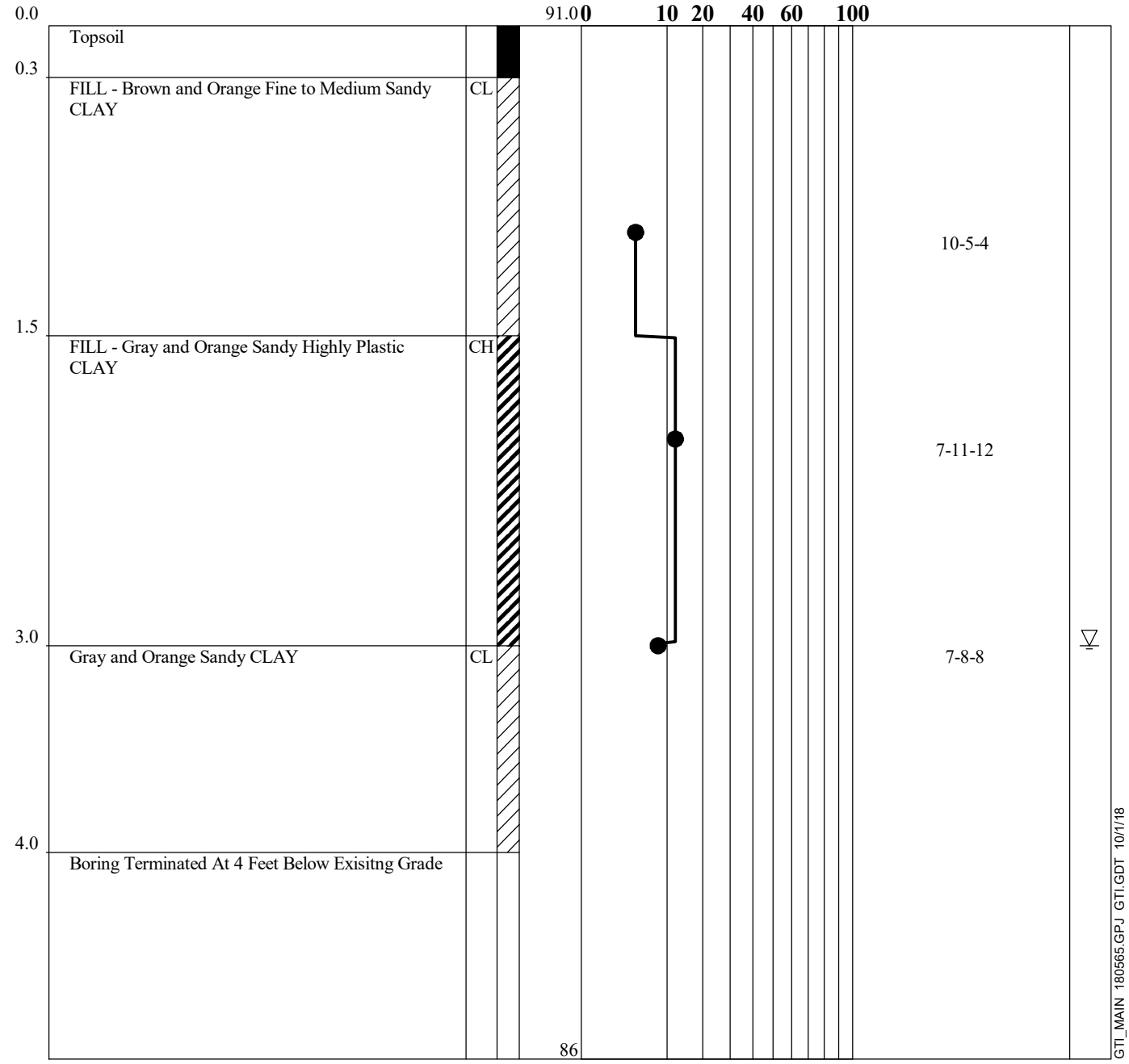
DYNAMIC HAND CONE PENETROMETER RECORD



Groundwater Encountered At 3.0 Feet Below Existing Grade At Time of Boring

GTI_MAIN 180565.GPJ GTI.GDT 10/1/18

JOB NUMBER 1-18-0565-EA
BORING NUMBER B-12
DATE 9-28-18

PAGE 1 OF 1

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APPENDIX B

1967 PIPE LAYING SCHEDULE

SPECIFICATION NO. CO-67-17-1

FOR 24",36"&48" PRESTRESSED CONCRETE CYLINDER PIPE WITH RUBBER & STEEL JOINT (SP-5)

CAPE FEAR WATER PURIFICATION PLANT

FAYETTEVILLE, NORTH CAROLINA

PEIRCON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, Section 1, Page 2

	RAW WATER LINES		
Nominal Pipe Diameter - inches	24	36	48
Approximate Footage - feet	675	1,385	15
Cylinder Gage - ASTM A-415	16	16	16
Cylinder Area - sq.in./ft.	0.718	0.718	0.718
Minimum Yield Strength of Cylinder - psi	27,000	27,000	27,000
Cylinder Test Pressure (25,000 psi) - psi	111	74	55
Wire Size - ASTM A 227-64	#8 MBU	#8MBU	#8 MBU
Wire Area - sq.in./ft.	0.256	0.359	0.461
No. of Wraps of Wire - per ft.	12,44	17.44	22.40
Minimum Ultimate Wire Strength - psi	231,000	231,000	231,000
Wire Wrapping Stress - psi	173,250	173,250	173,250
Dynamometer (1 wire) - lbs.	3,570	3,570	3,570
Pressure at zero concrete compression - psi	187	187	187
Resultant compression in concrete - psi	1,370	1,440	1,475
Minimum compressive strength of concrete at time of wrapping (Rodded cylinders) - psi	3,500	3,500	3,500
Core Thickness (including cylinder) - inches	1-1/2	2-1/4	3
Minimum Coating Thickness - inch	13/16	13/16	13/16
Zinc Coated Joint Rings:			
Spigot Ring Width - inches	4-1/2	4-1/2	5-1/2
Bell Ring- inches x inches	3/16x4-1/2	3/16x4-1/2	1/4x5-1/2
Joint Depth - inches	3-1/4	3-3/8	3-7/8
Creep - feet	0.02	0.03	0.03
Average Laid Length - feet	16.02	16.03	16.03

Calculation Data: $n_i = 6.0$, $n_r = 5.0$, $R_1 = 0.05$, $C_r = 1.50$

Design Conditions:
In Accordance with AWWA Specification C-301-64

Working Pressure - psi	150	150	150

LJ02405150

LJ03605150

LJ04805150

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAR APPROVED DJR DATE 8-23-67

471

SPECIFICATION NO. CO-67-17-2

FOR 24" & 30" PRESTRESSED CONCRETE CYLINDER PIPE WITH RUBBER & STEEL JOINT (SP-5)

CAPE FEAR WATER PURIFICATION PLANT

FAYETTEVILLE, NORTH CAROLINA

PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual - Section 1, Page 2

	HIGH SERVICE LINES	
Nominal Pipe Diameter - inches	24	30
Approximate Footage - feet	255	290
Cylinder Gage - ASTM A-415	16	16
Cylinder Area - sq.in./ft.	0.718	0.718
Minimum Yield Strength of Cylinder - psi	27,000	27,000
Cylinder Test Pressure (25,000 psi) - psi	111	89
Wire Size - ASTM A 227-64	#8 MBU	#8 MBU
Wire Area - sq.in./ft.	0.349	0.420
No. of Wraps of Wire - per ft.	16.96	20.40
Minimum Ultimate Wire Strength - psi	231,000	231,000
Wire Wrapping Stress - psi	173,250	173,250
Dynamometer (1 wire) - lbs.	3,570	3,570
Pressure at zero concrete compression - psi	250	250
Resultant compression in concrete - psi	1,790	1,845
Minimum compressive strength of concrete at time of wrapping (Rodded cylinders) - psi	4,410	4,400
Core Thickness (including cylinder) - inches	1-1/2	1-7/8
Minimum Coating Thickness - inch	13/16	13/16
Zinc Coated Joint Rings:		
Spigot Ring Width - inches	4-1/2	4-1/2
Bell Ring - inches x inches	3/16 x 4-1/2	3/16 x 4-1/2
Joint Depth - inches	3-1/4	3-1/4
Creep - feet	0.02	0.02
Average Laid Length - feet	16.02	16.02

Calculation Data: $n_i = 6.0$, $n_r = 5.0$, $R_1 = 0.05$, $C_r = 1.50$

Design Conditions:
In Accordance with AWWA Specification C-301-64

Working Pressure - psi	200	200

LJ02405200

LJ03005200

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAR APPROVED DJL DATE 8-23-67

SPECIFICATION NO. CO-67-17-3

FOR 42" & 48" PRESTRESSED CONCRETE CYLINDER PIPE WITH RUBBER & STEEL JOINT (SP-5)

CAPE FEAR WATER PURIFICATION PLANT

FAYETTEVILLE, NORTH CAROLINA

PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, Section 1, Page 2

	HIGH SERVICE LINES	
Nominal Pipe Diameter - inches	42	48
Approximate Footage - feet	160	155
Cylinder Gage - ASTM A-415	14	14
Cylinder Area - sq.in./ft.	0.896	0.896
Minimum Yield Strength of Cylinder - psi	27,000	27,000
Cylinder Test Pressure (25,000 psi) - psi	79	69
Wire Size - ASTM A 227-64	#8 MBU	#8 MBU
Wire Area - sq.in./ft.	0.574	0.644
No. of Wraps of Wire - per ft.	27,89	31.29
Minimum Ultimate Wire Strength - psi	231,000	231,000
Wire Wrapping Stress - psi	173,250	173,250
Dynamometer (1 wire) - lbs.	3,570	3,570
Pressure at zero concrete compression - psi	249	249
Resultant compression in concrete - psi	1,855	1,880
Minimum compressive strength of concrete at time of wrapping (Rodded cylinders) - psi	4,360	4,350
Core Thickness (including cylinder) - inches	2-5/8	3
Minimum Coating Thickness - inch	13/16	13/16
Zinc Coated Joint Rings:		
Spigot Ring Width - inches	5-1/2	5-1/2
Bell Ring - inches x inches	1/4 x 5-1/2	1/4 x 5-1/2
Joint Depth - inches	3-3/4	3-7/8
Creep - feet	0.03	0.03
Average Laid Length - feet	16.03	16.03

Calculation Data: $n_i = 6.0$, $n_r = 5.0$, $R_1 = 0.05$, $C_r = 1.50$

Design Conditions:

In Accordance with AWWA Specification C-301-64

Working Pressure - psi	200	200

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAR APPROVED DS DATE 8-23-67

SPECIFICATION NO. CO-67-17-4

FOR 54"&60" PRESTRESSED CONCRETE EMBEDDED CYLINDER PIPE W/RUBBER & STEEL JOINT (SP-12)

CAPE FEAR WATER PURIFICATION PLANT

FAYETTEVILLE, NORTH CAROLINA

PEIRSON & WHITMAN, INCL - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, Section 1, Page 3

	RAW WATER LINES	
Nominal Pipe Diameter - inches	54	60
Approximate Footage - feet	16	35
Cylinder Gage - ASTM A-415	16	16
Cylinder Area - sq.in./ft.	0.718	0.718
Cylinder Test Pressure (25,000 psi) - psi	53	47
Minimum Yield Strength of Cylinder - psi	27,000	27,000
Nominal Cylinder Diameter - inches	56-7/8	63
Wire Size - ASTM A 227-64	#8 MBU	#8 MBU
Wire Area - sq.in./ft.	0.430	0.485
No. of Wraps of Wire - per ft.	20.89	23.56
Minimum Ultimate Wire Strength - psi	231,000	231,000
Wire Wrapping Stress - psi	173,250	173,250
Dynamometer (1 wire) - lbs.	3,570	3,570
Pressure at zero concrete compression - psi	153	158
Resultant compression in concrete - psi	965	990
Minimum compressive strength of poured concrete at time of wrapping - psi	3,200	3,200
Core Thickness - inches	4	4-1/2
Minimum Coating Thickness - inch	13/16	13/16
Zinc Coated Joint Rings:		
Spigot Ring Width - inches	6-1/4	6-1/4
Bell Ring - inches x inches	1/4 x 5-1/2	1/4 x 5-1/2
Joint Depth - inches	4-1/8	4-1/4
Creep - feet	0.03	0.03
Average Laid Length - feet	16.03	16.03

Calculation Data: $n_i = 7.0$, $n_r = 6.0$, $R_1 = 0.05$, $R_2 = 0.05$, $C_r = 2.00$

Design Conditions:
In Accordance with AWWA Specifications C-301-64

Working Pressure - psi	150	150

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LJ06012150

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAR APPROVED DJL DATE 8-23-67

SPECIFICATION NO. CO-67-17-5

FOR 24" & 30" PRESTRESSED CONCRETE CYLINDER PIPE WITH RUBBER & STEEL JOINT (SP-5)

CAPE FEAR WATER PURIFICATION PLANT

FAYETTEVILLE, NORTH CAROLINA

PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, Section 1, Page 2

	DRAIN LINES	
Nominal Pipe Diameter - inches	24	30
Approximate Footage - feet	200	80
Cylinder Gage - ASTM A-415	16	16
Cylinder Area - sq.in./ft.	0.718	0.718
Minimum Yield Strength of Cylinder - psi	27,000	27,000
Cylinder Test Pressure (25,000 psi) - psi	111	89
Wire Size - ASTM A 227-64	#8 MBU	#8 MBU
Wire Area - sq.in./ft.	0.256	0.308
No. of Wraps of Wire - per ft.	12.44	14.96
Minimum Ultimate Wire Strength - psi	231,000	231,000
Wire Wrapping Stress - psi	173,250	173,250
Dynamometer (1 wire) - lbs.	3,570	3,570
Pressure at zero concrete compression - psi	187	188
Resultant compression in concrete - psi	1,370	1,410
Minimum compressive strength of concrete at time of wrapping (Rodded cylinders) - psi	3,500	3,500
Core Thickness (including cylinder) - inches	1-1/2	1-7/8
Minimum Coating Thickness - inch	13/16	13/16
Zinc Coated Joint Rings:		
Spigot Ring Width - inches	4-1/2	4-1/2
Bell Ring - inches x inches	3/16 x 4-1/2	3/16 x 4-1/2
Joint Depth - inches	3-1/4	3-1/4
Creep - feet	0.02	0.02
Average Laid Length - feet	16.02	16.02

Calculation Data: $n_i = 6.0$, $n_r = 5.0$, $R_1 = 0.05$, $C_r = 1.50$

Design Conditions:
In Accordance with AWWA Specification C-301-64

LJ02405150

LJ03005150

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAP APPROVED DEL DATE 8-23-67

471

SPECIFICATION NO. CO-67-17-6

FOR 24" & 36" SPECIALS FOR LOCK JOINT RUBBER & STEEL JOINT PIPE (SP-5)
CAPE FEAR WATER PURIFICATION PLANT
FAYETTEVILLE, NORTH CAROLINA
PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual or AS NOTED

24" SP-5 (RAW WATER)
(DESIGN FOR CLASS 150)

Elbows: (Type "B")

Adapter:
24" LJB x Flange

36" SP-5 (RAW WATER)
(DESIGN FOR CLASS 150)

Elbows: (Type "B")

Reducers: (Type "B")
36" LJS x 20" MJS

Adapters:
36" LJ x Flange
36" LJ x M.J.B.
36" LJ x C.I.B.

Follower Ring Closure:

Plugs & Caps:
36" LJS Plugs

Crosses:
36" FLG x 36" FLG x 36" LJB x 36" LJB (At Sta. 22+89)
36" FLG x 36" LJB x 36" LJB x 36" LJB (At Sta. 22+98)

Cylinder	= 1/2" x 56"
Saddle	= 1/2" x 54"
Saddle Neck	= 3/8"
Outlet Neck	= 3/8"

Tees:
36" FLG x 36" LJ x 36" LJ
36" FLG x 36" LJ x 24" FLG

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JAR APPROVED DJR DATE 8-23-67

SPECIFICATION NO. CO-67-17-7

FOR 48" & 42" SPECIALS FOR LOCK JOINT RUBBER & STEEL JOINT PIPE (SP-5)
CAPE FEAR WATER PURIFICATION PLANT
FAYETTEVILLE, NORTH CAROLINA
PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, or AS NOTED

48" SP-5 (HIGH SERVICE) (DESIGN FOR CLASS 200)

Outlets:
6" MJB
30" LJS

45° WYE:
48" LJ x 48" LJ x 36" LJ

Plugs & Caps:
48" LJS Plug
48" LJB Cap

42" SP-5 (HIGH SERVICE) (DESIGN FOR CLASS 200)

Outlets:
6" MJB

45° WYE:
42" LJ x 42" LJ x 30" LJ

Plugs:
42" LJS Plugs

Crosses:
42" LJ x 42" FLG x 30" FLG x 30" LJ (At Sta. 10+00)
42" FLG x 42" FLG x 30" FLG x 30" LJ (At Sta. 10+09)

Cylinder	= 5/8" x 60"
Saddle	= 5/8" x 60"
Saddle Neck	= 3/8"
Outlet Neck	= 3/8"

Tees:
42" FLG x 42" LJ x 30" LJ (At Sta. 10+19)
42" LJ x 42" LJ x 30" LJ (At Sta. 10+29)

Cylinder	= 5/8" x 60"
Saddle	= 5/8" x 60"
Saddle Neck	= 3/8"
Outlet Neck	= 3/8"

SPECIFICATION NO. CO-67-17-8

FOR 30" & 24" SPECIALS FOR LOCK JOINT RUBBER & STEEL JOINT PIPE (SP-5)
CAPE FEAR WATER PURIFICATION PLANT
FAYETTEVILLE, NORTH CAROLINA
PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual or AS NOTED

30" SP-5 (HIGH SERVICE)
(DESIGN FOR CLASS 200)

Elbows: (Type "B")

Outlets:
6" MJB

Adapters:
30" LJ x FLG

24" SP-5 (HIGH SERVICE)
(DESIGN FOR CLASS 200)

Elbows: (Type "B")

Reducers: (Type "B")
36" LJ x 24" LJ
30" LJ x 24" LJ

Adapters:
24" LJ x Dresser Coupling

Follower Ring Closure:

Plugs & Caps:
24" LJS Plug

30" SP-5 (DRAIN LINE)
(DESIGN FOR CLASS 150)

Elbows: (Type "B")

Reducer: (Type "B")
30" LJS x 8" MJB
Slope Length = 7.33'

Tee:
30" LJS x 30" LJB x 30" MJB

471

SPECIFICATION NO. CO-67-17-9

FOR 54" & 60" SPECIALS FOR LOCK JOINT RUBBER & STEEL JOINT PIPE (SP-12)
CAPE FEAR WATER PURIFICATION PLANT
FAYETTEVILLE, NORTH CAROLINA
PEIRSON & WHITMAN, INC. - ENGINEERS

SEE DRAWING INTERPACE Engineering Manual, or AS NOTED

54" SP-12
(DESIGN FOR CLASS 150)

Plugs & Caps:
- 54" LJS Plug
- 54" LJB Cap

60" SP-12 (RAW WATER)
(DESIGN FOR CLASS 150)

Outlets:
- 36" DRL FLG W/36" BLD FLANGE
- 36" LJB 45° WYE

DWG. SS-CO-67-17-1

Reducer: (Type "B")
- 60" LJB x 48" LJS

Plugs & Caps:
- 60" LJS Plug

International Pipe & Ceramics Corporation LOCK JOINT PIPE PRODUCTS

COMPILED ELH CHECKED JDR APPROVED DJR DATE 8-23-67

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-18-67	ELH:mw	01
Rev. A	8-29-67	ELH:mw	
Rev. B	9-26-67	ELH:mw	

RAW WATER LINES

	PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
		START LAYING PIPE AT EXISTING RAW WATER PUMPING STATION & LAY BELLS AHEAD. ASSUME SEAT OF WALL FITTING BELL = STRATION 0+00.00								
						0+00.00				68.5
36" ϕ SP-5	1	46°-10' ELBOW LT (LOCKED FASTITE SPIGOT x LJB) ROT CW FOR 45°-00' HORIZ DEFL LT & 11°-40' VERT DEFL W/LJB FIELD WELDED	S	1.42	1.42		0°-00'	0.0000	+ 0.0	
						0+01.42 PI				68.5
			B	1.66	1.63		11°-40'	0.2065		
						0+03.05				
	1	STRAIGHT W/BOTH ENDS FIELD WELDED		16.03	15.70					
						0+18.75				
	1	45°-00' ELBOW RT W/2.22' SPIGOT EXT. W/LJS FIELD WELDED	S	3.60	3.53					
						0+22.28 PI				
			B	1.63	1.60					
						0+23.88				
	1	STRAIGHT		16.03	15.70					
						0+39.58				
	1	SHORT (14.90' OA)		14.65	14.35					
						0+53.93				
	1	ADAPTER - 36" LJS x FLG (1.63' OA)		1.38	1.35					
						0+55.28				
	1	CHECK VALVE (BY OTHERS)		5.00	4.90					
						0+60.18				
	1	BUTTERFLY VALVE (BY OTHERS) (#8)		1.83	1.79					
						0+61.97				
48" ϕ SP-5	1	TEE - 48" LJB x 48" LJB x 36" DRL FLG-LAY INTO BRANCH & OUT	BR	4.91	4.81				+13.5	
		NORTHERLY BELL RUN W/0.42' BR. EXT. (RUN OA = 6.80') (BR. LL = 4.91')				0+66.78 PI				82.0
			B	3.40	3.40		0°-00'	0.0000		
	1	REDUCER 48" LJS x 36" FLG. (5.65' OA)		5.36	5.36					
						0+75.54				
	1	BUTTERFLY VALVE (BY OTHERS) (#9)		1.83	1.83					
						0+77.37				
	1	CHECK VALVE (BY OTHERS)		5.00	5.00					
						0+82.37				
36" ϕ SP-5	1	ADAPTER - 36" FLG x LJB (1.61' OA)		1.61	1.61					
						0+83.98				
	1	STRAIGHT		16.03	16.03					
						1+00.01				

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING. BELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
Rev. B	9-26-67	ELH:mw	01-A
Rev. C	1-22-68	ELH:mw	

RAW WATER LINES

36" ϕ SP-5

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
					1+00.01				
1	SHORT (7.79' OA) HOLD UNTIL VERIFIED IN FIELD		7.54	7.54					
					1+07.55				
1	90 °-00' ELBOW RIGHT	S	3.24	3.24					
					1+10.79 PI				
		B	3.48	3.48					
					1+14.27				
1	REDUCER - 36" LJS x 20" MJB (6.42' OA) HOLD UNTIL 20" END IS VERIFIED IN FIELD		6.17	6.17				+ 0.0	
					1+20.44				82.0

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PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

DATE:	BY:	SHEET:
8-18-67	ELH:mw	02
Rev. A 8-29-67	ELH:mw	
Rev. B 9-26-67	ELH:mw	
Rev. C 1-22-68	ELH:mw	

RAW WATER LINES

	PCS	DESCRIPTION	AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
		LAY THE FOLLOWING OUT OF THE SOUTHERLY RUN END OF THE TEE AT 0+66.78. ASSUME P.I. = STATION 10+00.00							
					10+00.00 PI				82.0
		LL OF RUN END	3.40	3.40		0°-00'	0.0000		
					10+03.40				
60" ø SP-12	1	REDUCER - 48" LJS x 60" LJB (5.81' OA)	5.52	5.52					
					10+08.92				
	1	STR W/36" DRL FLG OTL & BLD LG 12.00' FFB ON LEFT	16.03	16.03					
	1	SHORT (9.84' OA)	9.52	9.52					
					10+34.47				
	1	STR W/36" LJB 45° WYE OTL ON RT 6.00' FFB (BRANCH LL = 8.60') (BR. ADJ. TO BELL END)	16.03	16.03					
					10+50.50				
	1	60" LJS PLUG	0.00	0.00				+ 0.0	
					10+50.50				82.0
		LAY PIPE OUT OF WYE OTL, BELLS AHEAD. ASSUME P.I. OF OTL = STATION 11+00.00							
					11+00.00				82.0
		LL OF WYE OTL	8.60	8.60		0°-00'	0.0000		
					11+08.60				
36" ø SP-5	3	STRAIGHTS	48.09	48.09					
					11+56.69				
	1	CLOSURE ASSEMBLY (SHORT + CLOSURE)	± 7.60	7.60				+ 0.0	
					11+64.29				82.0
		LAY PIPE OUT OF EXISTING 36" x 36" TEE, BELLS AHEAD, IN A SOUTHERLY DIRECTION TOWARDS PLANT. P.I. OF EXISTING BELL IS ASSUMED TO BE 12+00.00							
					12+00.00 PI				87.5
		EXISTING BR. LL OF TEE	3.27	3.27		0°-00'	0.0000		
					12+03.27				
36" ø SP-5	1	CLOSURE ASSEMBLY	9.87	9.87					
					12+13.14				
	1	ADAPTER - 36" LJS x FLG (1.63' OA)	1.38	1.38					
					12+14.52				

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PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-18-67	ELH:mw	03
Rev. A	8-29-67	ELH:mw	
Rev. B	9-26-67	ELH:mw	

RAW WATER LINES

36" ø SP-5

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
					12+14.52				
1	VALVE (BY OTHERS) (#10)		1.71	1.71					
					12+16.23				
1	TEE-36" MJS x 36" LJB x 36" LJB W/36" CLAMP TIED DISHED SPIGOT BULKHEAD IN BRANCH-BRANCH LT (BR. LL = 3.23')(RUN OA = 7.55')	FLG	3.77	3.77					
					12+20.00 PI				
		B	3.31	3.31					
					12+23.31				
23	STRAIGHTS		368.69	368.69					
					15+92.00				
1	90°-00' ELBOW RT W/2.46' SPIGOT EXT.	S	5.70	5.70					
					15+97.70 PI				
		B	3.48	3.48					
					16+01.18				
13	STRAIGHTS		673.26	673.26					
					22+74.44				
1	SHORT (8.81' OA) HOLD UNTIL VERIFIED IN FIELD		8.56	8.56					
					22+83.00				
1	ADAPTER - 36" LJS x MJS (1.16' OA)		0.91	0.91					
					22+83.91				
1	VALVE (BY OTHERS) (#1)		1.71	1.71					
					22+85.62				
1	CROSS - 36" FLG x 36" FLG x 36" LJB x 36" LJB (RUN OA = 7.55') (BR. LL = 3.23') W/(1) 36" LJS PLUG	FLG	3.58	3.58					
					22+89.20 PI				
		FLG	3.58	3.58					
					22+92.78				
1	VALVE (BY OTHERS) (#2)		1.83	1.83					
					22+94.61				
1	CROSS - 36" FLG x 36" LJB x 36" LJB x 36" LJB W/0.66' EXT. ON BELL RUN (BR. LL = 3.23')	FLG	3.58	3.58					
					22+98.20 PI				
		B	3.31	3.31					
					23+01.51				
2	STRAIGHTS		32.06	32.06					
					23+33.57				
1	SHORT (8.27' OA)		8.02	8.02					
					23+41.59				
1	ADAPTER - 36" LJS x MJS (1.16' OA)		0.91	0.91					
					23+42.50				

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PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-18-67	ELH:mw	04
Rev. A	9-26-67	ELH:mw	

RAW WATER LINES

	PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
36"ø SP-5						23+42.50				
	1	VALVE (BY OTHERS)(#3)		1.71	1.71					
						23+44.21				
	1	TEE - 36" FLG x 36" LJB x 24" FLG TEE-BR RT (RUN OA = 7.55')	FLG	3.49	3.49				+ 0.0	
		(BR. LL = 4.16') LAY INTO FLG RUN & OUT FLG BR - (1) 36" LJS PLUG IN RUN BELL - ROT BR DN 0°-46'	FLG BR	4.16	4.16	23+47.70 PI	0°-46'	0.0133		87.5
						23+51.86				
	1	VALVE (BY OTHERS) (#4)		1.40	1.40					
						23+53.26				
	1	ADAPTER - 24" MJS x LJB (1.48' OA)		1.15	1.15					
						23+54.41				
24" ø SP-5	25	STRAIGHTS		400.75	400.75					
						27+55.16				
	1	90°-00' ELBOW RT W/1.97' SPIGOT EXT. & 1.87' BELL EXT. - ROT CCW FOR 0°-46' VERT DEFL UP	S	4.54	4.54				- 5.5	
						27+59.70 PI				82.0
			B	4.68	4.68		0°-00'	0.0000		
						27+64.38				
	16	STRAIGHTS		256.32	256.32					
						30+20.70				
	1	CLOSURE		± 4.00	4.00				+ 0.0	
						30+24.70				82.0
		LAY THE FOLLOWING PIPE FROM THE 36" x 36" CROSS (STA. 22+89.20) IN THE RAW WATER MAIN TOWARDS THE CHLORINE STORAGE. ASSUME THE PI STATION OF THE TEE = 0+00.00								
						0+00.00 PI				87.5
			BR OF TEE	3.23	3.23		0°-00'	0.0000		
						0+03.23				
SP-5	1	STRAIGHT		16.03	16.03					
						0+19.26				
	1	SWORD (12.98' OA)		[illegible]	[illegible]					
						0+31.09				
36"	1	ADAPTER - 36" LJS x CIS (2.16' OA)		1.91	1.91				+ 0.0	
						0+33.00				87.5

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PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-18-67	ELH:mw	05
Rev. A	9-26-67	ELH:mw	

RAW WATER LINES

PCS	DESCRIPTION	AVG LL	MOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	℄ ELEV
	LAY THE FOLLOWING PIPE FROM THE 36" x 36" CROSS (STA. 22+98.20) IN THE RAW WATER MAIN TOWARDS THE CHLORINE STORAGE. ASSUME THE PI STATION OF THE TEE = 0+00.00							
				0+00.00 PI				87.5
	BR OF TEE	3.23	3.23		0°-00'	0.0000		
				0+03.23				
1	STRAIGHT	16.03	16.03					
				0+19.26				
1	SHORT (12.08' OA)	11.83	11.83					
				0+31.09				
1	ADAPTER - 36" LJS x CIS (2.16' OA)	1.91	1.91				+ 0.0	
				0+33.00				87.5

36"ϕ SP-5

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	8-18-67	ELH:mw	06
Rev. A	9-26-67	ELH:mw	
Rev. B	12-8-67	ELH:mw	
Rev. C	1-22-68	ELH:mw	

HIGH SERVICE LINES

42" ø SP-5

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
	START LAYING WITH 42" x 30" x 30" TEE WITH PI AT THE COORDINATES N 6+00 & E 9+00 ASSUME PI OF CROSS IS STA. 10+00.00 AND LAY BELLS AHEAD IN A WESTERLY DIRECTION								
1	TEE - 42" FLG x 30" LJB x 30" FLG (30" LJB BR LL = 3.31') (30"FLG BR LL = 4.05')(RUN OA = 6.65') 30" FLG TO RIGHT W/0.50' BELL RUN EXT.	FLG	3.75	3.75	10+00.00 PI	0°-00'	0.0000		78.2
					10+03.75				
1	VALVE (BY OTHERS) (#7)		2.00	2.00					
					10+05.75				
1	CROSS - 42" FLG x 42" FLG x 30" LJB x 30" FLG (30" LJB BR LL = 3.31')(30" FLG BR LL = 4.05') (RUN OA = 7.75') W/0.25' FLG EXT. ON RUN - 30" FLG ON RIGHT	FLG	4.00	4.00	10+09.75 PI				
		FLG	3.75	3.75					
					10+13.50				
1	VALVE (BY OTHERS) (#7)		2.00	2.00					
					10+15.50				
1	TEE-42" FLG x 42" LJB x 30" LJB - BR. LT. (BR. LL = 3.31')(RUN OA = 6.90') W/0.25' FLG EXT. ON RUN & 0.50' BELL EXT. ON RUN	FLG	4.00	4.00	10+19.50 PI				
		B	3.40	3.40					
					10+22.90				
1	TEE-42" LJS x 42" LJB x 30" LJB-BR. LT (BR. LL = 3.31')(RUN OA = 10.03') W/3.72' SPIGOT EXT. & 0.50' BELL EXT. ON RUN	S	6.35	6.35	10+29.25 PI				
		B	3.40	3.40					
					10+32.65				
1	STRAIGHT		16.03	16.03	10+48.68			+ 0.0	78.2
4	STR - OPEN 1ST JT 3/4" ON TOP		64.12	64.11	11+12.79	0°-52'	0.4542	1.0	77.2
3	STR - OPEN 1ST JT 3/4" ON BOT(1ST STR TO HAVE 6" MJB OTL ON RT 8.00'FFB)		48.09	48.09	11+60.88	0°-00'	0.0000		
	Hold After This Station								
1	22°-30' ELBOW UP	S	0.82	0.82	11+61.70 PI			+ 0.0	77.2
		B	1.09	1.01		22°-30'	0.4142		
					11+62.71				
1	STRAIGHT		16.03	14.81	11+77.52				

HOLD

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PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-18-67	ELH:mw	C7
Rev. A	8-29-67	ELH:mw	
Rev. B	9-26-67	ELH:mw	
Rev. C	12-8-67	ELH:mw	
Rev. D	1-22-68	ELH:mw	

42" SP-5 (HOLD)

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
					11+77.52				
1	SHORT (8.46' OA)		8.18	7.56					
					11+85.08				
1	22°-30' ELBOW DOWN	S	0.82	0.76				+10.0	
					11+85.84 PI				87.2
		B	1.09	1.09		0°-00'	0.0000		
					11+86.93				
2	STRAIGHTS		32.06	32.06					
					12+18.99				
1	ADAPTER - 42" LJS x DRESSER COUPLING W/2.45' SPIGOT EXT. (4.36' OA)		4.08	4.08					
					12+23.07				
1	VENTURI ASSEMBLY - BY OTHERS		9.00	9.00					
					12+32.07				
1	ADAPTER - 42" DRESSER COUPLING x LJB (1.90' OA)		1.90	1.90					
					12+33.97				
1	STRAIGHT		16.03	16.03					
					12+50.00				
1	42" LJS PLUG		0.00	0.00				- 0.0	
					12+50.00				87.2

LAY THE FOLLOWING OUT OF THE 30" LJB BRANCH OF THE TEE AT STA. 10+00.00 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00

30"ϕ SP-5

					0+00.00 PI				78.2
		BR. LL	3.31	3.31	0+03.31	0°-00'	0.0000		
1	9°-18' ELBOW UP	S	0.31	0.31				+ 0.0	
					0+03.62 PI				78.2
		B	0.55	0.54		9°-18'	0.1637		
					0+04.16				

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	8-18-67	ELH:mw	08
Rev. A	8-29-67	ELH:mw	
Rev. B	9-26-67	ELH:mw	

HIGH SERVICE LINES

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
					0+04.16				
1	STRAIGHT		16.02	15.81					
					0+19.97				
1	SHORT (9.25' OA)		9.00	8.88					
					0+28.85				
1	ADAPTER - 30" LJS x FLG (1.44' OA)		1.19	1.17					
					0+30.02				
1	VALVE (BY OTHERS) (#5)		1.83	1.81					
					0+31.83				
1	ADAPTER - 30" FLG x LJB (1.43' OA) W/LJB FIELD WELDED		1.43	1.41					
					0+33.24				
1	SHORT (15.04' OA) W/BOTH ENDS FIELD WELDED		14.83	14.64					
					0+47.88				
1	9°-18' ELBOW DOWN (LJS x LOCKED FASTITE SPIGOT) W/LJS FIELD WELDED	S	0.35	0.35				+ 7.3	
	ELBOW TO BE STRAPPED TO FOOTING				0+48.23	PI			85.5
		LFS	1.02	1.02		0°-00'	0.0000	+ 0.0	
					0+49.25				85.5
	LAY THD FOLLOWING OUT OF THE 30" LJB BRANCH OF THE CROSS AT STA. 10+09.75 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00								
					0+00.00	PI			78.2
		BR. LL.	3.31	3.31		0°-00'	0.0000		
					0+03.31				
1	9°-18' ELBOW UP	S	0.31	0.31				+ 0.0	
					0+03.62	PI			78.2
		B	0.55	0.54		9°-18'	0.1637		
					0+04.16				
1	STRAIGHT		16.02	15.81					
					0+19.97				
1	SHORT (9.25' OA)		9.00	8.88					
					0+28.85				
1	ADAPTER - 30" LJS x FLG (1.44' OA)		1.19	1.17					
					0+30.02				
1	VALVE (BY OTHERS) (#5)		1.83	1.81					
					0+31.83				
1	ADAPTER - 30" FLG x LJB (1.43' OA) W/LJB FIELD WELDED		1.43	1.41					
					0+33.24				

30" ϕ (P-5)

30" ϕ (P-5)

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING. BELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
JOB NO. CO-67-17

DATE: 8-21-67 BY: ELH:mw SHEET: 09
Rev. A 8-29-67 ELH:mw
Rev. B 9-26-67 ELH:mw

HIGH SERVICE LINE

	PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
30"ø STP-5						0+33.24				
	1	SHORT (15.04' OA)W/BOTH ENDS FIELD WELDED		14.83	14.64					
						0+47.88				
	1	9°-18' ELBOW DOWN (LJS x LOCKED FASTITE SPIGOT) W/LJS FIELD WELDED	S	0.35	0.35				+ 7.3	
		ELBOW TO BE STRAPPED TO FOOTING				0+48.23	PI			85.5
			LFS	1.02	1.02		0°-00'	0.0000	+ 0.0	
						0+49.25				85.5
		LAY THE FOLLOWING OUT OF THE 30" LJB BRANCH OF THE TEE AT STA. 10+19.50 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00								
						0+00.00	PI			78.2
			BR. LL	3.31	3.31		0°-00'	0.0000		
						0+03.31				
	1	9°-18' ELBOW UP	S	0.31	0.31				+ 0.0	
						0+03.62	PI			78.2
			B	0.55	0.54		9°-18'	0.1637		
						0+04.16				
	1	STRAIGHT		16.02	15.81					
						0+19.97				
30" ø STP-5	1	SHORT (9.25' OA)		9.00	8.88					
						0+28.85				
	1	ADAPTER - 30" LJS x FLG (1.44' OA)		1.19	1.17					
						0+30.02				
	1	VALVE (BY OTHERS) (#5)		1.83	1.81					
						0+31.83				
	1	ADAPTER - 30" FLG x LJB (1.43' OA) W/LJB FIELD WELDED		1.43	1.41					
						0+33.24				
	1	SHORT (15.04' OA) W/BOTH ENDS FIELD WELDED		14.83	14.64					
						0+47.88				
	1	9°-18' ELBOW DOWN (LJS x LOCKED FASTITE SPIGOT) W/LJF FIELD WELDED	S	0.35	0.35				+ 7.3	
		ELBOW TO BE STRAPPED TO FOOTING					PI			85.5
			LFS	1.02	1.02		0°-00'	0.0000	+ 0.0	
						0+49.25				85.5

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING, SELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-21-67	ELH:mw	10
Rev. A	8-29-67	ELH:mw	
Rev. B	9-26-67	ELH:mw	

HIGH SERVICE LINE

	PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
		LAY THE FOLLOWING OUT OF THE 30" LJB BRANCH OF THE TEE AT STA. 10+29.25 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00								
						0+00.00 PI				78.2
			BR. LL	3.31	3.31		0°-00'	0.0000		
30" ø S2-5	1	9°-18' ELBOW UP	S	0.31	0.31	0+03.31			+ 0.0	
						0+03.62 PI				78.2
			B	0.55	0.54		9°-18'	0.1637		
	1	STR W/6" MJB OTL ON RT 2.00' FFB		16.02	15.81	0+04.16				
	1	SHORT (9.25' OA)		9.00	8.88	0+19.97				
	1	ADAPTER - 30" LJS x FLG (1.44' OA)		1.19	1.17	0+28.85				
	1	VALVE (BY OTHERS) (#5)		1.83	1.81	0+30.02				
	1	ADAPTER - 30" FLG x LJB (1.43' OA) W/LJB FIELD WELDED		1.43	1.41	0+31.83				
	1	SHORT (15.04' OA) W/BOTH ENDS FIELD WELDED		14.83	14.64	0+33.24				
	1	9°-18' ELBOW DOWN (LJS x LOCKED FASTITE SPIGOT) W/LJS FIELD WELDED ELBOW TO BE STRAPPED TO FOOTING	S	0.35	0.35	0+47.88			+ 7.3	
						0+48.23 PI				85.5
			LFS	1.02	1.02		0°-00'	0.0000	+ 0.0	
						0+49.25				85.5
		LAY THE FOLLOWING OUT OF THE 30" FLG BRANCH OF THE TEE AT STA. 10+00.00 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00								
			BR. LL	4.05	4.05	0+00.00 PI	0°-00'	0.0000		77.5
	1	VALVE (BY OTHERS) (#6)		1.83	1.83	0+04.05				
						0+05.88				
30" ø 3P-5	1	ADAPTER - 30" FLG x LJB (1.43' OA)		1.43	1.43	0+07.31				
	2	STRAIGHTS		32.04	32.04	0+39.35				
	1	SHORT (9.06' OA)		8.81	8.81	0+48.16				
		OUTLET LAID LENGTH (TO BE PLACED LATER)		1.84	1.84	0+50.00 PI			+ 0.0	77.5

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING, BELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CO-67-17

	DATE:	BY:	SHEET:
	8-21-67	ELH:mw	11
Rev. A	9-26-67	ELH:mw	
Rev. B	12-8-67	ELH:mw	
Rev. C	1-22-68	ELH:mw	

HIGH SERVICE LINE

	PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
		LAY THE FOLLOWING OUT OF THE 30" FLG BRANCH OF THE CROSS AT STA. 10+09.75 OF THE 42" LINE. ASSUME PI IS STA. 0+00.00								
			BR. LL.	4.05	4.05	0+00.00 PI	0°-00'	0.0000		77.5
30' ø SP-5	1	VALVE (BY OTHERS) (#6)		1.83	1.83	0+04.05				
	1	ADAPTER - 30" FLG x LJB (1.43' OA)		1.43	1.43	0+05.88				
	2	STRAIGHTS		32.04	32.04	0+07.31				
	1	SHORT (9.06' OA)		8.81	8.81	0+39.35				
		OUTLET LAID LENGTH (TO BE PLACED LATER)		1.84	1.84	0+48.16				
						0+50.00 PI				77.5
		START LAYING PIPE WITH STRAIGHT W/(2) 30" LJS OUTLETS PLACED IN THE (2) 30" LJB ENDS OF THE CROSS CONNECTIONS BETWEEN THE 42" ø & 48" ø LINES. ASSUME THE SPIGOT END OF THE STRAIGHT IS AT STATION 20+00.00								
						20+00.00				77.5
	1	48" LJB CAP		0.00	0.00	20+00.00	0°-00'	0.0000		
	1	STR W/(1) 30" LJS OTL ON LT 13.00' FFB & (1) 30" LJS OTL ON LT 3.25' FFB		16.03	16.03	20+16.03				
	3	STR - OPEN 1ST JT 5/16" ON TOP		48.09	48.09	20+64.12	0°-21'	0.0062	- 0.3	77.2
	3	STR - OPEN 1ST JT 5/16" ON BOTTOM		48.09	48.09	21+12.21	0°-00'	0.0000		
	1	STR - W/6" MJB OTL ON RT 9.24' FFB		16.03	16.03	21+28.24				
		Hold After This Station								
48" SP-5	2	STRAIGHTS		32.06	32.06	21+60.30				
	1	22°-30' ELBOW UP	S	0.91	0.91	21+61.21 PI			+ 0.0	77.2
			B	1.19	1.10		22°-30'	0.4142		
(HOLD)	1	STRAIGHT		16.03	14.81	21+62.31				
						21+77.12				
	1	SHORT (6.29' OA)		6.00	7.39	21+84.51				

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING, BELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. 66-67-17

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

	DATE:	BY:	SHEET:
	8-21-67	ELH:mw	12
Rev. A	9-26-67	ELH:mw	
Rev. B	12-8-67	ELH:mw	

PCS	DESCRIPTION		AVG LL	HOR LL	STATION	ANGLE	TANGENT	ELEV CHANGE	C/L ELEV
					21+84.51				
1	22°-30' ELBOW DOWN	S	0.91	0.84				+10.0	
					21+85.35	PI			87.2
		B	1.19	1.19		0°-00'	0.0000		
					21+86.54				
2	STRAIGHTS		32.06	32.06					
					22+18.60				
1	ADAPTER - 48" LJS x DRESSER COUPLING W/2.85' SPIGOT EXT. (4.76' OA)		4.62	4.47					
					22+23.07				
1	VENTURI ASSEMBLY - BY OTHERS		9.00	9.00					
					22+32.07				
1	ADAPTER - 48" DRESSER COUPLING x LJB (1.90' OA)		1.90	1.90					
					22+33.97				
1	STRAIGHT		16.03	16.03					
					22+50.00				
1	48" LJS PLUG		0.00	0.00				- 0.0	
					22+50.00				87.2

" SP-5
HOLD)

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING, BELLS AHEAD. THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE & FITTINGS. ADJUSTMENTS TO MEET FIELD CONDITIONS MUST BE MADE AS REQUIRED.

PIPE LAYING SCHEDULE

INTERNATIONAL PIPE & CERAMICS CORP.
LOCK JOINT PIPE PRODUCTS

FAYETTEVILLE, NORTH CAROLINA
CAPE FEAR WATER PURIFICATION PLANT
OUR JOB NO. CC-67-17

	DATE:	BY:	SHEET:
	8-21-67	ELH:mw	13
Rev. A	9-26-67	ELH:mw	

MISCELLANEOUS PIPE

	PCS	DESCRIPTION		AVG LL	STATION	c/L ELEV
		24" DRAIN LINE				
		LAY THE FOLLOWING PIPE, BEGINNING AT MANHOLE CLOSEST TO CONCRETE TUNNEL, BELLS AHEAD				
SP-5	5	STRAIGHTS		80.10		
	1	SHORT (13.15' OA)		12.90		
		MANHOLE (BY OTHERS)				
24"	6	STRAIGHTS		96.12		
	1	SHORT (12.13' OA)		11.88		
		30" DRAIN LINE				
		START LAYING PIPE AT MANHOLE NEAR N 4+50 & E 8+00, BELLS AHEAD, IN A EASTERLY DIRECTION			0+00	86.4
	1	STR		16.02	0+16	
	1	SHORT (8.23' OA)		7.98	0+24	
		CATCH BASIN (BY OTHERS)		4.00	0+28	
	1	STRAIGHT		16.02		
	1	90°-00' ELBOW LT W/0.07' SPIGOT EXT.	S	2.98		
					0+47 PI	87.5
			B	3.13	0+50	
30" SP-5	1	STRAIGHT		16.02	0+66	
	1	SHORT (4.01' OA)		3.76	0+70	
	1	TEE-30" LJS x 30" LJB x 30" MJB - BR. RT (BR. LL = 2.58') (RUN OA = 6.63')	S	3.07		
					0+73 PI	
			B	3.31	0+76	
	1	REDUCER - 30" LJS x 8" MJB (7.71' OA)		7.46	0+84	88.0

* ADJUSTED FOR SLOPE CORR.

ALL LAYING INSTRUCTIONS GIVEN LOOKING IN THE DIRECTION OF LAYING. BELLS AHEAD
THIS SCHEDULE SUPPLIED ONLY AS A GUIDE FOR DISTRIBUTING & INSTALLING PIPE &

APPENDIX C

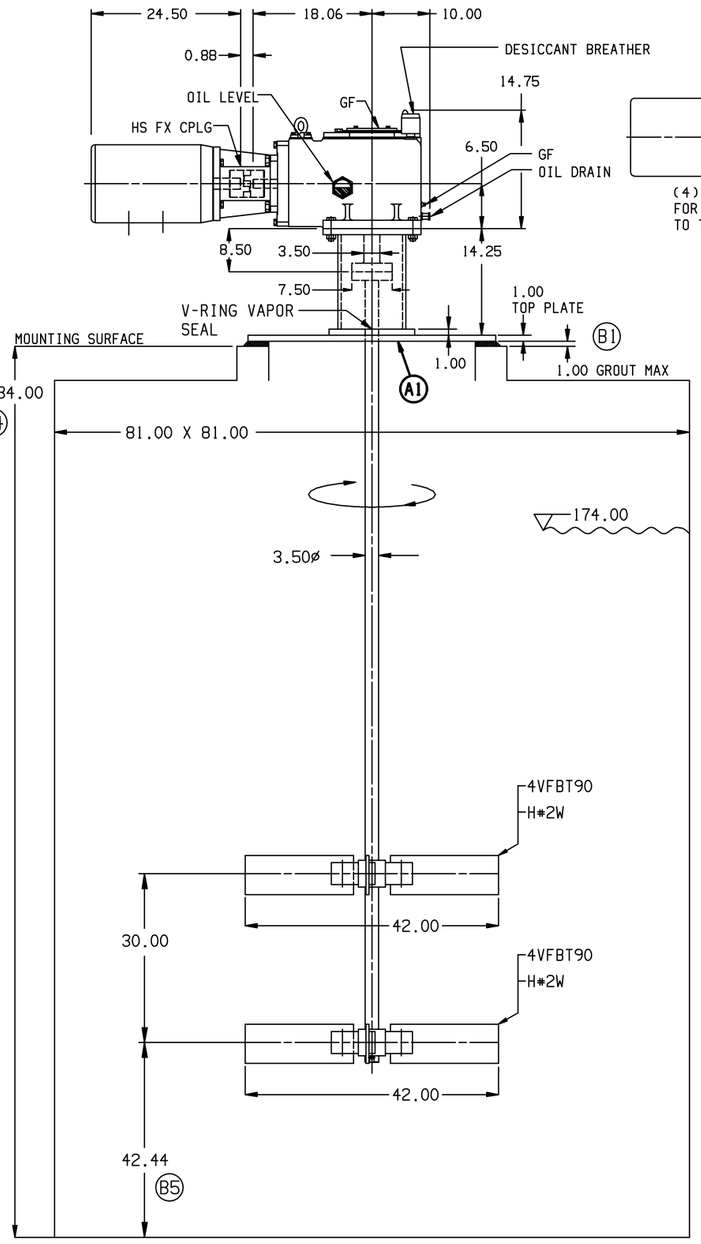
MIXING STATION MIXERS

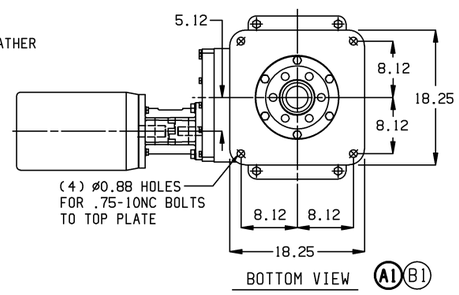
PHILADELPHIA MIXING SOLUTIONS, Ltd. 1221 E. MAIN STREET, PALMYRA, PA 17078, USA. Ph: (717) 832-2800, fx: (717) 832-1740 http://www.philamixers.com

OUTLINE INSTALLATION DRAWING

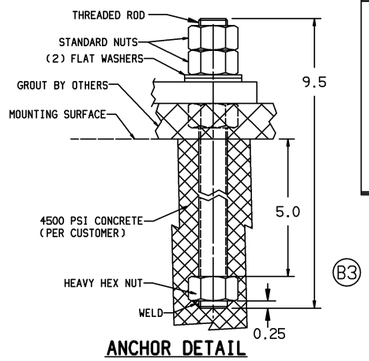
DWG. NO:	SERIAL NO:	ORDER NO:	REV:
13DEK0835-1	13DEK0835	58737	B

QUANTITY ON THIS ORDER: ONE (1) | DRN: CCS | APPRVD: --- | REVIEWED BY: CHAD SPANGLER | DATE: 10-09-13

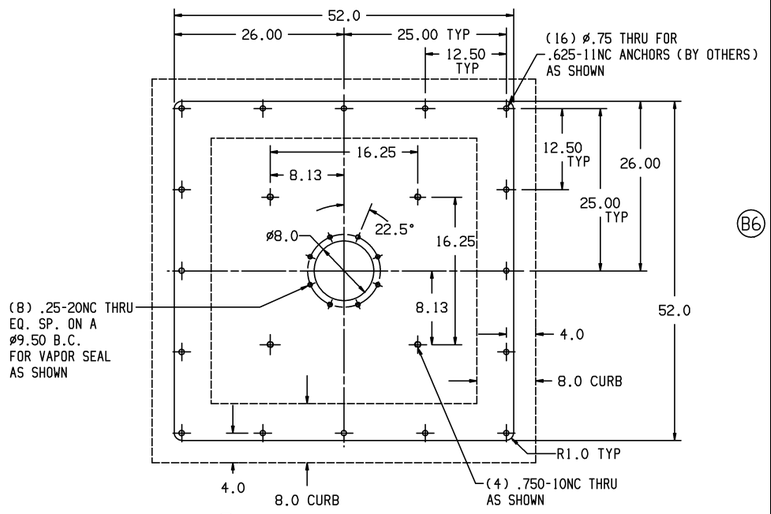




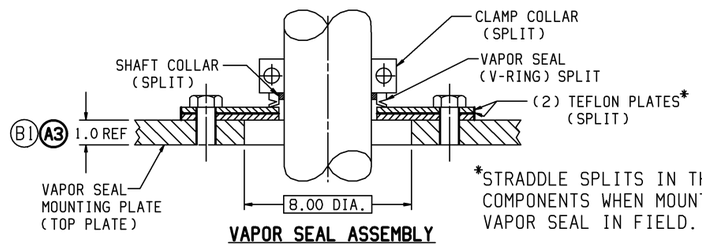
BOTTOM VIEW A1 B1



ANCHOR DETAIL



B2 TOP PLATE DETAIL



*STRADDLE SPLITS IN THESE COMPONENTS WHEN MOUNTING VAPOR SEAL IN FIELD.

VAPOR SEAL ASSEMBLY

RECOMMENDED WRENCH TORQUE [lb - ft] / [N - m]

CPLG SIZE	BOLT SIZE	THRUST PLATE	COUPLING
2914	7/8"-9		194

IMPELLER 2

4VFBT90 / 2W / 13.6
IMPELLER TYPE / HUB TYPE / HUB OD
CAST / BOLTED / 0.00
CONSTRUCTION IMPELLER/ HUB / KEYWAY
1/2-13NC / 42 FT-LBS
SET SCREW SIZE / TORQUE
4 / 3/4-10NC / 130 FT-LBS
NUMBER OF BOLTS / SIZE / TORQUE

IMPELLER 1

4VFBT90 / 2W / 13.6
IMPELLER TYPE / HUB TYPE / HUB OD
CAST / BOLTED / 0.00
CONSTRUCTION IMPELLER/ HUB / KEYWAY
1/2-13NC / 42 FT-LBS
SET SCREW SIZE / TORQUE
4 / 3/4-10NC / 130 FT-LBS
NUMBER OF BOLTS / SIZE / TORQUE

REV	DESCRIPTION	DATE	APVD
B6	ADDED	JJM 3-2-15	PER ENG REQUEST *1071
B5	WAS 42.00		
B4	WAS 235.56		
B3	ADDED ANCHOR DETAIL		
B2	ADDED TOP PLATE DETAIL		
B1	UPDATED VIEW		
A3	ADDED	SEF 6/9/14	
A2	WAS QTY OF (4) BAFFLES		
A1	REV. VIEW TO SHOW VAPOR SEAL MTG PLT		

REVISIONS

DRIVE DATA

3855M / 31.40:1 / PTOS
DRIVE TYPE / GEAR RATIO / SEAL TYPE

56.0 MIXER RPM	2.0 @ (100k hrs) SERVICE FACTOR

DESIGN CONDITION

4942.05 MAX MIX VOL [gal] / [cu.m]	MIN MIX VOL [gal] / [cu.m]
174.00 MAX LIQ LEV [in] / [m]	0 MIN LIQ LEV [ft] / [m]
1.00 MIX DENS [S.G.] / [kg/cu.m]	2 MIX VISCOSITY [cP]
0.00 SOLIDS CONCENTRATION	N OPERATE FILL OR DRAIN Y/N

OTHER

VESSEL INFORMATION
(VESSEL SUPPLIED BY OTHERS)

81.00 X 81.00 VESSEL [in] / [mm]	0 / 0 TAN TO TAN [in] / [m]
0 / 0 NOZZLES TOP/BOTTOM	14.7 - 40.0 PRESS/TEMP [psi/bar]/[F/C]
234.00 (B4) OVERALL HEIGHT [in] / [m]	2 / 7.63 (A2) BAFFLE NO/WIDTH [in] / [m]
204.00 BAFFLE LENGTH [in] / [m]	OPEN / FLAT HEADS TOP/BOTTOM

PAINT REQUIREMENT

CARBOGUARD 890: ORANGE, 4-6 MDFT
REDUCER AND MOTOR

N/A
AGITATOR PARTS

NOTES
1. ALL DIMENSIONS ARE IN INCHES UNLESS SPECIFIED.
2. MOUNTING HARDWARE BY OTHERS.
3. ALL DRIVES TO BE PREPARED FOR LONG TIME STORAGE.
4. SHAFT ROTATING CLOCKWISE LOOKING DOWN.
5. TOP PLATE DESIGNED BY PMSL AND SUPPLIED BY OTHERS.
6. ALL ANCHORAGE SUPPLIED BY OTHERS.
7. .25" MOUNTING PLATE SUPPLIED BY PMSL FOR VAPOR SEAL IS NOT TO BE USED. VAPOR SEAL MOUNTS TO 1.0" PLATE SUPPLIED BY OTHERS.

CAUTION:
1. CONSULT SERVICE MANUAL BEFORE PROCEEDING WITH INSTALLATION AND START-UP
2. ALL DIMENSIONS ARE IN INCHES UNLESS SPECIFIED
3. MIXER SUPPORT DESIGN LOADS INCLUDE SERVICE FACTOR
4. THIS DRAWING IS NOT TO SCALE

PHILADELPHIA MIXING SOLUTIONS, Ltd.
CERTIFIED DATA

NAME S.E. FOSTER | DATE 6/6/14

MOTOR DATA

PMSL STD / PMSL MOTOR MAKE / SUPPLIED BY	3 / 60 / 230/460 OR 460 PHASE/Hz/VOLTS
15.00 / 1800 / 254TC / PREM. EFF. - MILL/CHEM DUTY INVERTER DUTY MOTOR HP / RPM / FRAME / ENCLOSURE	
VARIABLE SPEED DRIVE/MAKE	WITH THERMOSTAT SPECIAL

MATERIAL REQUIREMENTS

316 S/S / 316 S/S
MATERIAL OF CONSTRUCTION / HARDWARE

YES
ALLOW SUBSTITUTION OF UPGRADED MATERIALS

COMPONENT WEIGHT

1130 REDUCER [lb] / [kg]	264 MOTOR [lb] / [kg]
741 SHAFT & IMP [lb] / [kg]	2135 TOTAL [lb] / [kg]

MIXER DESIGN LOADS
INCLUDING SUITABLE OVERLOAD FACTOR

THE MIXER SUPPORT STRUCTURE MUST BE LEVEL WITHIN .12 DEGREE AND IS TO BE DESIGNED SO THAT THE DYNAMIC ANGULAR DEFLECTION OF THE DRIVE IS LIMITED TO .12 DEGREE IN ANY DIRECTION.

3203 STATIC WEIGHT [lb] / [kg]	22280 WGT MOM [lb-in] / [N-m]
77014 DYN MOM [lb-in] / [N-m]	33461 DYN TORQ [lb-in] / [N-m]
441 DYNAMIC SHEAR [lb] / [N]	

CUSTOMER - SOLD TO

M.B. KAHN CONSTRUCTION CO. INC.
PO BOX 1179
COLUMBIA, SC 29202-1179

CUSTOMER - SHIP TO

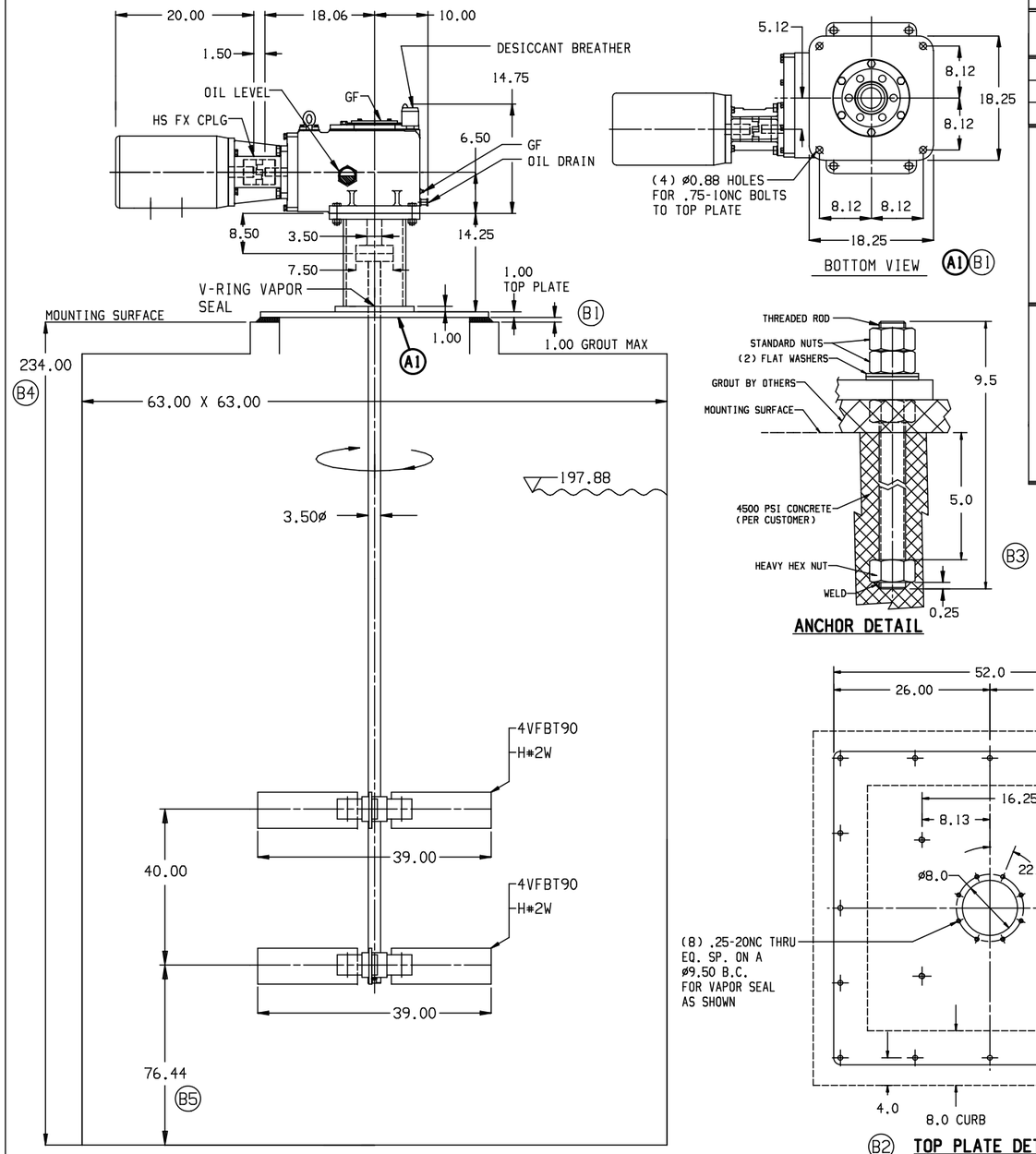
HOFFER WTF - PHASE 1 IMP
508 HOFFER DRIVE
FAYETTEVILLE, NC 28301

CUSTOMER PO. NUMBER: 1579011
ITEM TAG NO: FW MIXER
REQ ROUTING: BEST WAY - LFA

PHILADELPHIA MIXING SOLUTIONS, Ltd. 1221 E. MAIN STREET, PALMYRA, PA 17078, USA. Ph: (717) 832-2800, fx: (717) 832-1740 http://www.philamixers.com

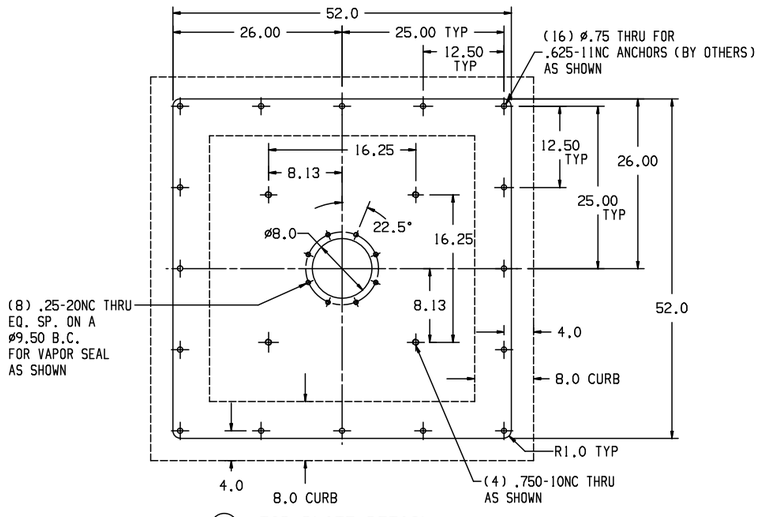
OUTLINE INSTALLATION DRAWING

DWG. NO:	SERIAL NO:	ORDER NO:	REV:	QUANTITY ON THIS ORDER:	DRN:	APPRVD:	REVIEWED BY:	DATE:
13DEK0836-1	13DEK0836	58737	B	ONE (1)	CCS	---	CHAD SPANGLER	10-09-13

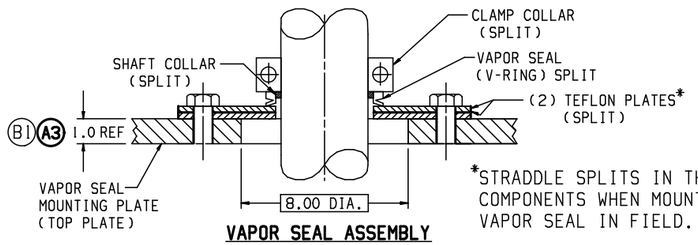


BOTTOM VIEW (A1)(B1)

ANCHOR DETAIL



B2 TOP PLATE DETAIL



VAPOR SEAL ASSEMBLY

*STRADDLE SPLITS IN THESE COMPONENTS WHEN MOUNTING VAPOR SEAL IN FIELD.

RECOMMENDED WRENCH TORQUE [lb - ft] / [N - m]

CPLG SIZE	BOLT SIZE	THRUST PLATE	COUPLING
2914	7/8"-9		194

IMPELLER 2

4VFBT90 / 2W / 13.6	IMPELLER TYPE / HUB TYPE / HUB OD
CAST / BOLTED / 0.00	CONSTRUCTION IMPELLER/ HUB / KEYWAY
1/2-13NC / 42 FT-LBS	SET SCREW SIZE / TORQUE
4 / 3/4-10NC / 130 FT-LBS	NUMBER OF BOLTS / SIZE / TORQUE

IMPELLER 1

4VFBT90 / 2W / 13.6	IMPELLER TYPE / HUB TYPE / HUB OD
CAST / BOLTED / 0.00	CONSTRUCTION IMPELLER/ HUB / KEYWAY
1/2-13NC / 42 FT-LBS	SET SCREW SIZE / TORQUE
4 / 3/4-10NC / 130 FT-LBS	NUMBER OF BOLTS / SIZE / TORQUE

REV	DESCRIPTION	DATE	APVD
B5	WAS 76.00	JJM 3-2-15	PER ENG
B4	WAS 235.56		
B3	ADDED ANCHOR DETAIL		
B2	ADDED TOP PLATE DETAIL		
B1	UPDATED VIEW		
A3	ADDED	SEF 6/9/14	
A2	WAS QTY OF (4) BAFFLES		
A1	REV. VIEW TO SHOW VAPOR SEAL MTG PLT		

REVISIONS

DRIVE DATA

3855M / 31.40:1 / PTOS DRIVE TYPE / GEAR RATIO / SEAL TYPE	
56.0 MIXER RPM	2.0 @ (100k hrs) SERVICE FACTOR

DESIGN CONDITION

3400.00 MAX MIX VOL [gal] / [cu.m]	MIN MIX VOL [gal] / [cu.m]
197.88 MAX LIQ LEV [in] / [m]	0 MIN LIQ LEV [ft] / [m]
1.00 MIX DENS [S.G.] / [kg/cu.m]	2 MIX VISCOSITY [cP]
0.00 SOLIDS CONCENTRATION	N OPERATE FILL OR DRAIN Y/N
OTHER	

VESSEL INFORMATION
(VESSEL SUPPLIED BY OTHERS)

63.00 X 63.00 VESSEL [in] / [mm]	0 / 0 TAN TO TAN [in] / [m]
0 / 0 NOZZLES TOP/BOTTOM	14.7 - 40.0 PRESS/TEMP [psi/bar]/[F/C]
234.00 (B4) OVERALL HEIGHT [in] / [m]	2 / 5.93 (A2) BAFFLE NO/WIDTH [in] / [m]
228.00 BAFFLE LENGTH [in] / [m]	OPEN / FLAT HEADS TOP/BOTTOM

PAINT REQUIREMENT

CARBOGUARD 890; ORANGE, 4-6 MDFT
REDUCER AND MOTOR

N/A
AGITATOR PARTS

NOTES
1. ALL DIMENSIONS ARE IN INCHES UNLESS SPECIFIED.
2. MOUNTING HARDWARE BY OTHERS.
3. ALL DRIVES TO BE PREPARED FOR LONG TIME STORAGE.
4. SHAFT ROTATING CLOCKWISE LOOKING DOWN.

CAUTION:
1. CONSULT SERVICE MANUAL BEFORE PROCEEDING WITH INSTALLATION AND START-UP
2. ALL DIMENSIONS ARE IN INCHES UNLESS SPECIFIED
3. MIXER SUPPORT DESIGN LOADS INCLUDE SERVICE FACTOR
4. THIS DRAWING IS NOT TO SCALE

PHILADELPHIA MIXING SOLUTIONS, Ltd.
CERTIFIED DATA

NAME S.E. FOSTER DATE 6/6/14

MOTOR DATA

PMSL STD / PMSL MOTOR MAKE / SUPPLIED BY	3 / 60 / 230/460 OR 460 PHASE/Hz/VOLTS
15.00 / 1800 / 215TC / PREM. EFF. - MILL/CHEM DUTY MOTOR HP / RPM / FRAME / ENCLOSURE INVERTER DUTY	
VARIABLE SPEED DRIVE/MAKE	**WITH THERMOSTAT** SPECIAL

MATERIAL REQUIREMENTS

316 S/S / 316 S/S
MATERIAL OF CONSTRUCTION / HARDWARE

YES
ALLOW SUBSTITUTION OF UPGRADED MATERIALS

COMPONENT WEIGHT

1130 REDUCER [lb] / [kg]	178 MOTOR [lb] / [kg]
626 SHAFT & IMP [lb] / [kg]	1934 TOTAL [lb] / [kg]

MIXER DESIGN LOADS
INCLUDING SUITABLE OVERLOAD FACTOR

THE MIXER SUPPORT STRUCTURE MUST BE LEVEL WITHIN .12 DEGREE AND IS TO BE DESIGNED SO THAT THE DYNAMIC ANGULAR DEFLECTION OF THE DRIVE IS LIMITED TO .12 DEGREE IN ANY DIRECTION.

2901 STATIC WEIGHT [lb] / [kg]	13697 WGT MOM [lb-in] / [N-m]
66196 DYN MOM [lb-in] / [N-m]	22308 DYN TORQ [lb-in] / [N-m]
514 DYNAMIC SHEAR [lb] / [N]	

CUSTOMER - SOLD TO

M.B. KAHN CONSTRUCTION CO. INC.
PO BOX 1179
COLUMBIA, SC 29202-1179

CUSTOMER - SHIP TO

HOFFER WTF - PHASE 1 IMP
508 HOFFER DRIVE
FAYETTEVILLE, NC 28301

CUSTOMER PO. NUMBER: 1579011
ITEM TAG NO: FW MIXER
REQ ROUTING: BEST WAY - LFA

APPENDIX 1

DWGS MCP 1 of 10

DWGS MCP 2 of 10

DWGS MCP 3 of 10

DWGS MCP 4 of 10

DWGS MCP 5 of 10

DWGS MCP 6 of 10

DWGS MCP 7 of 10

DWGS MCP 8 of 10

DWGS MCP 9 of 10

DWGS MCP 10 of 10 elec

DWGS MCP 10 of 10

FIELD | PANEL REAR | PANEL FRONT

NOTE: MAIN DISCONNECT TO BE SUPPLIED BY OTHERS

FLA FOR PANEL 18.38 AMPS

120VAC H N G

TB1 1 2 3

L N H

CB1 20A

LINE PROTECTOR SP-1

H1 N1

DUPLEX RECEPTICLE

CB2 15A CB2 N1 G

CB3 10A CB3 N1 F1,5A ISOLATION TRANSF. 150 VA N2

GFI DO NOT USE RECEPT. FOR EXTERNAL LOAD

L1 L2 G 120VAC TO INSTRUMENTS

CB4 10A CB4 H1 N1 G 120VAC TO CONTROLS

CB5 10A CB5 N1 G 120VAC TO PLC

CB6 1A SPARE

TB6 4 5 6 7 8 9 +

10 L1

11 12 13 14 15 16 N 17 18 19 20 21 L2

F2 4A F7 1A

24 VDC POWER SUPPLY 5

+ 24VDC TO INSTRUMENTS −

TO POWER SUPPLIES 1,2,3,4&6 (SEE SHT MCP-9)

F2 L2

PANEL FRONT

WARNING – USE OF THE FOLLOWING COMPONENTS IS DEPENDENT UPON THE ADDITIONAL PROTECTION AFFORDED BY THE GROUND FAULT INTERRUPTER AND THE OVERCURRENT PROTECTIVE DEVICE PROVIDED. DO NOT REMOVE OR DEFEAT THESE PROTECTIVE COMPONENTS.

COMPONENT	TAG
CONTROLLER	UIC4405
TEXMATE INDICATORS	VARIES
ANNUNCIATOR	ANN

THE GROUND FAULT CIRCUIT INTERRUPTER SHOULD BE CHECKED PERIODICALLY FOR PROPER OPERATION.

NOTE: THE ELECTRICAL EQUIPMENT IS DIVIDED BETWEEN TWO INTERCONNECTED CABINETS (MCP AND CABINET 2). EQUIPMENT IN MCP IS TERMINATED ON TERMINAL BOARDS TB1, 2, 3, 4, 5, 6, 7 & 17. EQUIPMENT IN CABINET 2 IS TERMINATED ON TERMINAL BOARDS TB8, 9, 10, 11, 12, 13, 14, 15, & 16.

ANNUNCIATOR

PS6 + 24V PS6 −

Y1 Y T S A R H1

TEST

ACKLOWLEDGE

RESET

HORN TB6 49 50 RY-HORN L N

RY2010B RY HORN

UA2010 RWP 10 FAIL

DR2000 1-9 1 2 2000X

UA2000 RWP 6 OR 7 FAIL

OR5440 1-9 3 4 5440X

AAH5440 FILTERED WATER HIGH TURBIDITY

CHLORINE SCALE ROOM LEAK

TB1 22 23 1-22 1-23

XR8410 12 1-8 L2 8410X

UA8410 CHLORINE STORAGE ROOM LEAK

FIELD | PANEL REAR | PANEL FRONT

CHLORINATOR ROOM LEAK

TB1 24 25 1-24 1-23

XR8411 13 1-8 L1 8411X

UA8411 CHLORINATOR ROOM LEAK

OR7000 9 6 RY 7000 7 L2 N

RY7000

UA7000 FINISHED WATER PUMP FAIL

DEC7404 1-9 13 14 7404X

AAL7404 PUMPED WATER RESIDUAL CHLORINE LOW

DEC7403 (HIGH) 1-9 8 9 7403XH

DEC7403 (LOW) 1-9 11 12 7403XL

AALH7403 PUMPED WATER PH HIGH/LOW

CHLORINE SYSTEM VACUUM SWITCH LOW HIGH

TB2 26 27 1-26 1-27

XR8413 14 1-8 L1 8413X

PALH8413 CHLORINE SYSTEM VACUUM HIGH/LOW

DEC9402 1-9 11 12 9402X

LAH9402 WASH WATER EQUALIZATION BASIN HIGH

RWP 2010 STARTER

120VAC MR CR LSL2404 CR FAIL

TB1 28 29 30 31 32 33 34 1-28

RY 2010A RY 2404 2010B (2-POLE)

RY2010A CB4 2010 2010A 1-1 5 AR2010 N

RY2404 CB4 2404X 1-6 18 XR2404

RWP2010 PTT G R CB4 IL2010(OFF) IL2010(RUN)

PTT HS2010(START) HS2010(STOP)

RY2010B L2 2010F 1-1 6 FR2010

RWP 2006 STARTER

120VAC MR CR LSL2403 CR FAIL

TB1 35 36 37 38 39 40 41 1-35

RY 2006A RY 2403 2006B

RY2006A CB4 2006 2006A 1-1 1 AR2006 N

RY2403 CB4 2403X 1-6 17 XR2403

RWP2006 PTT G R CB4 IL2006(OFF) IL2006(RUN)

PTT HS2006(START) HS2006(STOP)

RY2006B L2 2006F 1-1 2 FR2006

LEGENDS

r – p n PLC DIGITAL INPUT TERMINAL

r – p n PLC DIGITAL OUTPUT

r – p n PLC ANALOG INPUT TERMINAL

r – p n PLC ANALOG OUTPUT TERMINAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC

SCALE: NONE | DRAWN BY: HRM

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 1 OF 10

DATE: 1/18/93 | DRAWING NUMBER: MCP-1 | REV: 2

AS BUILT

File name: H:\ACAD\GLEN\MCP-1.DWG Last edited: 94/01/28 @ 10:07

RWP 2007 STARTER
120VAC
MR
FAIL
2007A
2007B
RY2007A
2007
CB4
PTT
IL2007(OFF)
IL2007(RUN)
RY2007B
2007F
FR2007
HS2007(START)
HS2007(STOP)
RAPID MIXER RM3031 STARTER 120VAC
3031A
3031B
RY3031A
3031F
FR3031
IL3031(OFF)
IL3031(RUN)
RAPID MIXER RM3032 STARTER 120VAC
3032A
3032B
RY3032A
3032F
FR3032
IL3032(OFF)
IL3032(RUN)
RAPID MIXER RM3033 STARTER 120VAC
3033A
3033B
RY3033A
3033F
FR3033
IL3033(OFF)
IL3033(RUN)
RAPID MIXER RM3034 STARTER 120VAC
3034A
3034B
RY3034A
3034F
FR3034
IL3034(OFF)
IL3034(RUN)
FLOC. BASIN MIXER FLM3041 VFD 120VAC
RUN
3041A
3041B
RY3041A
3041F
FR3041
AR3041
FLOC. BASIN MIXER FLM3043 VFD 120VAC
3043A
3043B
RY3043A
3043F
FR3043
AR3043
FLOC. BASIN MIXER FLM3044 VFD 120VAC
3044A
3044B
RY3044A
3044F
FR3044
AR3044
FLOC. BASIN MIXER FLM3047 VFD 120VAC
3047A
3047B
RY3047A
3047F
FR3047
AR3047
FLOC. BASIN MIXER FLM3048 VFD 120VAC
3048A
3048B
RY3048A
3048F
FR3048
AR3048
FLOC. BASIN MIXER FLM3051 VFD 120VAC
3051A
3051B
RY3051A
3051F
FR3051
AR3051
FLOC. BASIN MIXER FLM3052 VFD 120VAC
3052A
3052B
RY3052A
3052F
FR3052
AR3052
FLOC. BASIN MIXER FLM3042 VFD 120VAC
3042A
3042B
RY3042A
3042F
FR3042
AR3042

FLOC. BASIN MIXER FLM3045 VFD 120VAC
TB2
3045A
3045B
RY3045A
3045F
FR3045
AR3045
FLOC. BASIN MIXER FLM3046 VFD 120VAC
3046A
3046B
RY3046A
3046F
FR3046
AR3046
FLOC. BASIN MIXER FLM3049 VFD 120VAC
3049A
3049B
RY3049A
3049F
FR3049
AR3049
FLOC. BASIN MIXER FLM3050 VFD 120VAC
3050A
3050B
RY3050A
3050F
FR3050
AR3050
FLOC. BASIN MIXER FLM3053 VFD 120VAC
3053A
3053B
RY3053A
3053F
FR3053
AR3053
FLOC. BASIN MIXER FLM3054 VFD 120VAC
TB3
3054A
3054B
RY3054A
3054F
FR3054
AR3054
SEDIMENTATION BASIN #1 SLUDGE COLLECTOR LOCAL CONTROL PANEL
OPEN
CLOSED
4031A
4031B
4201A
4201B
RY4031A
4031F
FR4031
AR4031
RY4201A
4201C
CR4201
RY4201B
4201D
DR4201
SEDIMENTATION BASIN #2 SLUDGE COLLECTOR LOCAL CONTROL PANEL
4032A
4032B
4202A
4202B
RY4032A
4032F
FR4032
AR4032
RY4202A
4202C
CR4202
RY4202B
4202D
DR4202
SEDIMENTATION BASIN #3 SLUDGE COLLECTOR LOCAL CONTROL PANEL
4033A
4033B
4203A
4203B
RY4033A
4033F
FR4033
AR4033
RY4203A
4203C
CR4203
RY4203B
4203D
DR4203
SEDIMENTATION BASIN #4 SLUDGE COLLECTOR LOCAL CONTROL PANEL
4034A
4034B
4204A
4204B
RY4034A
4034F
FR4034
AR4034
RY4204A
4204C
CR4204
RY4204B
4204D
DR4204
SEDIMENTATION BASIN #5 SLUDGE COLLECTOR LOCAL CONTROL PANEL
4035A
4035B
4205A
4205B
RY4035A
4035F
FR4035
AR4035
RY4205A
4205C
CR4205
RY4205B
4205D
DR4205

LEGENDS

r – p
(n) PLC DIGITAL INPUT TERMINAL
r – p
(n) PLC DIGITAL OUTPUT
r – p
(n) PLC ANALOG INPUT TERMINAL
r – p
(n) PLC ANALOG OUTPUT TERMUNAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC

SCALE: NONE
DRAWN BY: HRW

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 2 OF 10

DATE: 1/20/93
DRAWING NUMBER: MCP-2
REV: 2

AS BUILT

File name: H:\ACAD\GLEN\MCP-2.DWG Last edited: 94/01/28 @ 11:19

FIELD | PANEL REAR | PANEL FRONT

SEDIMENTATION BASIN #6 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
TB3 29 30 31 32 33
4036A 4036B 4206A 4206B
CR4 RY4036A 4036A 1-4 13 AR4036
RY4036B 4036F 1-4 14 FR4036
RY4206A 4206C 1-7 13 CR4206
RY4206B 4206D 1-7 14 DR4206

SEDIMENTATION BASIN #7 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
34 35 36 37 38
4037A 4037B 4207A 4207B
CR4 RY4037A 4037A 1-4 15 AR4037
RY4037B 4037F 1-4 16 FR4037
RY4207A 4207C 1-7 15 CR4207
RY4207B 4207D 1-7 16 DR4207

SEDIMENTATION BASIN #8 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
39 40 41 42 43
4038A 4038B 4208A 4208B
CR4 RY4038A 4038A 1-4 17 AR4038
RY4038B 4038F 1-4 18 FR4038
RY4208A 4208C 1-7 17 CR4208
RY4208B 4208D 1-7 18 DR4208

SEDIMENTATION BASIN #9 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
44 45 46 47 48
4039A 4039B 4209A 4209B
CR4 RY4039A 4039A 1-5 1 AR4039
RY4039B 4039F 1-8 2 FR4039
RY4209A 4209C 1-8 1 CR4209
RY4209B 4209D 1-8 2 DR4209

SEDIMENTATION BASIN #10 SLUDGE COLLECTOR LOCAL CONTROL PANEL
TB4
RUN, FAIL, OPEN, CLOSED, 120VAC
1 2 3 4 5
4040A 4040B 4210A 4210B
CR4 RY4040A 4040A 1-5 3 AR4040
RY4040B 4040F 1-5 4 FR4040
RY4210A 4210C 1-8 3 CR4210
RY4210B 4210D 1-8 4 DR4210

SEDIMENTATION BASIN #11 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
6 7 8 9 10
4141A 4141B 4211A 4211B
CR4 RY4141A 4141A 1-5 5 AR4141
RY4141B 4141F 1-5 6 FR4141
RY4211A 4211C 1-8 5 CR4211
RY4211B 4211D 1-8 6 DR4211

SEDIMENTATION BASIN #12 SLUDGE COLLECTOR LOCAL CONTROL PANEL
RUN, FAIL, OPEN, CLOSED, 120VAC
11 12 13 14 15
4242A 4242B 4212A 4212B
CR4 RY4242A 4242A 1-5 7 AR4242
RY4242B 4242F 1-5 8 FR4242
RY4212A 4212C 1-8 7 CR4212
RY4212B 4212D 1-8 8 DR4212

SETTLED WATER MIXER SWM4000 STARTER
RUN, FAIL, 120VAC
16 17 18
4000A 4000B
CR4 RY4000A 4000A 1-3 13 AR4000
RY4000B 4000F 1-3 14 FR4000
SWM4000
PTT R IL4000(OFF)
PTT G IL4000(RUN)
CB4 N
HS4000(START) 19 4-19
HS4000(STOP) 20 4-20, 21 4-21

FIELD | PANEL REAR | PANEL FRONT

WASHWATER PUMP WWP7001 STARTER
RUN, FAIL, 120VAC
TB4 22 23 24
7001A 7001B
START CIRCUIT AND STOP CIRCUIT RUN TO ALL LFC'S AND TO LOCAL S/S STAT. PARALLEL STARTS AND SERIES STOPS
25A 25 26 27 28
CB4 RY1001A 7001A 1-5 11 AR7001
RY7001B 7001F 1-5 12 FR7001

LOW SERVICE PUMP LSP7002 STARTER
RUN, FAIL, 120VAC
29 30 31
7002A 7002B
CB4 RY7002A 7002 LSP7002
PTT G IL7002(OFF)
7002A 1-5 13 AR7002
CB4 N
PTT R IL7002(RUN)
RY7002B 7002F 1-5 14 FR7002
HS7002(START) 32 4-32
HS7002(STOP) 33 4-33, 34 4-34

LOW SERVICE PUMP LSP7003 STARTER
RUN, FAIL, 120VAC
35 36 37
7003A 7003B
CB4 RY7003A 7003 LSP7003
PTT G IL7003(OFF)
7003A 1-5 15 AR7003
CB4 N
PTT R IL7003(RUN)
RY7003B 7003F 1-5 16 FR7003
HS7003(START) 38 4-38
HS7003(STOP) 39 4-39, 40 4-40

HIGH SERVICE PUMP HSP7004 STARTER
RUN, FAIL, 120VAC
41 42 43
7004A 7004B
CB4 RY7004A 7004 LSP7004
PTT G IL7004(OFF)
7004A 1-5 17 AR7004
CB4 N
PTT R IL7004(RUN)
RY7004B 7004F 1-5 18 FR7004
HS7004(START) 44 4-44
HS7004(STOP) 45 4-45, 46 4-46

5KV MCC
TB6 14 15 16 17 18 19
6-14 6-15 6-16 6-17 6-18
N, 120 VAC
PTT R BUS #1
PTT R TIE SWITCH
PTT R BUS #2

480V MCC
TB6 20 21 22 23
6-20 6-21 6-22 6-23
N, 120 VAC
PTT R BUS #1
PTT R BUS #2

LEGENDS

r — p
(n) PLC DIGITAL INPUT TERMINAL
⬡ n PLC DIGITAL OUTPUT
(n) PLC ANALOG INPUT TERMINAL
△ n PLC ANALOG OUTPUT TERMINAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

MR. PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC
SCALE: NONE | DRAWN BY: HRW
MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 3 OF 10
DATE: 1/20/93 | DRAWING NUMBER: MCP-3 | REV: 3

AS BUILT

File name: H:\ACAD\GLEN\MCP-3.DWG Last edited: 94/08/04 @ 13:54

FIELD | PANEL REAR | PANEL FRONT

HIGH SERVICE PUMP HSP7005 STARTER

RUN, FAIL, 120VAC — TB4 47, 48, 49 — RY 7005A, RY 7005B — CB4 RY7005A 7005 — 7005A 1-6 (1) AR7005 — RY7005B 7005F 1-6 (2) FR7005

HSP7005: PTT G, PTT R, CB4, N — IL7005(OFF), IL7005(RUN)

TB5 1, 2, 3 — 5-1, 5-2, 5-3 — HS7005(START), HS7005(STOP)

HIGH SERVICE PUMP HSP7008 STARTER

RUN, FAIL, 120VAC — TB4 4, 5, 6 — RY 7008A, RY 7008B — CB4 RY7008A 7008 — 7008A 1-6 (3) AR7008 — RY7008B 7008F 1-6 (4) FR7008

HSP7008: PTT G, PTT R, CB4, N — IL7008(OFF), IL7008(RUN)

7, 8, 9 — 5-7, 5-8, 5-9 — HS7008(START), HS7008(STOP)

HIGH SERVICE PUMP HSP7009 STARTER

RUN, FAIL, 120VAC — 10, 11, 12 — RY 7009A, RY 7009B — CB4 RY7009A 7009 — 7009A 1-5 (5) AR7009 — RY7009B 7009F 1-6 (6) FR7009

HSP7009: PTT G, PTT R, CB4, N — IL7009(OFF), IL7009(RUN)

13, 14, 15 — 5-13, 5-14, 5-15 — HS7009(START), HS7009(STOP)

RECONNECT TO RESIDUALS PUMPS CONTROL PANEL PROVIDED BY OTHERS UNDER DIVISION II

REDIDUALS PUMP RP1050-1

RUN, FAIL, 120VAC, PUMP 1 START, R1, R3 — 16, 17, 18 — RY 4001A, RY 4001B — CB4 RY4001A 4001 — 4001A 1-3 (15) AR4001 — RY4001B 4001F 1-3 (16) FR4001

RP1050-1: PTT G, PTT R, CB4, N — IL1050-1(OFF), IL1050-1(RUN)

19, 20, 21 — 5-19, 5-20, 5-21 — HS1050-1(START), HS1050-1(STOP)

REDIDUALS PUMP RP1050-2

RUN, FAIL, 120VAC, PUMP 2 START, R2, R3 — 22, 23, 24 — RY 4002A, RY 4002B — CB4 RY4002A 4002 — 4002A 1-3 (17) AR4002 — RY4002B 4002F 1-3 (18) FR4002

RP1050-2: PTT G, PTT R, CB4, N — IL1050-2(OFF), IL1050-2(RUN)

25, 26, 27 — 5-25, 5-26, 5-27 — HS1050-2(START), HS1050-2(STOP)

LIT-9401(HIGH), LIT9401 LOW, 120VAC, R3, N — 28, 29 — RY 4002C

RY4002C 4002C — IL1050(HIGH LEVEL)

RY4002D 4002D — IL1050(LOW LEVEL)

4002E — IL1050(OVERIDE)

L2

LIT-9401(LOW-LOW) — 30, 31, 32 — RY 4002D, RY 4002E — 5-31, 5-32 — HS1050(RESET)

FIELD | PANEL REAR | PANEL FRONT

ALUM DAY TANK LSHH8404 — 120VAC — TB5 33, 34 — 8404X — 1 8 (11) XRB404 — CB4

ALUM DAY TANK LSH8405 — 120VAC — TO ALUM TRANSFER PUMPS CUT-OFF PANEL

P'PHOSPHATE DAY TANK LSH8441 — 120VAC — 35, 36 — 8441X — 1 8 (17) XRB441 — CB4

P'PHOSPHATE DAY TANK LSH8442 — 120VAC — TO P'PHOSPHATE TRANSFER PUMPS CUT-OFF PANEL

FLUORIDE DAY TANK LSHH8421 — 120VAC — 37, 38 — 8421X — 1 8 (16) XRB421 — CB4

LIME PUMP VFD LP8001

RUN, FAIL, 120VAC — TB5 39, 40, 41 — RY 8001A, RY 8001B — CB4 RY8001A 8001A — 1-6 (7) AR8001 — RY8001B 8001F 1-6 (8) FR8001

TB6 1, 2, 3, 4 — F8001 — RAW WATER FLOW, TRAIN A (SEE SH. MCP-10) — C102

LIME PUMP VFD LP8002

RUN, FAIL, 120VAC — TB5 42, 43, 44 — RY 8002A, RY 8002B — CB4 RY8002A 8002A — 1-6 (11) AR8002 — RY8002B 8002F 1-6 (12) FR8002

TB6 5, 6, 7, 8 — F8002 — RAW WATER FLOW, TRAIN B (SEE SH. MCP-10) — C103

LIME PUMP VFD LP8003

RUN, FAIL, 120VAC — TB5 45, 46, 47 — RY 8003A, RY 8003B — CB4 RY8003A 8003A — 1-6 (13) AR8003 — RY8003B 8003F 1-6 (14) FR8003

TB6 9, 10, 11 — F8003 — TOTAL FILTER RATE FLOW (SEE SH MCP-9) — C110

LIME PUMP VFD LP8004

RUN, FAIL, 120VAC — TB5 48, 49, 50 — RY 8004A, RY 8004B — CB4 RY8004A 8004A — 1-6 (13) AR8004 — RY8004B 8004F 1-6 (16) FR8004

TB6 12, 13, 14 — F8004 — TOTAL FILTER RATE FLOW (SEE SH MCP-9) — C111

LEGENDS

- r – p / (n) — PLC DIGITAL INPUT TERMINAL
- r – p / (n) — PLC DIGITAL OUTPUT
- r – p / (n) — PLC ANALOG INPUT TERMINAL
- r – p / (n) — PLC ANALOG OUTPUT TERMINAL
- r – PLC RACK NUMBER
- p – MODULE POSITION NUMBER
- n – MODULE TERMINAL NUMBER

REV	DESCRIPTION	DATE
6	LIT9401 LOW & LOW-LOW REVISED	7/28/99
3	AS BUILT	3/2/99
4	RECONNECT SLUDGE PUMPS CONTROLS TO RESIDUALS PUMPS CONTROLS	10/30/97

NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC

SCALE: NONE — DRAWN BY: HRM

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 4 OF 10

DATE: 1/20/93 — DRAWING NUMBER: MCP-4 — REV: 6

Nix, Purser & Assoc., Inc. 3/2/99 3:10 PM MCP-4

FIELD | PANEL REAR | PANEL FRONT

120 VAC TURBIDITY AE/AIT2405 — 4-20MA — TB8 15 16 17 — A2405 — AR2405 — C1 — RAW WATER

120 VAC PH AE/AIT2406 — 4-20MA — 18 19 — A2406 — AR2406 — C2 — RAW WATER

2 PEN REC IN LAB

120 VAC STREAMING CURRENT AE/AIT3401 — 4-20MA — C3 — TRAIN A TREATED WATER

20 21 22 23 — A3401 — AR3401 — C4 — 4-20MA — C3 — TB16 TB17 — TRAIN A STREAMING CURRENT AIR3401 — H N G — L1 N G

NOTE: THIS RECORDER IS MOUNTED ON WALL IN THE CHEMICAL BUILDING

120 VAC PH AE/AIT3402 — 4-20MA — 24 25 — A3402 — AR3402 — C5 — TRAIN A TREATED WATER

2 PEN REC IN LAB

120 VAC STREAMING CURRENT AE/AIT3403 — 4-20MA — C4 — TRAIN B TREATED WATER

28 27 28 29 — A3403 — AR3403 — C7 — 4-20MA — C6 — TB16 TB17 — TRAIN B STREAMING CURRENT AIR3403 — H N G — L1 N G

NOTE: THIS RECORDER IS MOUNTED ON WALL IN THE CHEMICAL BUILDING

120 VAC PH AE/AIT3404 — 4-20MA — 30 31 — A3404 — AR3404 — C8 — TRAIN B TREATED WATER

FIELD | PANEL REAR | PANEL FRONT

24VDC

FIT2401 — 4-20MA — RAW WATER TRAIN A AE2401 — MOV2201

TB8 32 33 34 35 36 — NPA — 4-20MA — C9 — TB16 TB17 — TRAIN A RAW WATER FLOW FI2401 — H N G — L1 N G

ISOLATOR SEE MCP-10 — FR2401 — C10

M — TB6 1 2 3 4 — 6-1 6-2 6-3 6-4 — HS2201(OPEN) HS2201(CLOSE)

ZIC2201 — 4-20MA — TB8 37 38 39 — NPA — C11 — 4-20MA — TB16 TB17 — TRAIN A RAW WATER VALVE POSITION ZI2201 — H N G — L1 N G

24VDC

FIT2402 — 4-20MA — RAW WATER TRBIN B AE2402 — MOV2202

TB9 1 2 3 4 5 — NPA — 4-20MA — C12 — TB16 TB17 — TRBIN B RAW WATER FLOW FI2402 — H N G — L1 N G

ISOLATOR SEE MCP-10 — FR2402 — C13

M — TB6 5 6 7 8 — 6-5 6-6 6-7 6-8 — HS2202(OPEN) HS2202(CLOSE)

ZIC2202 — 4-20MA — TB9 6 7 8 — NPA — 4-20MA — C14 — TB16 TB17 — TRBIN B RAW WATER VALVE POSITION ZI2202 — H N G — L1 N G

LEGENDS

r — p / n — PLC DIGITAL INPUT TERMINAL

r — p / n — PLC DIGITAL OUTPUT

r — p / n — PLC ANALOG INPUT TERMINAL

r — p / n — PLC ANALOG OUTPUT TERMUNAL

r — PLC RACK NUMBER
p — MODULE POSITION NUMBER
n — MODULE TERMINAL NUMBER

REVISED 8/10/99

NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC

SCALE: NONE | DRAWN BY: HRM

MAIN CONTROL PANEL — MCP
ELECTRICAL DIAGRAM 5 OF 10

DATE: 1/22/93 | DRAWING NUMBER: MCP-5 | REV: 2

Last edited: 94/01/25 @ 10:48

FIELD | PANEL REAR | PANEL FRONT

120 VAC
LEVEL
AE/AIT4401
SEDIMENTATION BASIN EFFLUENT CHANNEL
4-20MA
C15
C16
TB9 9 10 11 12
TB16 TB17 19 19 20 20 21 21
MASTER FILTER RATE CONTROLLER
UC4405
L1 L2 G
SEE DWG LL
250 OHM
LR4401
L4401
C17
FY4405
250 OHM
H N G
L1 N G

120 VAC
TURBIDITY
AE/AIT4403
SEDIMENTATION BASIN
4-20MA
13 14 15
A4403
AR4403

120 VAC
PH
AE/AIT4404
SEDIMENTATION BASIN EFFLUENT CHANNEL
4-20MA
16 17
A4404
AR4404
C18

RESIDUAL CL2
AR5460 (EXIST)
1-5V
H N G
L1 L2 G

120 VAC
RESIDUAL CL2
AE/AIT5460
FILTERED WATER
4-20MA
18 19 20
A5460
AR5460
C20

120 VAC
LEVEL
AE/AIT6401
5MG CLEARWELL
4-20MA
21 22 23 24
TB16 TB17 22 22 23 23 24 24
5MG CLEARWELL LEVEL
LI6401
H N G
L1 L2 G
L6401
C22
LR6401

FIELD | PANEL REAR | PANEL FRONT

24VDC
FLOW
FIT6403
TO 1MG CLEARWELL
AE6403
4-20MA
MOV6201
TB9 25 26 27 28 29
C23
TB16 TB17 25 25 26 26 27 27
1MG CLEARWELL FLOW
FI6403
H N G
L1 L2 G
FR6403
C24
TB6 9 10 11 12
6-9
6-10
6-11
6-12
HS6201(OPEN)
HS6201(CLOSE)
M
ZIC6201
TB10 1 2 3
C25
TB16 TB17 28 28 29 29 30 30
1MG CLEARWELL VALVE POSITION
ZI6201
H N G
L1 L2 G

120 VAC
LEVEL
AE/AIT6402
1MG CLEARWELL
4-20MA
TB10 4 5 6 7
C26
TB16 TB17 31 31 32 32 33 33
1MG CLEARWELL LEVEL
LI6402
H N G
L1 L2 G
L6402
C27
LR6402

120 VAC
RESIDUAL CL2
AE/AIT6404
CLEARWELL EFFLUENT
4-20MA
TB10 8 9
A6404
AR6404
C28

120 VAC
PH
AE/AIT6405
CLEARWELL EFFLUENT
4-20MA
TB10 11 12
A6405
AR6405
C29

120 VAC
LEVEL
AE/AIT7401
HSPS WETWELL
TB10 13 14 15
L7401
LR7401
C30

LEGENDS

- PLC DIGITAL INPUT TERMINAL
- PLC DIGITAL OUTPUT
- PLC ANALOG INPUT TERMINAL
- PLC ANALOG OUTPUT TERMINAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

NPA
W.K. PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC

SCALE: NONE
DRAWN BY: HRN

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 6 OF 10

DATE: 1/22/93
DRAWING NUMBER: MCP-6
REV: 3

AS BUILT

File name: H:\ACAD\GLEN_MCP-6.DWG Last edited: 04/08/04 @ 14:30

FIELD | PANEL REAR | PANEL FRONT

120 VAC
PH
AE/AIT7403
4-20MA
LOW SERVICE WATER
TB10 16 17 18
A7403
AR7403
C31

120 VAC
RESIDUAL CL2
AE/AIT7404
4-20MA
LOW SERVICE WATER
19 20
A7404
AR7404
C32
1-5V
RESIDUAL CL2
AR7404 (EXIST)
+ -
H N G
L1 L2 G

120 VAC
TURBIDITY
AE/AIT7407
4-20MA
LOW SERVICE WATER
21 22 23
A7407
AR7407
C33

24VDC
LOW SERVICE PRESSURE
PIT7405
LOW SERVICE WATER
24 25 26 27 28
C34
TB16 TB17 34 34 / 35 35 / 36 36
P7405
C35
PR7405
LOW SERVICE PRESSURE
PI7405
H N G
L1 L2 G

24VDC
HIGH SERVICE PRESSURE
PIT7402
HIGH SERVICE WATER
29 30 31 32 33
C36
TB16 TB17 37 37 / 38 38 / 39 39
P7402
C37
PR7402
HIGH SERVICE PRESSURE
PI7402
H N G
L1 L2 G

PS7
24V
HIGH SERVICE ZONE
LOOP 7410 CURRENT
FROM FIR7425 PEN 1
FIT7410 FLOW
(+) (-)
34A 34 35
F7410
C38
FR7410 VAULT 5

Pumps 5/8/89

FIELD | PANEL REAR | PANEL FRONT

PS7
24V
HIGH SERVICE ZONE
LOOP 7420 CURRENT
FROM FIR7425 PEN 2
FIT7420 FLOW
(+) (-)
TB10 36A 36 37 38
F7420
C39
FR7420 VAULT 4
Not used

PS7
24V
HIGH SERVICE ZONE
LOOP 7430 CURRENT
FROM FIR7425 PEN 3
FIT7420 FLOW
(+) (-)
TB11 1A 1 2
F7430
C40
FR7430 VAULT 3
Pump 4

PS7
24V
I/I8003
IN 1 2 3 4 OUT
LOW SERVICE ZONE
LOOP 7440 CURRENT
FROM FIR7425 PEN 1
FIT7440 FLOW
(+) (-)
3A 3 4 5
F7440
C41
FR7440 VAULT 2
Pump 3

PS7
24V
LOW SERVICE ZONE
LOOP 7450 CURRENT
FROM FIR7425 PEN 2
FIT7450 FLOW
(+) (-)
6A 6 7
F7450
C42
FR7450 VAULT 1
Pump 2

120 VAC
LEVEL
LE/LIT9401
WASHWATER SLUDGE
EQUALIZATION BASIN
8 9 10 11
NPA
C43
L9401
C44
LR9401
TB16 TB17 40 40 / 41 41 / 42 42
WASHWATER SLUDGE
EQUALIZATION BASIN LEVEL
LI9401
H N G
L1 L2 G

ALUM STORAGE TANK 1
LEVEL
LIT8401
24VDC (+) (-)
12 13 14 15
L8401
C45
LR8401

ALUM STORAGE TANK 2
LEVEL
LIT8402
24VDC (+) (-)
16 17 18 19
L8402
C46
LR8402

ALUM STORAGE TANK 3
LEVEL
LIT8403
24VDC (+) (-)
20 21 22 23
L8403
C47
LR8403

LEGENDS

r – p
n PLC DIGITAL INPUT TERMINAL

r – p
n PLC DIGITAL OUTPUT

r – p
n PLC ANALOG INPUT TERMINAL

r – p
n PLC ANALOG OUTPUT TERMUNAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

NPA NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

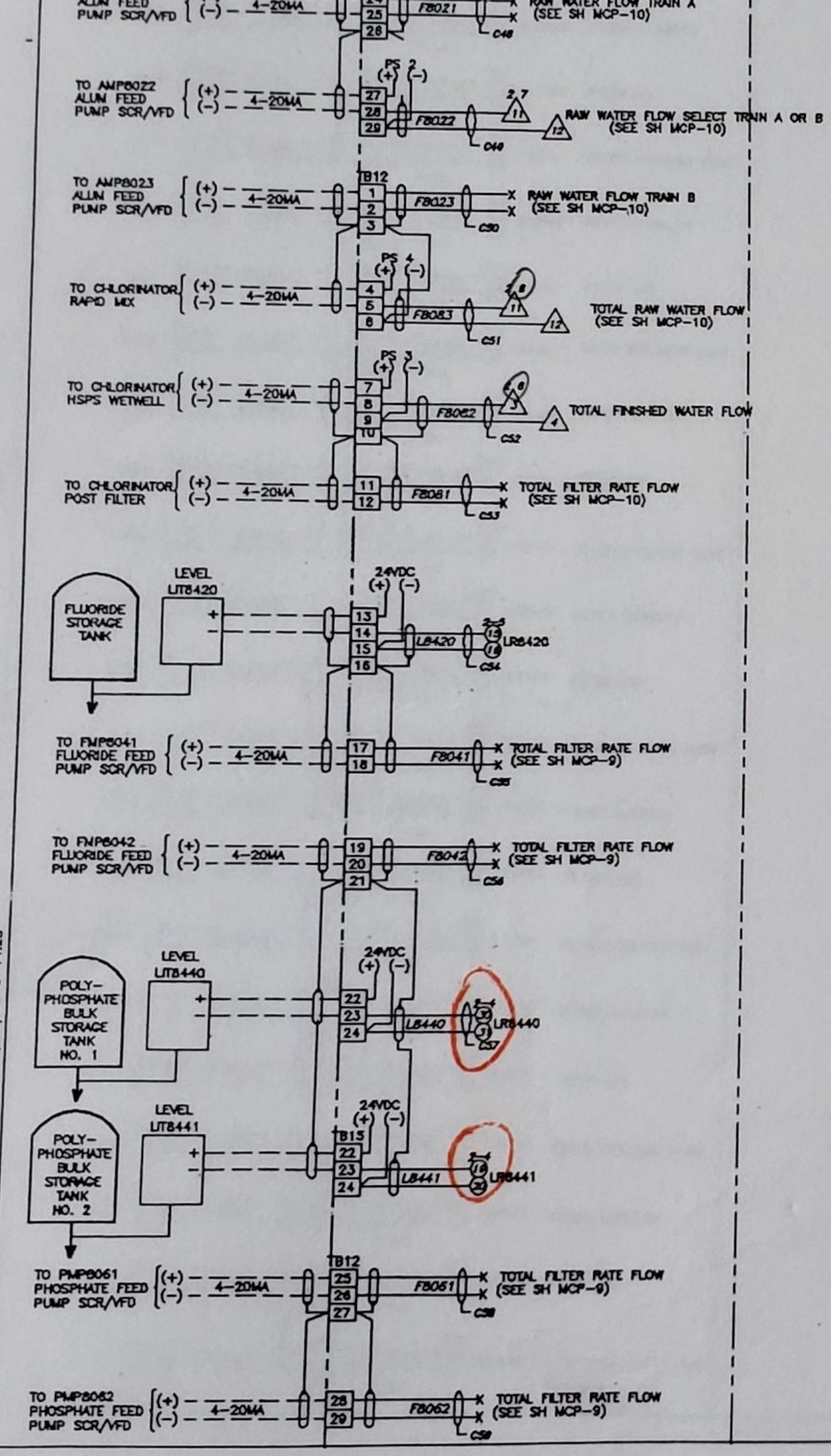
GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC
SCALE: NONE | DRAWN BY: HRM

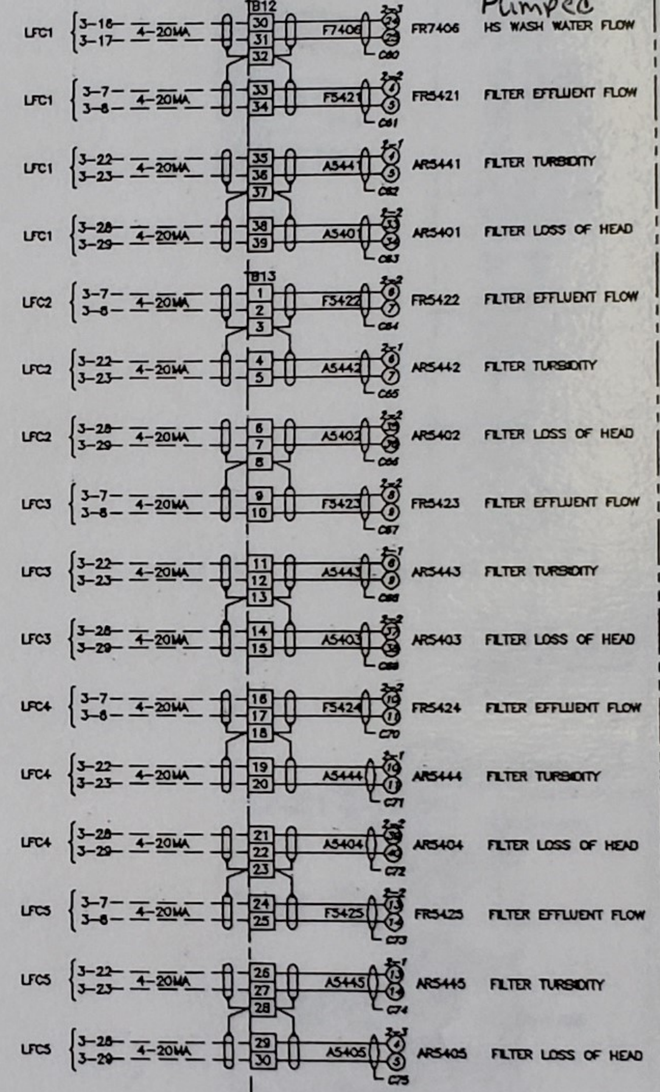
MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 7 OF 10

DATE: 1/22/93 | DRAWING NUMBER: MCP-7 | REV: 2

AS BUILT

File name: ...CAD\GLEN\MCP-7.DWG Last edited: 94/08/04 @ 15:43





LEGENDS

- PLC DIGITAL INPUT TERMINAL
- PLC DIGITAL OUTPUT
- PLC ANALOG INPUT TERMINAL
- PLC ANALOG OUTPUT TERMINAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

MCKIM, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28105

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC

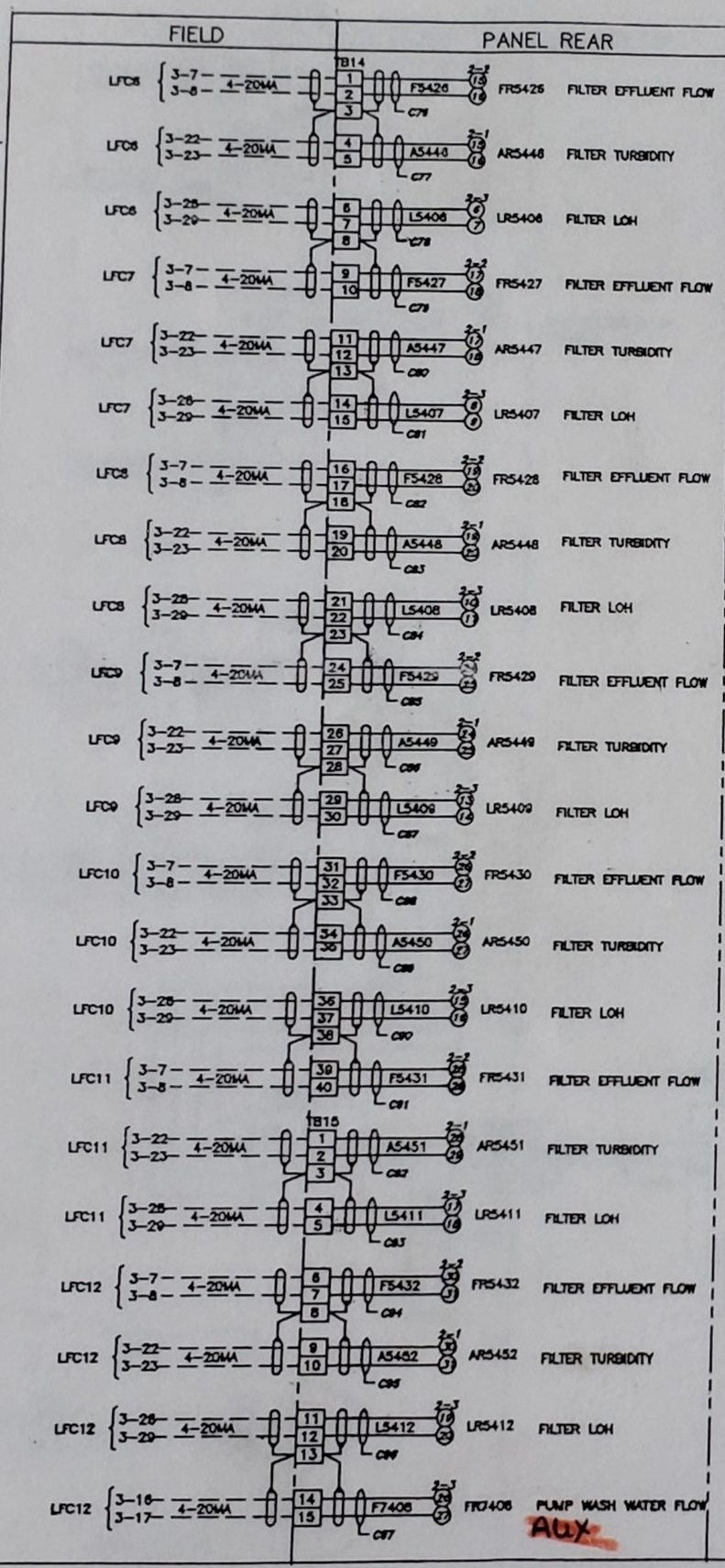
DRWG NONE | DRWN BY HRM

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 6 OF 10

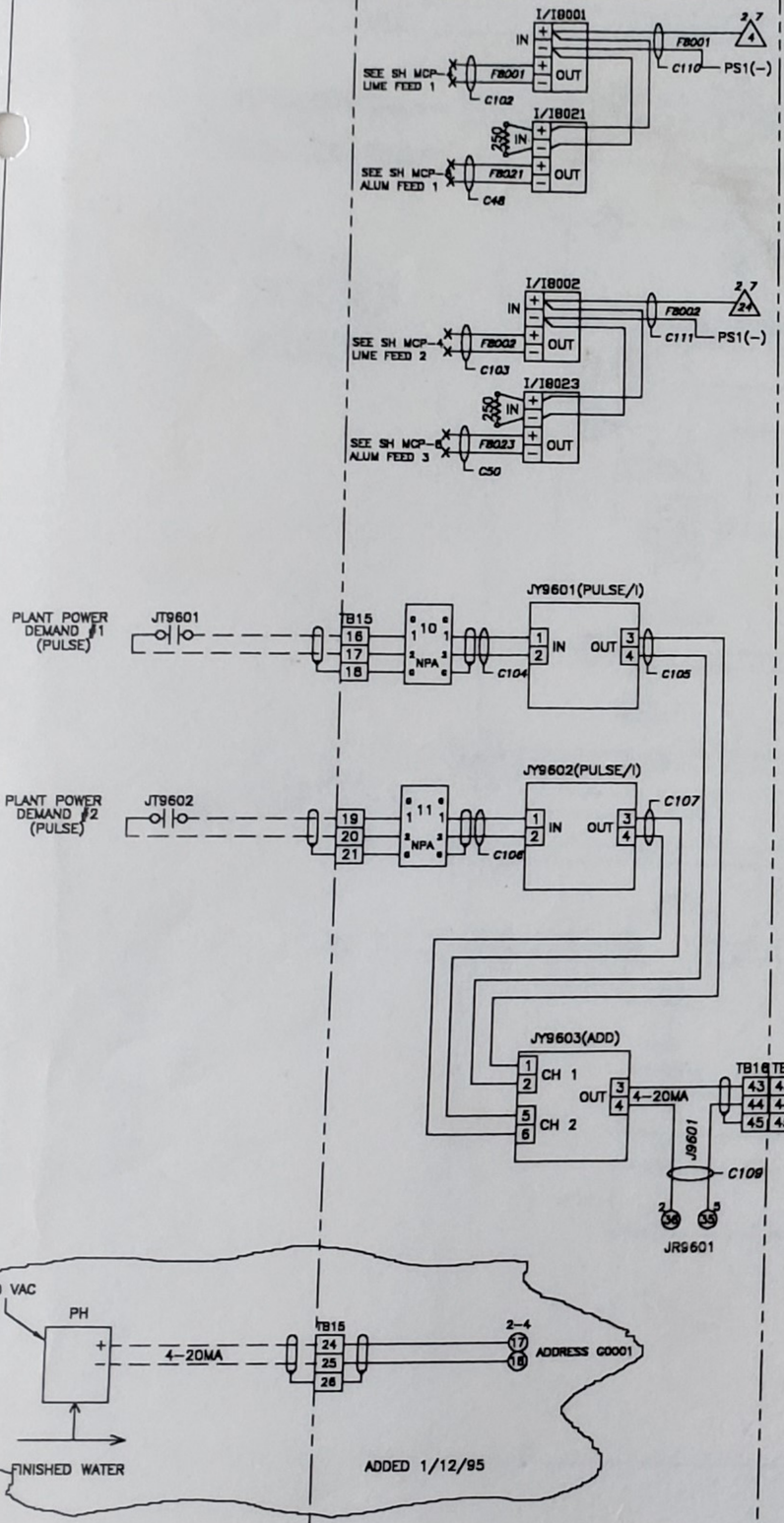
DATE 1/25/93 | DRAWING NUMBER MCP-6 | REV 3

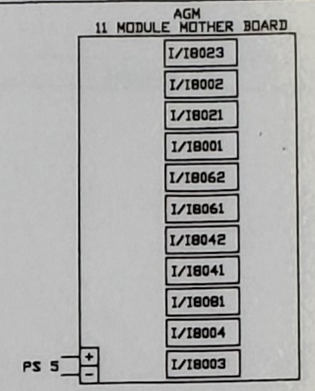
AS BUILT

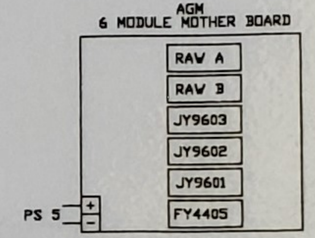
File name: H:\ACAD\GLEN\MCP-6.DWG Last edited: 04/08/04 ● 14:20


FIELD
PANEL REAR
PANEL FRONT
TB14
LFC6 3-7 3-8 4-20MA 1 2 3 F5426 FR5426 FILTER EFFLUENT FLOW C76
LFC6 3-22 3-23 4-20MA 4 5 A5446 AR5446 FILTER TURBIDITY C77
LFC6 3-28 3-29 4-20MA 6 7 8 L5406 LR5406 FILTER LOH C78
LFC7 3-7 3-8 4-20MA 9 10 F5427 FR5427 FILTER EFFLUENT FLOW C79
LFC7 3-22 3-23 4-20MA 11 12 13 A5447 AR5447 FILTER TURBIDITY C80
LFC7 3-28 3-29 4-20MA 14 15 L5407 LR5407 FILTER LOH C81
LFC8 3-7 3-8 4-20MA 16 17 18 F5428 FR5428 FILTER EFFLUENT FLOW C82
LFC8 3-22 3-23 4-20MA 19 20 A5448 AR5448 FILTER TURBIDITY C83
LFC8 3-28 3-29 4-20MA 21 22 23 L5408 LR5408 FILTER LOH C84
LFC9 3-7 3-8 4-20MA 24 25 F5429 FR5429 FILTER EFFLUENT FLOW C85
LFC9 3-22 3-23 4-20MA 26 27 28 A5449 AR5449 FILTER TURBIDITY C86
LFC9 3-28 3-29 4-20MA 29 30 L5409 LR5409 FILTER LOH C87
LFC10 3-7 3-8 4-20MA 31 32 33 F5430 FR5430 FILTER EFFLUENT FLOW C88
LFC10 3-22 3-23 4-20MA 34 35 A5450 AR5450 FILTER TURBIDITY C89
LFC10 3-28 3-29 4-20MA 36 37 38 L5410 LR5410 FILTER LOH C90
LFC11 3-7 3-8 4-20MA 39 40 F5431 FR5431 FILTER EFFLUENT FLOW C91
TB15
LFC11 3-22 3-23 4-20MA 1 2 3 A5451 AR5451 FILTER TURBIDITY C92
LFC11 3-28 3-29 4-20MA 4 5 L5411 LR5411 FILTER LOH C93
LFC12 3-7 3-8 4-20MA 6 7 8 F5432 FR5432 FILTER EFFLUENT FLOW C94
LFC12 3-22 3-23 4-20MA 9 10 A5452 AR5452 FILTER TURBIDITY C95
LFC12 3-28 3-29 4-20MA 11 12 13 L5412 LR5412 FILTER LOH C96
LFC12 3-16 3-17 4-20MA 14 15 F7406 FR7406 PUMP WASH WATER FLOW C97
Aux
FIELD
PANEL REAR
PANEL FRONT
TB16 TB17
45 45 PS-1
46 46
47 47 PS-2
48 48
49 49 PS-3
50 50
51 51 PS-4
52 52
53 53 PS-5
54 54
F2
L2
G
24 VDC POWER SUPPLY 1
F3 25A
TO 1/18001
1/1 18002
1/1 18003
INK-J
SHT'S MCP 9 & 10
24 VDC POWER SUPPLY 2
F4 25A
TB10 27
TB10 29
24 VDC POWER SUPPLY 3
F5 25A
TB11 7
TB11 9
24 VDC POWER SUPPLY 4
F6 25A
TB11 4
TB11 6
ANNUNCIATOR POWER SUPPLY 6
F8, 4A
V+ V-
24 VDC POWER SUPPLY 7
F7 25A
1/18003
IN 1 2 3 4 OUT
F5433
C98
PS1(-)
3.6
TOTAL FILTER FLOW
SEE SH MCP-4 LIME PUMP 3
F8033
C100
C99
1/18004
SEE SH MCP-4 LIME PUMP 4
F8034
C101
1/18081
SEE SH MCP-8 CL2 TO POST FILTER
F8081
C53
1/18041
SEE SH MCP-8 FLUORIDE FEED 1
F8041
C55
1/18042
SEE SH MCP-8 FLUORIDE FEED 2
F8042
C56
1/18061
SEE SH MCP-8 PHOSPHATE FEED 1
F8061
C58
1/18062
SEE SH MCP-8 PHOSPHATE FEED 2
F8062
C59
LEGENDS
r – p (n) PLC DIGITAL INPUT TERMINAL
r – p (n) PLC DIGITAL OUTPUT
r – p (n) PLC ANALOG INPUT TERMINAL
r – p (n) PLC ANALOG OUTPUT TERMINAL
r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER
MR. PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28105
GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC
SCALE NONE
DRAWN BY HRM
MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 9 OF 10
DATE 1/28/93
DRAWING NUMBER MCP-9
REV 3
AS BUILT
File name: H:\ACAD\OLEN\MCP-9.DWG Last edited: 94/08/04 ● 15:58

FIELD	PANEL REAR	PANEL FRONT	FIELD	PANEL REAR	PANEL FRONT







LEGENDS

- r — p / n — PLC DIGITAL INPUT TERMINAL
- r — p / n — PLC DIGITAL OUTPUT
- r — p / n — PLC ANALOG INPUT TERMINAL
- r — p / n — PLC ANALOG OUTPUT TERMUNAL

r — PLC RACK NUMBER
p — MODULE POSITION NUMBER
n — MODULE TERMINAL NUMBER

REVISED 8/10/99

NPA NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION CITY OF FAYETTVILLE, NC	SCALE: NONE	DRAWN BY: HRM
MAIN CONTROL PANEL — MCP ELECTRICAL DIAGRAM 10 OF 10		
DATE: 2/2/93	DRAWING NUMBER: MCP-10	REV: 3

AS BUILT

File name: H:\ACAD\MISC\MCP-10.DWG Last edited: 95/01/12 @ 12:00

FIELD | PANEL REAR | PANEL FRONT

MASTER FILTER RATE CONTROLLER UC4405

120 VAC LEVEL AE/AIT4401 — SEDIMENTATION BASIN EFFLUENT CHANNEL

TB9 9 10 11 12 — 4-20MA — C15 — TB16 TB17 19 19 20 20 21 21

C16

LR4401 — 4401 — 4-20MA — C17 — FY4405 250 OHM — H N G — L1 N G

L1 L2 G — SEE DWG LL — 250 OHM

120 VAC TURBIDITY AE/AIT4403 — 4-20MA — 13 14 15 — A4403 — AR4403

SEDIMENTATION BASIN

120 VAC PH AE/AIT4404 — 4-20MA — 16 17 — A4404 — AR4404 — C18

SEDIMENTATION BASIN EFFLUENT CHANNEL

RESIDUAL CL2 AR5460 (EXIST) — 1-5V — H N G — L1 L2 G

120 VAC RESIDUAL CL2 AE/AIT5460 — 4-20MA — 18 19 20 — A5460 — AR5460 — C20

FILTERED WATER

5MG CLEARWELL LEVEL LI6401

120 VAC LEVEL AE/AIT6401 — 21 22 23 24 — NPA — 4-20MA — C21 — TB16 TB17 22 22 23 23 24 24 — H N G — L1 L2 G

L6401 — C22 — LR6401

5MG CLEARWELL

FIELD | PANEL REAR | PANEL FRONT

24VDC

FLOW FIT6403 — 4-20MA — TO 1MG CLEARWELL — AE6403 — MOV6201

TB9 25 26 27 28 29 — NPA — 4-20MA — C23 — TB16 TB17 25 25 26 26 27 27

F6403 — C24 — FR6403

1MG CLEARWELL FLOW FI6403 — H N G — L1 L2 G

M — TB6 9 10 11 12 — 6-9 6-10 6-11 6-12 — HS6201(OPEN) — HS6201(CLOSE)

ZIC6201 — 4-20MA — TB10 1 2 3 — NPA — 4-20MA — C25 — TB16 TB17 28 28 29 29 30 30

1MG CLEARWELL VALVE POSITION ZI6201 — H N G — L1 L2 G

120 VAC LEVEL AE/AIT6402 — TB10 4 5 6 7 — NPA — 4-20MA — C26 — TB16 TB17 31 31 32 32 33 33

L6402 — C27 — LR6402

1MG CLEARWELL

1MG CLEARWELL LEVEL LI6402 — H N G — L1 L2 G

120 VAC RESIDUAL CL2 AE/AIT6404 — 4-20MA — TB10 8 9 — A6404 — AR6404 — C28

CLEARWELL EFFLUENT

120 VAC PH AE/AIT6405 — 4-20MA — TB10 11 12 — A6405 — AR6405 — C29

CLEARWELL EFFLUENT

120 VAC LEVEL AE/AIT7401 — TB10 13 14 19 — L7401 — LR7401 — C30

HSPS WETWELL

LEGENDS

- r – p / n — PLC DIGITAL INPUT TERMINAL
- r – p / n — PLC DIGITAL OUTPUT
- r – p / n — PLC ANALOG INPUT TERMINAL
- r – p / n — PLC ANALOG OUTPUT TERMINAL

r – PLC RACK NUMBER
p – MODULE POSITION NUMBER
n – MODULE TERMINAL NUMBER

NPA MCKIM PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC

SCALE: NONE | DRAWN BY: HRN

MAIN CONTROL PANEL – MCP
ELECTRICAL DIAGRAM 6 OF 10

DATE: 1/22/93 | REFERENCE NUMBER: MCP-6 | REV: 3

AS BUILT

File name: H:\ACAD\GLEN\MCP-6.DWG Last edited: 94/08/04 @ 14:30

APPENDIX 2

DWGS CHEM (1)

DWGS CHEM (2)

DWGS CHEM (3)

DWGS CHEM (4)

DWGS CHEM (5)

DWGS CHEM (6)

DWGS CHEM (7)

DWGS CHEM (8)

DWGS CHEM (9)

DWGS CHEM (10)

DWGS CHEM (11)

DWGS CHM Transfer Pumps

FIELD | BEHIND PANEL | FRONT OF PANEL | FIELD | BEHIND PANEL | FRONT OF PANEL

RECIRCULATION PUMP NO. 1 — RUN / FAIL — TB2 1,2,3 — F1
RECIRCULATION PUMP NO. 2 — RUN / FAIL — TB2 4,5,6 — F1
METERING PUMP NO. 1 FLOCCULATOR-1 — RUN / FAIL — TB2 7,8,9 — F1
METERING PUMP NO. 2 FLOCCULATOR-2 — RUN / FAIL — TB2 10,11,12 — F1
METERING PUMP NO. 3 PRE-FILTER — RUN / FAIL — 13,14,15 — F2
METERING PUMP NO. 4 POST-FILTER — RUN / FAIL — 16,17,18 — F2
METERING PUMP NO. 5 POST-CLEARWELL — RUN / FAIL — 19,20,21 — F2
⚠3 METERING PUMP NO. 6 SODIUM HYPOCHLORITE — RUN / FAIL — 22,23,24 — F2

R2 S2 BDEP-218: 1 N1, 2–11, 12 N1, 13–22

METERING PUMP NO. 1 LOW DISCHARGE PRESSURE — G-3005-PS1 — 25 — F3
METERING PUMP NO. 2 LOW DISCHARGE PRESSURE — G-3005-PS2 — 26 — F3
METERING PUMP NO. 3 LOW DISCHARGE PRESSURE — G-3005-PS3 — 27 — F3
METERING PUMP NO. 4 LOW DISCHARGE PRESSURE — G-3005-PS4 — 28 — F3
METERING PUMP NO. 5 LOW DISCHARGE PRESSURE — G-3005-PS5 — 29 — F3
METERING PUMP PRESSURE RELIEF FLOW — G-3005-FS1 — 24 VDC + POWER − — +24 V, −24V — 30 — F3
FIRE VALVE CLOSED — 31 — F3
SUMP HI LEVEL — TB30, TB31 — 32 — F3

R2 S3 BDEP-218: 1 N1, 2–11, 12 N1, 13–22

TO LOCAL ALARM PANEL HYPOCHLORITE
CL2 GAS DETECTED — TB32 — 33 — F4
SHOWER/EYE WASH STATION ACTIVATED — TB33, TB34, TB35 — 34 — F4
CAUSTIC TRANSFER PUMP — RUN / FAIL — 35,36 — F4
CAUSTIC METERING PUMP 1 LOW DISCHARGE PRESSURE — LOW — 37 — F4
CAUSTIC METERING PUMP 2 LOW DISCHARGE PRESSURE — LOW — 38 — F4
TO LOCAL ALARM PANEL CAUSTIC AREA
SUMP HI LEVEL — TB 26, TB 27 — G-3005-LS2 — 39 — F4
SHOWER/EYE WASH STATION 4 ACTIVATED — TB 28, TB 29 — G-3005-FS6 — 40 — F4

CAUSTIC METERING PUMP PRESSURE RELIEF FLOW DETECT — G-3005-FS5 — 24 VDC + POWER − — +24 V, −24V — TB2 56,57 — F5
FIRE FLOW SWITCH — 58
FIRE PULL BOX — 59
SODIUM HYPO METERING PUMP #6 — AUTO — 60
SPARES — 61,62,63,64,65 — F5

R2 S4 BDEP-218: 1 N1, 2–11, 12 N1, 13–22

SPARES — 66,67,68,69,70,71,72,73 — F5

R2 S5 BDAP-204: 1 F7, 2 N, 3 F6, 4–10, 11 (−), 12–22

N.C.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 1 STARTER — 74,75 — CR1 — F6
N.C.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 2 STARTER — 76,77 — CR2 — F6
⚠3 START/STOP DRY CONTACT NACIO METERING PUMP 6 STARTER — 78,79 — CR3 — F6

REV	DESCRIPTION	DATE
3	AMMONIA FACILITY UPGRADE	6/17/02
2	AS BUILT	7/23/98
1	CAUSTIC AREA MONITORING ADDI	12/5/97
0	RELEASED FOR REVIEW	7/18/97

NPA NIX, PURSER & ASSOC. MATTHEWS, LLC

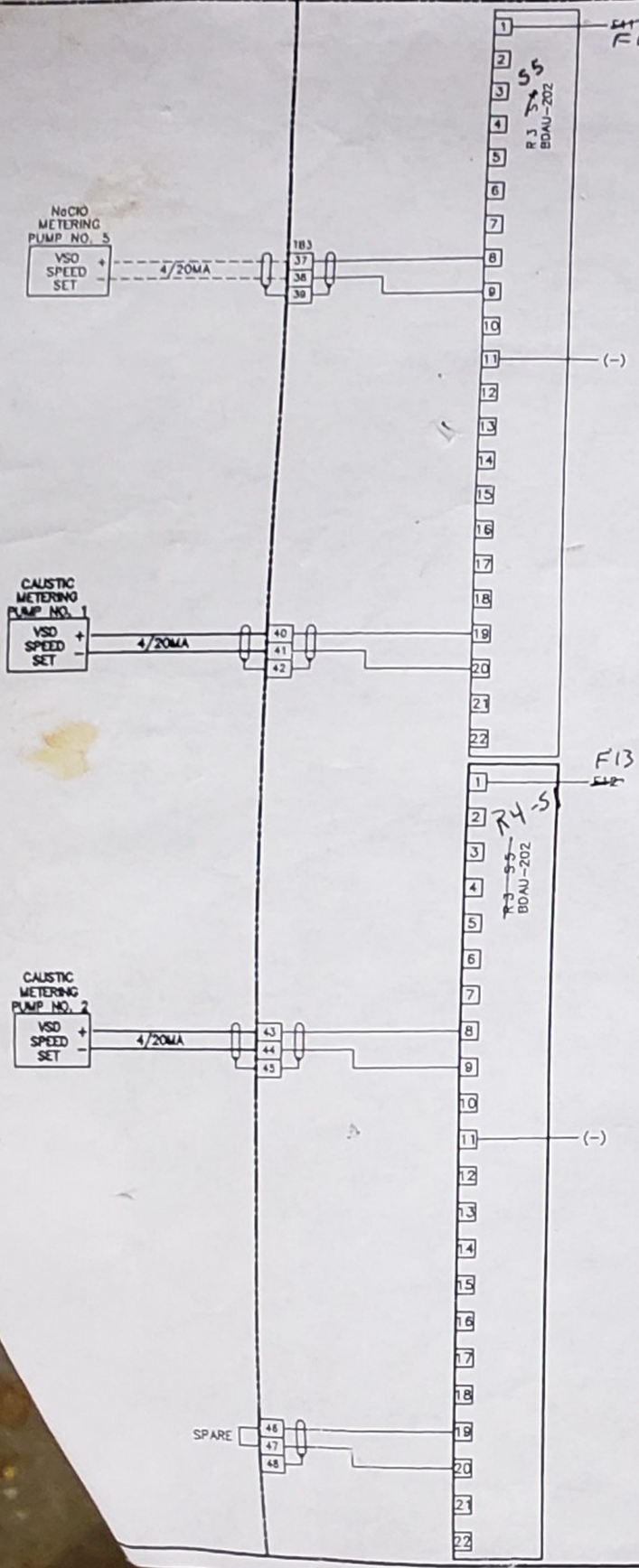
GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA
SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM 3 OF 3

6/16/97 | INSTRUMENTATION AND SCADA UPGRADE | G-3005-21 | 3

PROPOSED

GLENVILLE LAKE PLC1 NaClO, CAUSTIC & AMMONIA FACILITY UPGRADE

FIELD	BEHIND PANEL	FRONT OF PANEL	BEHIND PANEL	FRONT OF PANEL



SEE PWC FOR ELECTRICAL DRAWING OF EXISTING PLC1 AT THE CHEMICAL BUILDING

REV	DESCRIPTION	DATE
2		
1	CAUSTIC AREA MONITORING ADDED	12/9/97
0	RELEASED FOR REVIEW	7/18/97

NPA NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA

SCALE: NONE | DRAWN BY: HRM

SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM 3 OF 3
INSTRUMENTATION AND SCADA UPGRADE

DATE: 6/16/96 | DRAWING NUMBER: GPLC1-E3 | REV: 1

PRELIMINARY

FIELD | BEHIND PANEL | FRONT OF PANEL

RECIRCULATION PUMP NO. 1 — RUN / FAIL
RECIRCULATION PUMP NO. 2 — RUN / FAIL
METERING PUMP NO. 1 FLOCCULATOR-1 — RUN / FAIL
METERING PUMP NO. 2 FLOCCULATOR-2 — RUN / FAIL
METERING PUMP NO. 3 PRE-FILTER — RUN / FAIL
METERING PUMP NO. 4 POST-FILTER — RUN / FAIL
METERING PUMP NO. 5 POST-CLEARWELL — RUN / FAIL
(3) METERING PUMP NO. 6 SODIUM HYPOCHLORITE — RUN / FAIL

TB2 F1 F2

METERING PUMP NO. 1 LOW DISCHARGE PRESSURE — G-3005-PS1
METERING PUMP NO. 2 LOW DISCHARGE PRESSURE — G-3005-PS2
METERING PUMP NO. 3 LOW DISCHARGE PRESSURE — G-3005-PS3
METERING PUMP NO. 4 LOW DISCHARGE PRESSURE — G-3005-PS4
METERING PUMP NO. 5 LOW DISCHARGE PRESSURE — G-3005-PS5
METERING PUMP PRESSURE RELIEF FLOW — G-3005-FS1 (24 VDC + POWER, +24 V, -24V)
FIRE VALVE CLOSED
SUMP HI LEVEL — TB30 / TB31
TO LOCAL ALARM PANEL HYPOCHLORITE
CL2 GAS DETECTED — TB32 / TB33
SHOWER/EYE WASH STATION ACTIVATED — TB34 / TB35
CAUSTIC TRANSFER PUMP — RUN / FAIL
CAUSTIC METERING PUMP 1 LOW DISCHARGE PRESSURE — LOW
CAUSTIC METERING PUMP 2 LOW DISCHARGE PRESSURE — LOW
TO LOCAL ALARM PANEL CAUSTIC AREA
SUMP HI LEVEL — TB 26 / TB 27 — G-3005-LS2
SHOWER/EYE WASH STATION 4 ACTIVATED — TB 28 / TB 29 — G-3005-FS6

F3 F4

R2 S2 BDEP-218
R2 S3 BDEP-218

N1

FIELD | BEHIND PANEL | FRONT OF PANEL

CAUSTIC METERING PUMP PRESSURE RELIEF FLOW DETECT — G-3005-FS5 (24 VDC + POWER, +24 V, -24V)
FIRE FLOW SWITCH
FIRE PULL BOX
SODIUM HYPO METERING PUMP #6 — AUTO
SPARES
SPARES

TB2 F5

R2 S4 BDEP-218

N1

N.O.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 1 STARTER — 13 / 14 — CR1
N.O.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 2 STARTER — 15 / 16 — CR2
(3) START/STOP DRY CONTACT NaClO METERING PUMP 6 STARTER — CR3

N F6 F7

R2 S5 BDAP-204

(-)

REV	DESCRIPTION	DATE
3	AMMONIA FACILITY UPGRADE	6/17/02
2	AS BUILT	7/23/98
1	CAUSTIC AREA MONITORING ADDED	12/5/97
0	RELEASED FOR REVIEW	7/15/97

NPA NIX, PURSER & ASSOCIATES, INC. MATTHEWS, N.C. 28106

GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA

SCALE: NONE | Drawn BY: HRM

SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM 1 OF 3

DATE: 6/16/97 | INSTRUMENTATION AND SCADA UPGRADE | DRAWING NUMBER: GPLC1-E1 | REV: 3

PROPOSED

GLENVILLE LAKE PLC1 NaClO, CAUSTIC & AMMONIA FACILITY UPGRADE

FIELD | BEHIND PANEL | FRONT OF PANEL

TO NaClO LAP TERMINALS
10 11 26 27
HI LO
24 25 21 22
120 VAC
1(+) 2(-)
HI LT1 LO
0-17'
NaClO BULK STORAGE TANK NO. 1 LEVEL
G-3005-LT1
TB3 1 2 3
CABLE 1

TO NaClO LAP TERMINALS
12 13 29 28
HI LO
24 25 21 22
120 VAC
1(+) 2(-)
HI LT2 LO
0-17'
NaClO BULK STORAGE TANK NO. 2 LEVEL
G-3005-LT2
4 5 6
CABLE 2

TO NaClO LAP TERMINALS
10 11 30 31
24 25 21 22
120 VAC
1(+) 2(-)
HI LT3 HI-HI
0-7'
NaClO DAY TANK LEVEL
G-3005-LT3
7 8 9
CABLE 3

TO CAUSTIC LAP TERMINALS
10 11 22 23
24 25 21 22
120 VAC
1(+) 2(-)
HI LT4 HI-HI
0-13'
CAUSTIC BULK STORAGE TANK 1 LEVEL
G-3005-LT4
10 11 12
CABLE 4

TO CAUSTIC LAP TERMINALS
12 13 24 25
24 25 21 22
120 VAC
1(+) 2(-)
HI LT5 HI-HI
0-13'
CAUSTIC BULK STORAGE TANK 2 LEVEL
G-3005-LT5
TB3 13 14 15
CABLE 5

TO CAUSTIC LAP TERMINALS
14 15 16 17
24 25 21 22
120 VAC
1(+) 2(-)
HI LT6 HI-HI
0-5'
CAUSTIC DAY TANK LEVEL
G-3005-LT6
16 17 18
CABLE 6

SPARES
19 20 21
CABLE 7
22 23 24
CABLE 8

BADU-206 R3 S1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
F8 — 24VDC +
(-)

BADU-206 R3 S2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
F9 24VDC +
(-)

FIELD | BEHIND PANEL | FRONT OF PANEL

NaClO METERING PUMP NO. 1
VSD SPEED SET + -
4/20MA
CABLE #1
TB3 25 26 27
CABLE 9

NaClO METERING PUMP NO. 2
VSD SPEED SET + -
4/20MA
CABLE 2
28 29 30
CABLE 10

NaClO METERING PUMP NO. 3
VSD SPEED SET + -
4/20MA
CABLE 3
31 32 33
CABLE 11

NaClO METERING PUMP NO. 4
VSD SPEED SET + -
4/20MA
CABLE 4
34 35 36
CABLE 12

BDAU-202 R3 S3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
F10 24VDC +
(-)

BDAU-202 R3 S4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
F11 — 24VDC +

SEE PWC FOR ELECTRICAL DRAWING OF EXISTING PLC1 AT THE CHEMICAL BUILDING

REV	DESCRIPTION	DATE
2		
1	CAUSTIC AREA MONITORING ADDED	12/9/97
0	RELEASED FOR REVIEW	7/18/97

NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA

SCALE: NONE | DRAWN BY: HRM

SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM 2 OF 3

DATE: 6/16/96 | INSTRUMENTATION AND SCADA UPGRADE | DRAWING NUMBER: GPLC1-E2 | REV: 1

GLENVILLE LAKE PLC1 NaClO & CAUSTIC UPGRADE

PRELIMINARY

ANALOG INPUTS

MODICON
BMX AMI 0410
RACK 2
SLOT 1
4-CH ANALOG INPUT
PLC1

CAUSTIC BULK TANK 2 LEVEL — SHLD — IU0 — 4
COM0 — 6
II0 — 5

CAUSTIC BULK DAY TANK LEVEL — SHLD — UI1 — 8
COM1 — 10
II1 — 9

FERRIC PUMP 2 SPEED FEEDBACK — SHLD — UI2 — 15
COM2 — 17
II2 — 16

FERRIC PUMP 3 SPEED FEEDBACK — SHLD — UI3 — 19
COM3 — 21
II3 — 20

ANALOG OUTPUTS

MODICON
BMX AMO 0210
RACK 2
SLOT 2
2-CH ANALOG OUTPUT
PLC1

HYPO PUMP 1 SPEED OUTPUT — SHLD — U/I 0 — 3
COM 0 — 4

HYPO PUMP 2 SPEED OUTPUT — SHLD — U/I 1 — 17
COM 1 — 18

MODICON
BMX AMO 0210
RACK 2
SLOT 3
2-CH ANALOG OUTPUT
PLC1

F11 — PWR — 1, 8
HYPO PUMP 3 SPEED OUTPUT — SHLD — 9
-24V COMO 103 — 9
-24V — C — 11
HYPO PUMP 4 SPEED OUTPUT — SHLD — 19
COM 1 — 20

MODICON
BMX AMO 0210
RACK 2
SLOT 4
2-CH ANALOG OUTPUT
PLC1

F12 — PWR — 1, 8
HYPO PUMP 5 SPEED OUTPUT — 13 — SHLD — 9
-24V COMO 103 — 9
-24V — C — 11
CAUSTIC PUMP 1 SPEED OUTPUT — 14 — SHLD — 19
COM 1 — 20

MODICON
BMX AMO 0210
RACK 2
SLOT 5
2-CH ANALOG OUTPUT
PLC1

F13 — PWR — 1, 8
CAUSTIC PUMP 2 SPEED OUTPUT — 15 — SHLD — 9
-24V COMO 103 — 9
-24V — C — 11
HYPO PUMP 6 SPEED OUTPUT — 16 — SHLD — 19
COM 1 — 20

ANALOG INPUTS

MODICON
BMX AMI 0810
RACK 2
SLOT 6
8-PT ANALOG INPUT
PLC1

FERRIC BULK TANK 1 LEVEL — SHLD — RED — II0 — 1
COM0 — 2

FERRIC BULK TANK 2 LEVEL — SHLD — RED — VI0 — 3
VI1 — 4
COM1 — 5
II1 — 6

CAUSTIC BULK TANK LEVEL — SHLD — RED — II2 — 7
COM2 — 8

SPARE INPUT — SHLD — RED — VI2 — 9
VI3 — 10
COM3 — 11
II3 — 12
13
14

SPARE INPUT — SHLD — RED — II4 — 15
COM4 — 16
17

SPARE INPUT — SHLD — RED — VI4 — 18
VI5 — 19
COM5 — 20
II5 — 21

SPARE INPUT — SHLD — RED — II6 — 22
COM6 — 23

SPARE INPUT — SHLD — RED — VI6 — 24
VI7 — 5
COM7 — 26
II7 — 27
28

NO.	DATE	REVISION	BY
1	5/12/13	FOR REVIEW	KRM
2	6/6/13	AS BUILT	CJF
3	3/15/17	MODIFIED FOR AEG STYLE TB	KRM

5 OF 5

ENGINEER	JDC	CHECKED BY	RJS
JOB NO		DRAWN BY	KRM
SCALE		DATE	8/12/2013

NCCUN
CUSTOM CONTROLS UNLIMITED INC
152 ANNARON CT
RALEIGH NC 27603
PHONE: 919-661-5556
FAX: 919-661-5557

PWC_CHEM_PLC
POWER, PLC AND FIELD WIRING
SCADA PANEL
FAYETTVILLE, NC

DIGITAL INPUTS 2 / DIGITAL OUTPUTS

BMX DDM 16025
RACK 1
SLOT 10
8-PT INPUT, 8-PT OUTPUT DISCRETE

+24V
104
DC INPUTS

SPARE INPUT DI1 — FU1 — TB2 — 2.0 — TB2 — I0 — 01
SPARE INPUT DI2 — FU1 — TB2 — 2.1 — TB2 — I1 — 02
SPARE INPUT DI3 — FU1 — TB2 — 2.1 — TB2 — I2 — 03
SPARE INPUT DI4 — FU1 — TB2 — 2.1 — TB2 — I3 — 04
SPARE INPUT DI5 — FU1 — TB2 — 2.1 — TB2 — I4 — 05
SPARE INPUT DI6 — FU1 — TB2 — 2.1 — TB2 — I5 — 06
SPARE INPUT DI7 — FU1 — TB2 — 2.1 — TB2 — I6 — 07
SPARE INPUT DI8 — FU1 — TB2 — 2.1 — TB2 — I7 — 08

09 — 0VDC
10 — +24VDC

-24V
210
-24VDC
-24V

N
120N

82 — CR5 — 83 — TB1 — TB1 — FERRIC 1 START COMMAND
84 — CR6 — 85 — TB1 — TB1 — FERRIC 2 START COMMAND
86 — CR7 — 87 — TB1 — TB1 — FERRIC 3 START COMMAND

F6
213
120V

11 — DO.0 — CR5 — A1 A2 — FERRIC 1 START COMMAND — NO 411 NC
12 — DO.1 — CR6 — A1 A2 — FERRIC 2 START COMMAND — NO 412 NC
13 — DO.2 — CR7 — A1 A2 — FERRIC 3 START COMMAND — NO 413 NC
14 — DO.3 — CR8 — A1 A2 — SPARE — NO 355 NC
15 — DO.4 — CR9 — A1 A2 — SPARE — NO 356 NC
16 — DO.5 — CR10 — A1 A2 — SPARE — NO 357 NC
17 — DO.6 — CR11 — A1 A2 — SPARE — NO 358 NC
18 — DO.7 — CR12 — A1 A2 — SPARE — NO 359 NC
-24V

19 — Pwr
20 — Pwr

DISCRETE OUTPUTS

MODICON
BMX DRA 0805
RACK 1
SLOT 11
8-PT RELAY OUTPUT
PLC421

C0 — 01 — 02 — Q0
C1 — 03 — 04 — Q1
C2 — 05 — 06 — Q2
C3 — 07 — 08 — Q3
C4 — 09 — 10 — Q4
C5 — 11 — 12 — Q5
C6 — 13 — 14 — Q6
C7 — 15 — 16 — Q7

XBE 1000 BACKPLANE EXTENDER RACK 1 / XTEND SLOT

A

XBE 1000 BACKPLANE EXTENDER RACK 2 / XTEND SLOT

B

ANALOG INPUTS

MODICON
BMX AMI 0410
RACK 2
SLOT 0
4-CH ANALOG INPUT
PLC1

SODIUM HYPO BULK TANK 1 LEVEL — SHLD — IU0 — 4 — COM0 — 6 — II0 — 5
SODIUM HYPO BULK TANK 2 LEVEL — SHLD — IU1 — 8 — COM1 — 10 — II1 — 9
SODIUM HYPO DAY TANK LEVEL — SHLD — IU2 — 15 — COM2 — 17 — II2 — 16
CAUSTIC BULK TANK 1 LEVEL — SHLD — IU3 — 19 — COM3 — 21 — II3 — 20

NO.	DATE	REVISION	BY
1	5/12/13	FOR REVIEW	KRM
2	6/5/13	AS BUILT	CJF
3	3/15/17	MODIFIED FOR AEG STYLE TB	KRM

4 OF 5

ENGINEER	JDC	CHECKED BY	RJS
JOB NO		DRAWN BY	KRM
SCALE		DATE	8/12/2013

AEGUN
CUSTOM CONTROLS UNLIMITED INC
152 ANNARON CT
RALEIGH NC 27603
PHONE: 919-661-5556
FAX: 919-661-5557

PWC_CHEM_PLC
POWER, PLC AND FIELD WIRING
SCADA PANEL
FAYETTVILLE, NC

DISCRETE INPUTS

MODICON RACK 1 SLOT 8 BMX DAI 1604 16-PT DISCRETE INPUT PLC1

300 F3 120V
301 HYPO METERING 1 DISCHARGE PRESSURE DRY CONTACT 2-25 I1 — 01
302 F3 TB1 — RED_18AWG
HYPO METERING 2 DISCHARGE PRESSURE DRY CONTACT 2-27 I2 — 02
303 HYPO METERING 3 DISCHARGE PRESSURE DRY CONTACT 2-29 I3 — 03
304 HYPO METERING 4 DISCHARGE PRESSURE DRY CONTACT 2-31 I4 — 04
305 HYPO METERING 5 DISCHARGE PRESSURE DRY CONTACT 2-33 I5 — 05
306 F3 TB1
HYPO METERING PRESSURE RELIEF DRY CONTACT 2-35 I6 — 06
307 FIRE VALVE ALARM DRY CONTACT 2-37 I7 — 07
308 SODIUM HYPO SUMP LEVEL DRY CONTACT 2-39 I8 — 08
309 09
310 F4 120V — 10
311 SODIUM HYPO CL2 GAS ALARM DRY CONTACT 2-41 I9 — 11
312 F4 TB1
SODIUM HYPO ROOM SHOWER/EYEWASH DRY CONTACT 2-43 I10 — 12
313 CAUSTIC P1 TRANSFER PUMP STATUS DRY CONTACT 2-45 I11 — 13
314 CAUSTIC P1 TRANSFER PUMP ALARM DRY CONTACT 2-47 I12 — 14
315 CAUSTIC METER 1 DISCHARGE PRESSURE DRY CONTACT 2-48 I13 — 15
316 F4 TB1
CAUSTIC METER 2 DISCHARGE PRESSURE DRY CONTACT 2-50 I14 — 16
317 CAUSTIC ROOM SUMP LEVEL DRY CONTACT 2-52 I15 — 17
318 CAUSTIC ROOM SHOWER/ EYEWASH ALARM DRY CONTACT 2-54 I16 — 18
319 F5 120V — 19
20
21
22 COM

N — 120N — WHT_18AWG

DISCRETE INPUTS

MODICON RACK 1 SLOT 9 BMX DAI 1604 16-PT DISCRETE INPUT PLC1

320 F5 120V
321 SPARE DRY CONTACT 2-56 I1 — 01
322 F5 TB1 — RED_18AWG
FIRE FLOW SWITCH DRY CONTACT 2-58 I2 — 02
323 SPARE DRY CONTACT 2-60 I3 — 03
324 SODIUM HYPO 6 AUTO/MAN DRY CONTACT 2-61 I4 — 04
325 CAUSTIC 1 ALARM DRY CONTACT 2-62 I5 — 05
326 F5 TB1
CAUSTIC 2 ALARM DRY CONTACT 2-63 I6 — 06
327 CAUSTIC 3 ALARM DRY CONTACT 2-64 I7 — 07
328 FERRIC 1 ALARM DRY CONTACT 2-65 I8 — 08
329 09
330 10
331 FERRIC 2 ALARM DRY CONTACT 2-66 I9 — 11
332 F5 TB1
FERRIC 3 ALARM DRY CONTACT 2-67 I10 — 12
333 CAUSTIC TRANSFER PUMP 3 STATUS DRY CONTACT 2-68 I11 — 13
334 CAUSTIC TRANSFER PUMP 3 ALARM DRY CONTACT 2-69 I12 — 14
335 CAUSTIC TRANSFER PUMP 4 STATUS DRY CONTACT 2-70 I13 — 15
336 F5 TB1
CAUSTIC TRANSFER PUMP 4 ALARM DRY CONTACT 2-71 I14 — 16
337 CAUSTIC TRANSFER PUMP 2 STATUS DRY CONTACT 2-72 I15 — 17
338 CAUSTIC TRANSFER PUMP 2 ALARM DRY CONTACT 2-73 I16 — 18
339 19
20
21
22 COM

N — 120N — WHT_18AWG

DISCRETE OUTPUTS

BMX DRA 0805 RACK 1 SLOT 9 8 PT RELAY OUTPUT

340 F7 120V
341 PWR — 01
F6 102 DI
342 COM — 02
03
343 COM — 04
344 01 — 05
CR1 TB1 — CR1 TB1 — CAUSTIC PUMP 1 START COMMAND
74 CR1 75 NO 344 TB1 TB1 341 CAUSTIC PUMP 1 START COMMAND
345 01 — 06
346 COM — 07
347 COM — 08
348 02 — 09
CR2 TB1 — CR2 TB1 — CAUSTIC PUMP 2 START COMMAND
76 CR2 77 NO 346 TB1 TB1 345 CAUSTIC PUMP 2 START COMMAND
349 02 — 10
-24V — -24V
350 C — 11
351 12
352 13
353 COM — 14
354 COM — 15
355 03 — 16
17 CR3 TB1 — CR3 TB1 — HYPO PUMP 6 START COMMAND
78 CR3 79 NO 348 TB1 TB1 347 HYPO PUMP 6 START COMMAND
356 03 — 17
357 COM — 18
358 COM — 19
359 04 — 20
18 CR4 TB1 — CR4 TB1 — CAUSTIC PUMP 3 START COMMAND
80 CR4 81 NO 350 TB1 TB1 349 CAUSTIC PUMP 3 START COMMAND
04 — 21

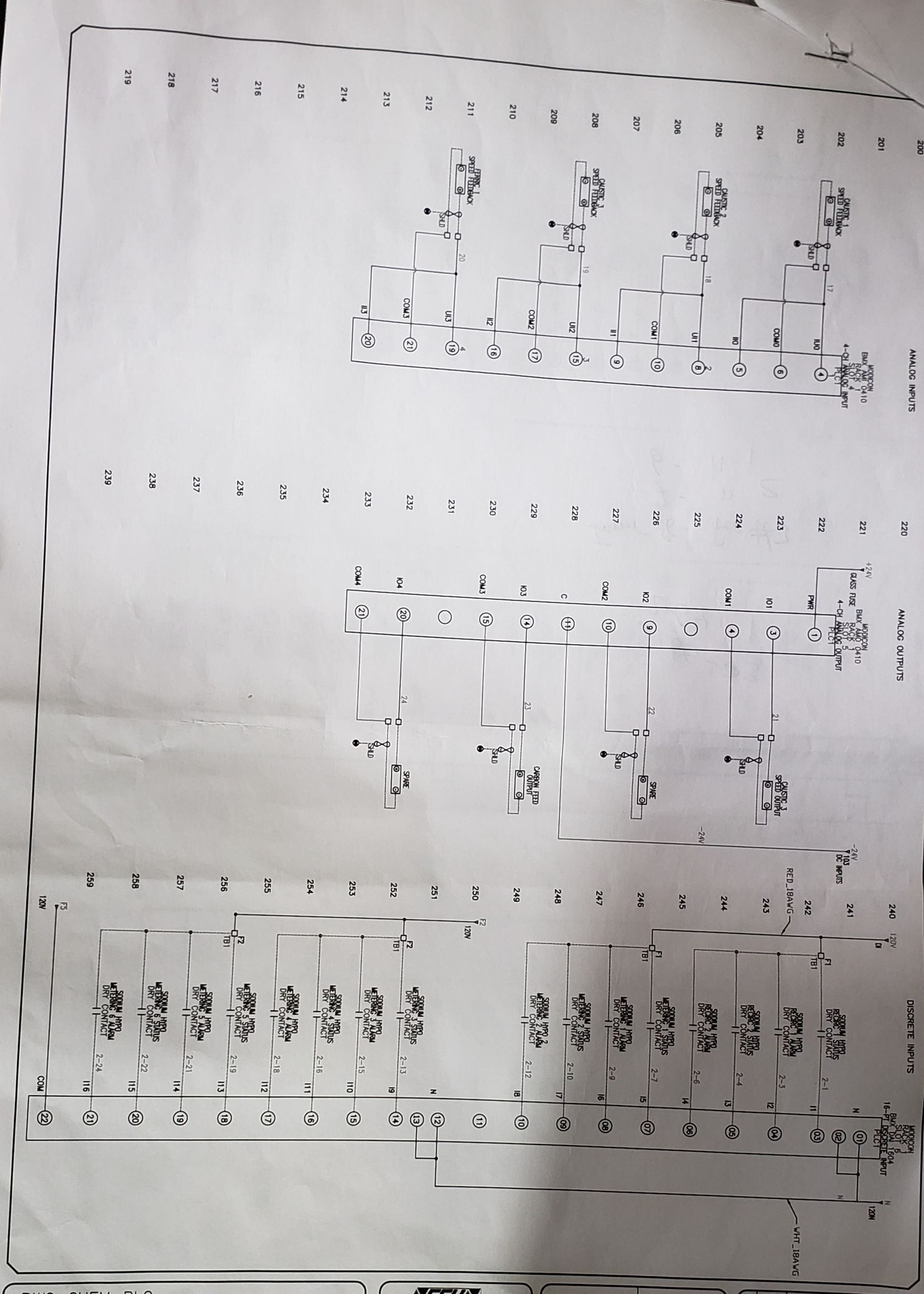
NO.	DATE	REVISION	BY
1	5/12/13	FOR REVIEW	KRM
2	8/5/13	AS BUILT	CJF
3	5/15/17	MODIFIED FOR AEG STYLE TB	KRM

3 OF 5

ENGINEER	JDC	CHECKED BY	RJS
JOB NO		DRAWN BY	KRM
SCALE		DATE	8/12/2013

CUSTOM CONTROLS UNLIMITED INC
152 ANNARON CT
RALEIGH NC 27603
PHONE: 919-661-5556
FAX: 919-661-5557

PWC_CHEM_PLC
POWER, PLC AND FIELD WIRING
SCADA PANEL
FAYETTVILLE, NC



PWC_CHEM_PLC
POWER, PLC AND FIELD WIRING
SCADA PANEL
FAYETTVILLE, NC

CCUN
CUSTOM CONTROLS UNLIMITED INC
152 ANNARON CT
RALEIGH NC 27603

PHONE: 919-661-5556
FAX: 919-661-5557

ENGINEER JDC	CHECKED BY RJS
JOB NO	DRAWN BY KRM
SCALE	DATE 8/12/2013

NO.	DATE	REVISION	BY
1	5/12/13	FOR REVIEW	KRM
2	8/5/13	AS BUILT	KRM
3	3/18/17	MODIFIED FOR AEG STYLE TB	KRM

DISCONNECT BY OTHERS
120VAC 1Ph 60Hz #14AWG CU 90°C
PANEL FLA = 3A
SCCR = NOT PROVIDED

POWER WIRING

MODICON
M340
RACK 1
POWER SUPPLY
PLC POWER
CPS2000

+24V → 24V → +24V DC INPUTS
-24V → -24V → -24V DC INPUTS
GND → GND → GND
GRN_14AWG
N → 120N → N
WHT_14AWG
FU21 → PLC → FU21 L
RED_14AWG

TCSEGDB23F24FA
MODBUS PLUS PROXY SWITCH
MODBUS PLUS ADDRESS 4

BMX P34 2020
RACK 1
SLOT 0
PROCESSOR

PLC1

192.168.1.2
255.255.255.0
0.0.0.0

192.168.1.1
255.255.255.0
0.0.0.0

CISCO
CATALYST 3560-C
MANAGED SWITCH

PORT 8 ONLY

BMX NOE 0100
RACK 1
SLOT 1
ETHERNET NETWORK MODULES

PLC1

10.36.10.23
255.255.0.0
10.36.100.1

MODICON
RACK 1
SLOT 2
BMX DAI 1604
16-PT DISCRETE INPUT
PLC1

F5 102 DI
N 109 120N

F5 TB1

CARBON ROOM FLOOD ALARM DRY CONTACT 1 → I1 (03)
FREEIC 1 RUN DRY CONTACT 2 → I3 (05)
FERRIC 1 PULSE DRY CONTACT 3 → I5 (07)
FERRIC 2 RUN DRY CONTACT 4 → I7 (09)
FERRIC 2 PULSE DRY CONTACT 5 → I9 (14)
FERRIC 3 RUN DRY CONTACT 6 → I11 (16)
FERRIC 3 PULSE DRY CONTACT 7 → I13 (18)
SPARE DRY CONTACT 8 → I15 (20)

RED_18AWG
WHT_18AWG
N → 01, 02, 12, 13
I2 (04), I4 (06), I6 (08), I8 (10), I10 (15), I12 (17), I14 (19), I16 (21)
COM (22)

MODICON
RACK 1
SLOT 3
BMX DAI 1604
16-PT DISCRETE INPUT
PLC1

F5 102 DI
N 109 120N

F5 TB1

SPARE DRY CONTACT 9 → I1 (03)
SPARE DRY CONTACT 10 → I3 (05)
SPARE DRY CONTACT 11 → I5 (07)
SPARE DRY CONTACT 12 → I7 (09)
SPARE DRY CONTACT 13 → I9 (14)
SPARE DRY CONTACT 14 → I11 (16)
SPARE DRY CONTACT 15 → I13 (18)
SPARE DRY CONTACT 16 → I15 (20)

RED_18AWG
WHT_18AWG
N → 01, 02, 12, 13
I2 (04), I4 (06), I6 (08), I8 (10), I10 (15), I12 (17), I14 (19), I16 (21)
COM (22)

NO.	DATE	REVISION	BY
1	5/12/13	FOR REVIEW	KRM
2	8/5/13	AS BUILT	CLF
3	3/16/17	MODIFIED FOR A&B STYLE TB	KRM

1 OF 5

ENGINEER	JDC	CHECKED BY	RJS
JOB NO		DRAWN BY	KRM
SCALE		DATE	8/12/2013

VCCUN
CUSTOM CONTROLS UNLIMITED INC
152 ANNARON CT
RALEIGH NC 27603
PHONE: 919-661-5556
FAX: 919-661-5557

PWC_CHEM_PLC
POWER, PLC AND FIELD WIRING
SCADA PANEL
FAYETTVILLE, NC

FIELD

BEHIND PANEL

FRONT OF PANEL

RECIRCULATION PUMP NO. 1 — RUN / FAIL — TB2 1, 2, 3 — F1
RECIRCULATION PUMP NO. 2 — RUN / FAIL — TB2 4, 5, 6 — F1
METERING PUMP NO. 1 FLOCCULATOR-1 — RUN / FAIL — TB2 7, 8, 9 — F1
METERING PUMP NO. 2 FLOCCULATOR-2 — RUN / FAIL — TB2 10, 11, 12 — F1
R2 BDEP-218 — 1 N1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 N1, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
S2

METERING PUMP NO. 3 PRE-FILTER — RUN / FAIL — 13, 14, 15 — F2
METERING PUMP NO. 4 POST-FILTER — RUN / FAIL — 16, 17, 18 — F2
METERING PUMP NO. 5 POST-CLEARWELL — RUN / FAIL — 19, 20, 21 — F2
SPARE — 22, 23, 24 — F2

METERING PUMP NO. 1 LOW DISCHARGE PRESSURE — G-3005-PS1 — 25 — F3
METERING PUMP NO. 2 LOW DISCHARGE PRESSURE — G-3005-PS2 — 27 — F3
METERING PUMP NO. 3 LOW DISCHARGE PRESSURE — G-3005-PS3 — 29 — F3
METERING PUMP NO. 4 LOW DISCHARGE PRESSURE — G-3005-PS4 — 31 — F3
METERING PUMP NO. 5 LOW DISCHARGE PRESSURE — G-3005-PS5 — 33 — F3
METERING PUMP PRESSURE RELIEF FLOW — G-3005-FS1 — 24 VDC POWER +24 V, -24V — 35, 36 — F3
FIRE ALARM — 37, 38 — F3
SUMP HI LEVEL — TB30, TB31 — 39, 40 — F3
R2 BDEP-218 — 1 N1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 N1, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
S3

TO LOCAL ALARM PANEL HYPOCHLORITE
CL2 GAS DETECTED — TB32, TB33 — 41, 42 — F4
SHOWER/EYE WASH STATION ACTIVATED — TB34, TB35 — 43, 44 — F4
CAUSTIC TRANSFER PUMP — RUN / FAIL — 45, 46, 47 — F4
CAUSTIC METERING PUMP 1 LOW DISCHARGE PRESSURE — LOW — 48, 49 — F4
CAUSTIC METERING PUMP 2 LOW DISCHARGE PRESSURE — LOW — 50, 51 — F4
TO LOCAL ALARM PANEL CAUSTIC AREA
SUMP HI LEVEL — TB 26, TB 27 — G-3005-LS2 — 52, 53 — F4
SHOWER/EYE WASH STATION ACTIVATED — TB 28, TB 29 — G-3005-FS8 — 54, 55 — F4

Valve closed

FIELD

BEHIND PANEL

FRONT OF PANEL

CAUSTIC METERING PUMP PRESSURE RELIEF FLOW DETECT — G-3005-FS5 — 24 VDC POWER +24 V, -24V — TB2 56, 57 — F5
Fire flow switch
SPARES — 58, 59, 60, 61, 62, 63, 64, 65 — F5
SPARES — 66, 67, 68, 69, 70, 71, 72, 73 — F5
R2 BDEP-218 — 1 N1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 N1, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
S4

.125A — +24V — F7 24VDC PS-2

N — F8

N.C.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 1 STARTER — 74, 75 — CR1
N.C.(STOP) DRY CONTACT TO CAUSTIC METERING PUMP 2 STARTER — 76, 77 — CR2
R2 BDAP-204 — 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 (-), 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22
S5

REV	DESCRIPTION	DATE
1	CAUSTIC AREA MONITORING ADD.	12/5/97
0	RELEASED FOR REVIEW	7/18/97

NIX, PURSER & ASSOC.
MATTHEWS, N.C.

GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA
SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM

DRAWN BY HRM
DATE 5/16/97
INSTRUMENTATION AND SCADA UPGRADE
DRAWING E1
REV 1

GLENVILLE LAKE PLC1 NaClO & CAUSTIC UPGRADE

FIELD | BEHIND PANEL | FRONT OF PANEL | FIELD | BEHIND PANEL | FRONT OF PANEL

NaClO METERING PUMP NO. 5
VSD SPEED SET + −
4/20MA
TBJ 37 38 39
R3 S5 BDAU-202
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
F12 24VDC PS-2
(−)

CAUSTIC METERING PUMP NO. 1
VSD SPEED SET + −
4/20MA
40 41 42

CAUSTIC METERING PUMP NO. 2
VSD SPEED SET + −
4/20MA
43 44 45

SPARE
46 47 48

F13 24VDC PS-2
R4-S1
R3-S5-BDAU-202
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
(−)

SEE PWC FOR ELECTRICAL / [illegible]ISTING PLC1 AT THE CHEMICAL BU[illegible]

REV	DESCRIPTION	DATE
2		
1	CAUSTIC AREA MONITORING ADDED	11/19/97
0	RELEASED FOR REVIEW	6/16/97

NPA NIX, PURSER & ASSOCIATES, INC. MATTHEWS, N.C. 28106

GLENVILLE LAKE WT FACILITY
FAYETTEVILLE, NORTH CAROLINA
SODIUM HYPOCHLORITE DISINFECTION SYSTEM
NaClO BLDG. WIRING DIAGRAM 3 OF 3

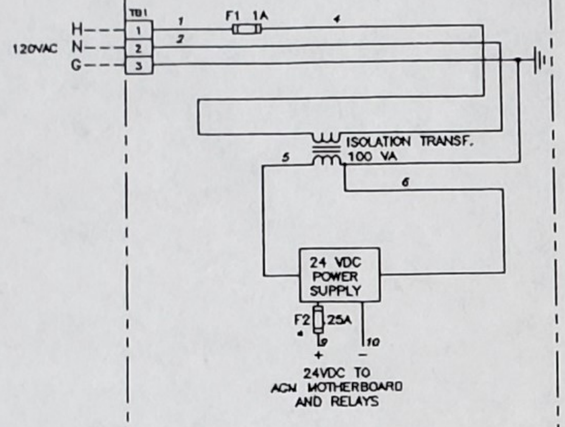
DATE		SCALE	CHK'D BY
5/16/96	INSTRUMENTATION AND SCADA UPGRADE	NONE	TRM
	DRAWING NUMBER: GPLC1-E3		REV: 1

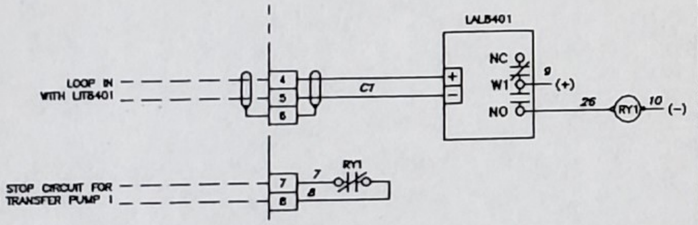
GLENVILLE LAKE PLC1 NaClO & CAUSTIC UPGRADE

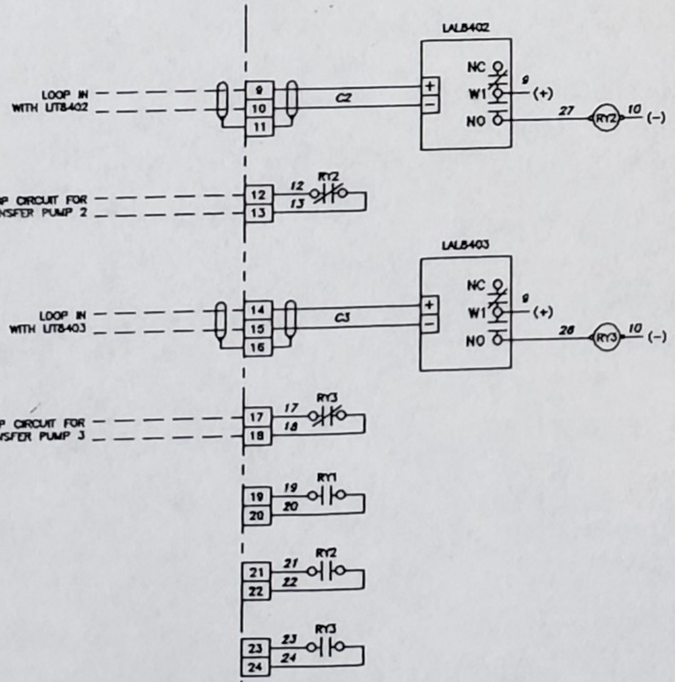
PRELIMENARY

FIELD | BACKPLATE | PANEL FRONT

ALUM TANKS

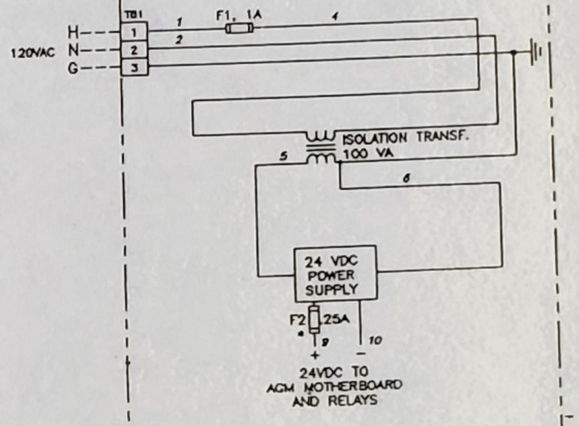


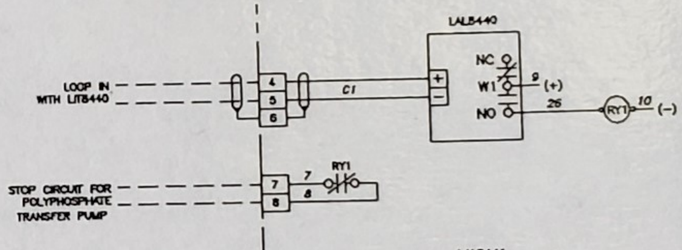


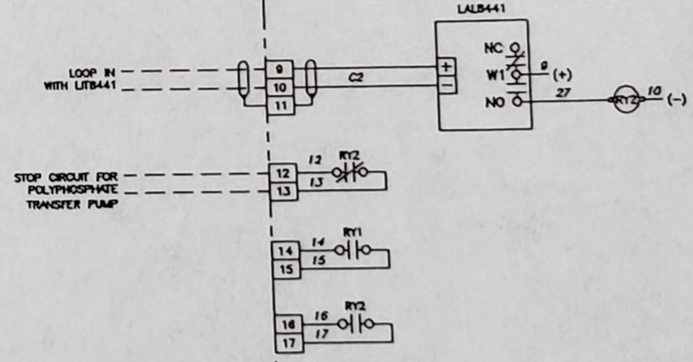


FIELD | BACKPLATE | PANEL FRONT

POLYPHOSPHATE TANKS







• NOTE: F2 LOCATED ON AGM MOTHERBOARD

NPA NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION CITY OF FAYETTVILLE, NC	SCALE: NONE	DRAWN BY: HRW
ALUM & POLYPHOSPHATE BULK STORAGE TANKS TRANSFER PUMPS LOW LEVEL SHUTOFF		
DATE: 4/25/94	ELECTRICAL DIAGRAMS	DRAWING NUMBER: LOCUTOFF	REV: 1

AS BUILT

File name: H:\ACAD\GLEN\LOCUTOFF.DWG Last edited: 94/05/16 @ 09:11

APPENDIX 3

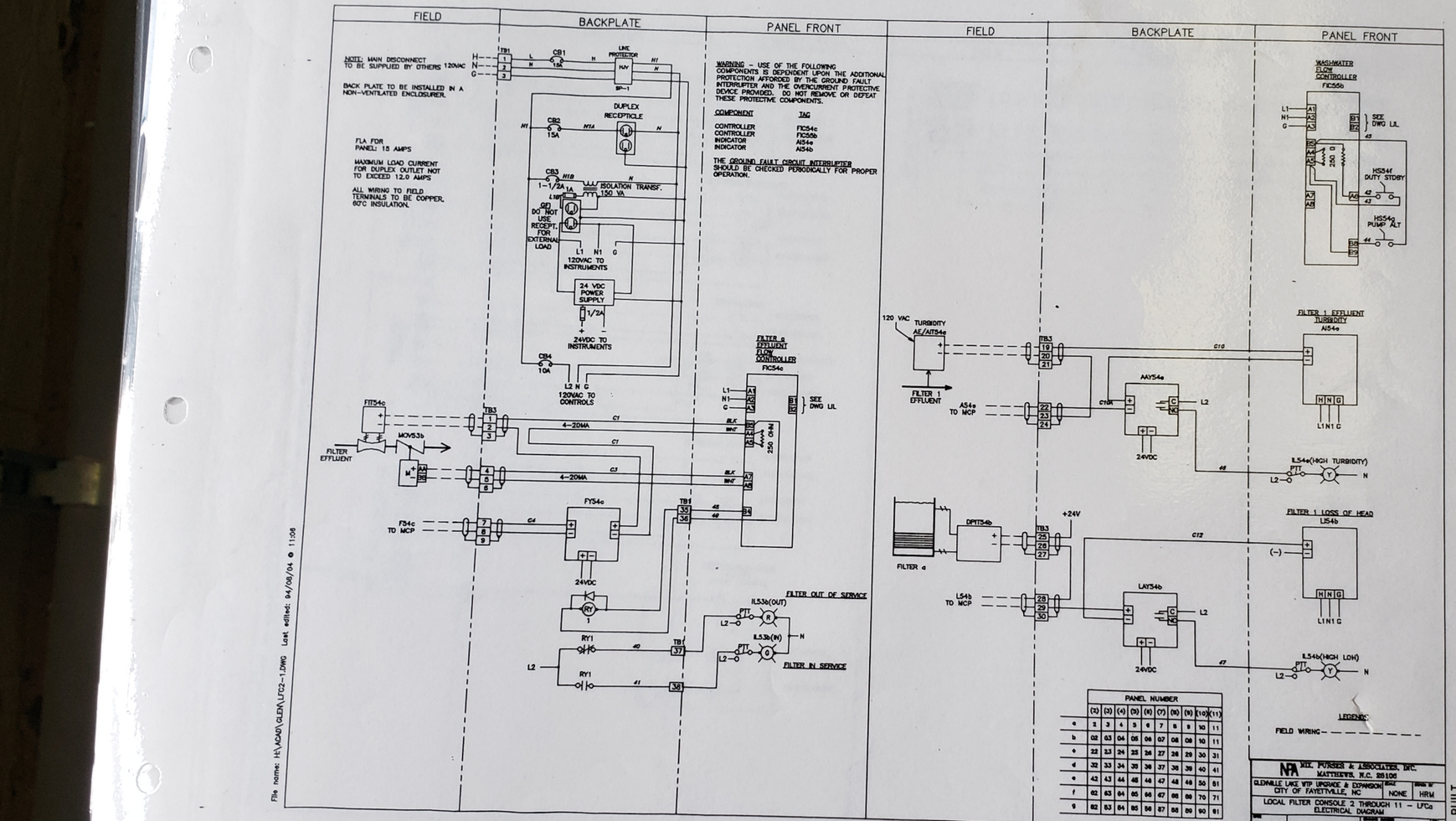
DWGS Filter 2 to 11

DWGS Filter 12

DWGS Filter Console 1 ZAS

DWGS Filter Console 1

DWGS Filter FIC Connection


FIELD
BACKPLATE
PANEL FRONT
FIELD
BACKPLATE
PANEL FRONT
NOTE: MAIN DISCONNECT TO BE SUPPLIED BY OTHERS 120VAC
BACK PLATE TO BE INSTALLED IN A NON-VENTILATED ENCLOSURE.
FLA FOR PANEL: 15 AMPS
MAXIMUM LOAD CURRENT FOR DUPLEX OUTLET NOT TO EXCEED 12.0 AMPS
ALL WIRING TO FIELD TERMINALS TO BE COPPER, 60°C INSULATION.
WARNING - USE OF THE FOLLOWING COMPONENTS IS DEPENDENT UPON THE ADDITIONAL PROTECTION AFFORDED BY THE GROUND FAULT INTERRUPTER AND THE OVERCURRENT PROTECTIVE DEVICE PROVIDED. DO NOT REMOVE OR DEFEAT THESE PROTECTIVE COMPONENTS.
COMPONENT TAG
CONTROLLER FIC54c
CONTROLLER FIC55b
INDICATOR AI54e
INDICATOR AI54b
THE GROUND FAULT CIRCUIT INTERRUPTER SHOULD BE CHECKED PERIODICALLY FOR PROPER OPERATION.
TB1
CB1 15A
LINE PROTECTOR
DUPLEX RECEPTICLE
CB2 15A
CB3 1-1/2A
ISOLATION TRANSF. 150 VA
GFI DO NOT USE RECEPT. FOR EXTERNAL LOAD
120VAC TO INSTRUMENTS
24 VDC POWER SUPPLY
1/2A
24VDC TO INSTRUMENTS
CB4 10A
120VAC TO CONTROLS
FILTER a EFFLUENT FLOW CONTROLLER FIC54c
SEE DWG LIL
FIT54c
FILTER EFFLUENT
MOV53b
4-20MA
250 OHM
FY54c
FJ4c TO MCP
24VDC
FILTER OUT OF SERVICE
IL53b(OUT)
IL53b(IN)
FILTER IN SERVICE
RY1
WASHWATER FLOW CONTROLLER FIC55b
HS54f DUTY STDBY
HS54g PUMP ALT
120 VAC
TURBIDITY AE/AIT54e
FILTER 1 EFFLUENT
AS4e TO MCP
AAY54e
FILTER 1 EFFLUENT TURBIDITY AI54e
IL54e(HIGH TURBIDITY)
DPIT54b
FILTER a
+24V
LAY54b
L54b TO MCP
FILTER 1 LOSS OF HEAD LI54b
IL54b(HIGH LOH)
PANEL NUMBER
LEGEND:
FIELD WIRING
NPA
WM. PURNELL & ASSOCIATES, INC.
MATTHEWS, N.C. 28105
GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC
NONE
HRW
LOCAL FILTER CONSOLE 2 THROUGH 11 - LFC2
ELECTRICAL DIAGRAM
1/26/93
LFC2-1
2
AS BUILT
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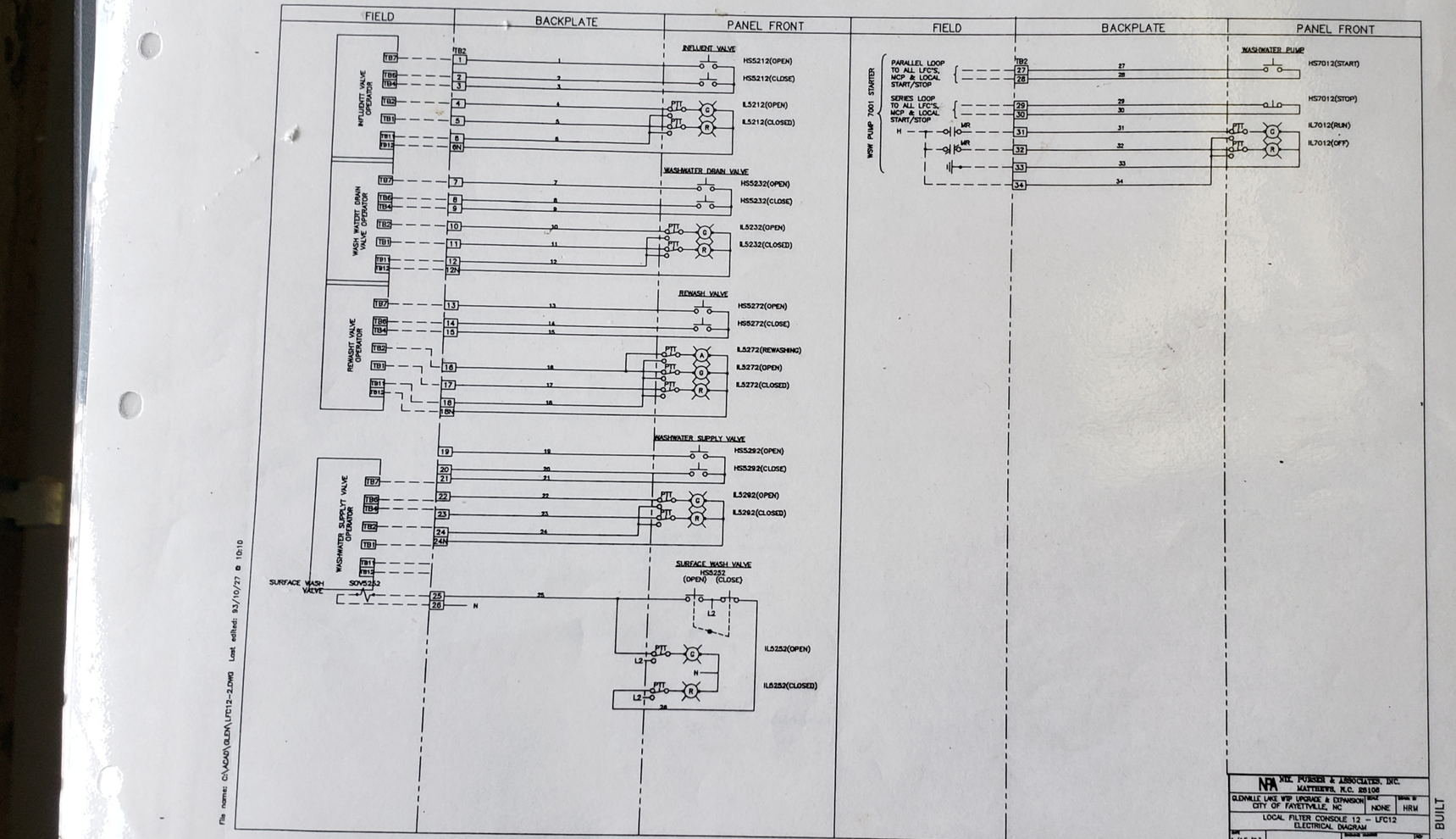
FIELD
BACKPLATE
PANEL FRONT
INFLUENT VALVE
INFLUENT VALVE OPERATOR
HS5212(OPEN)
HS5212(CLOSE)
IL5212(OPEN)
IL5212(CLOSED)
WASHWATER DRAIN VALVE
WASH WATER DRAIN VALVE OPERATOR
HS5232(OPEN)
HS5232(CLOSE)
IL5232(OPEN)
IL5232(CLOSED)
REWASH VALVE
REWASH VALVE OPERATOR
HS5272(OPEN)
HS5272(CLOSE)
IL5272(REWASHING)
IL5272(OPEN)
IL5272(CLOSED)
WASHWATER SUPPLY VALVE
WASHWATER SUPPLY VALVE OPERATOR
HS5292(OPEN)
HS5292(CLOSE)
IL5292(OPEN)
IL5292(CLOSED)
SURFACE WASH VALVE
SOV5252
SURFACE WASH VALVE
HS5252
(OPEN) (CLOSE)
IL5252(OPEN)
IL5252(CLOSED)
FIELD
BACKPLATE
PANEL FRONT
WSW PUMP 7001 STARTER
PARALLEL LOOP TO ALL LFCS, MCP & LOCAL START/STOP
SERIES LOOP TO ALL LFCS, MCP & LOCAL START/STOP
WASHWATER PUMP
HS7012(START)
HS7012(STOP)
IL7012(RUN)
IL7012(OFF)
File name: C:\ACAD\GLEN\LFC12-2.DWG Last edited: 93/10/27 @ 10:10
NIX, FORSEN & ASSOCIATES, INC.
MATTHEWS, N.C. 28105
GLENVILLE LAKE WSP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC
NONE
HRM
LOCAL FILTER CONSOLE 12 - LFC12
ELECTRICAL DIAGRAM
1/15/93
LFC12-2
1
AS BUILT

FIELD | BACKPLATE | PANEL FRONT

INFLUENT VALVE OPERATOR
TB7 — TB2 1 — 1 — HS5201(OPEN)
TB6 — TB4 2 — 2 — HS5201(CLOSE)
3 — 3
TB2 — 4 — 4 — IL5201(OPEN)
TB1 — 5 — 5 — IL5201(CLOSED)
TB11 — 6 — 6
TB12 — 6N — 6N

WASH WATERT DRAIN VALVE OPERATOR
TB7 — 7 — 7 — HS5221(OPEN)
TB6 — TB4 8 — 8 — HS5221(CLOSE)
9 — 9
TB2 — 10 — 10 — IL5221(OPEN)
TB1 — 11 — 11 — IL5221(CLOSED)
TB11 — 12 — 12
TB12 — 12N — 12N

REWASHT VALVE OPERATOR
TB7 — 13 — 13 — HS5261(OPEN)
TB6 — TB4 14 — 14 — HS5261(CLOSE)
15 — 15
TB2 — TB1 16 — 16 — IL5261(REWASHING)
17 — 17 — IL5261(OPEN)
TB11 — TB12 18 — 18 — IL5261(CLOSED)
18N — 18N

WASHWATER SUPPLYT VALVE OPERATOR
TB7 — 19 — 19 — HS5281(OPEN)
TB6 — TB4 20 — 20 — HS5281(CLOSE)
21 — 21
TB2 — 22 — 22 — IL5281(OPEN)
TB1 — 23 — 23 — IL5281(CLOSED)
TB11 — 24 — 24
TB12 — 24N — 24N

SURFACE WASH VALVE — SOV5241 — 25 — 25 — N — 26

SURFACE WASH VALVE
HS5241 (OPEN) (CLOSE)
L2
IL5241(OPEN)
IL5241(CLOSED)
N

WASHWATER DRAIN VALVE
WASHWATER SUPPLY VALVE

FIELD | BACKPLATE | PANEL FRONT

WSW PUMP 7001 STARTER
PARALLEL LOOP TO ALL LFC'S, MCP & LOCAL START/STOP — TB2 27 — 28
SERIES LOOP TO ALL LFC'S, MCP & LOCAL START/STOP — 29 — 30
H — MR — 31
MR — 32
33
34

WASHWATER PUMP
HS7001(START)
HS7001(STOP)
IL7001(RUN)
IL7001(OFF)

NPA NDC PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTVILLE, NC

SCALE: NONE | DRAWN BY: HRM

LOCAL FILTER CONSOLE 1 – LFC1
ELECTRICAL DIAGRAM

DATE: 1/15/93 | DRAWING NUMBER: LFC1-2 | REV: 1

AS BUILT

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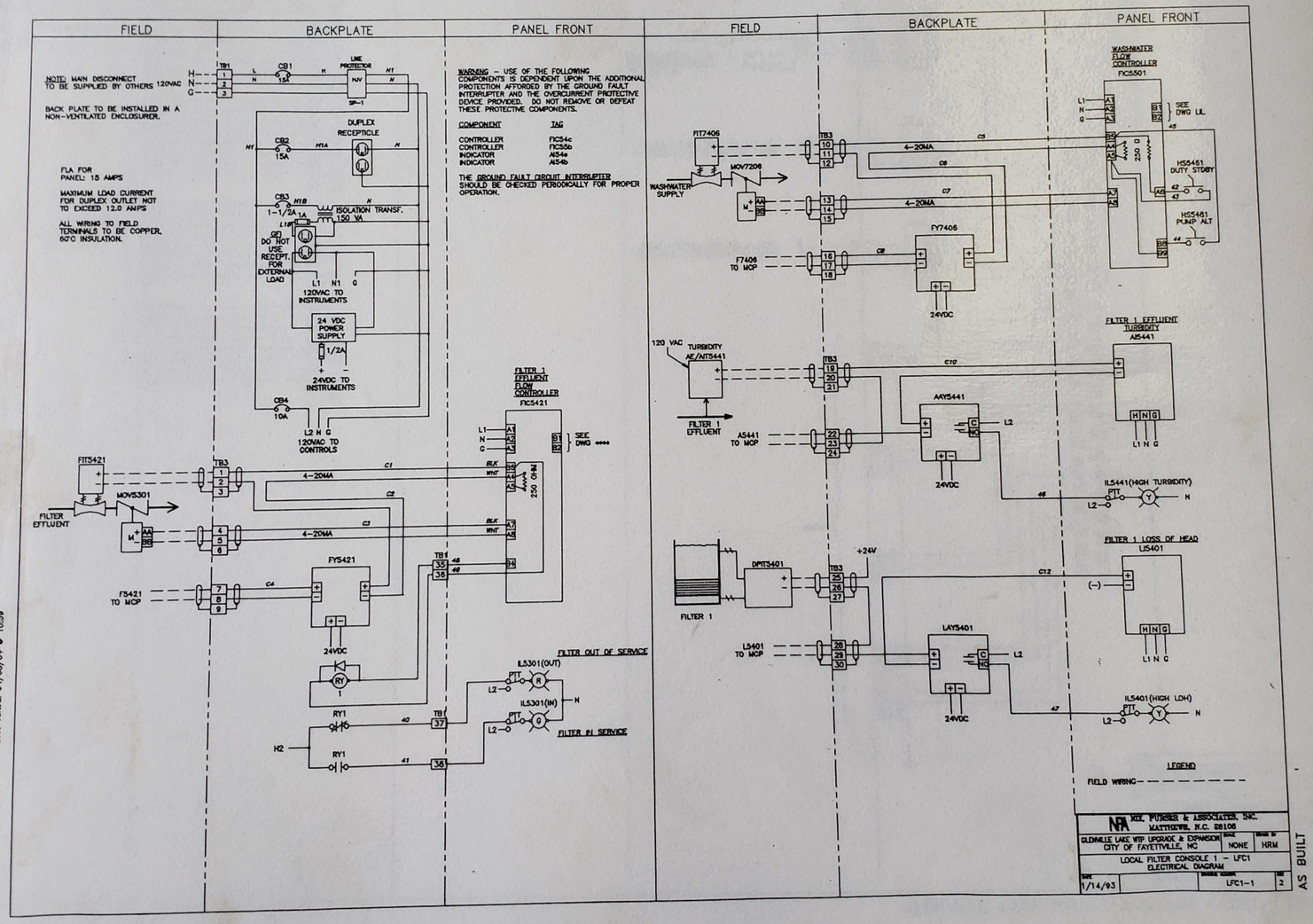
FIELD
BACKPLATE
PANEL FRONT
FIELD
BACKPLATE
PANEL FRONT
NOTE: MAIN DISCONNECT TO BE SUPPLIED BY OTHERS 120VAC
BACK PLATE TO BE INSTALLED IN A NON-VENTILATED ENCLOSURER.
FLA FOR PANEL: 15 AMPS
MAXIMUM LOAD CURRENT FOR DUPLEX OUTLET NOT TO EXCEED 12.0 AMPS
ALL WIRING TO FIELD TERMINALS TO BE COPPER, 60°C INSULATION.
WARNING - USE OF THE FOLLOWING COMPONENTS IS DEPENDENT UPON THE ADDITIONAL PROTECTION AFFORDED BY THE GROUND FAULT INTERRUPTER AND THE OVERCURRENT PROTECTIVE DEVICE PROVIDED. DO NOT REMOVE OR DEFEAT THESE PROTECTIVE COMPONENTS.
COMPONENT TAG
CONTROLLER FIC54c
CONTROLLER FIC55b
INDICATOR AI54e
INDICATOR AI54b
THE GROUND FAULT CIRCUIT INTERRUPTER SHOULD BE CHECKED PERIODICALLY FOR PROPER OPERATION.
LINE PROTECTOR
DUPLEX RECEPTICLE
ISOLATION TRANSF. 150 VA
DO NOT USE RECEPT. FOR EXTERNAL LOAD
120VAC TO INSTRUMENTS
24 VDC POWER SUPPLY
24VDC TO INSTRUMENTS
120VAC TO CONTROLS
FILTER 1 EFFLUENT FLOW CONTROLLER FIC5421
SEE DWG ****
FIT5421
MOV5301
FILTER EFFLUENT
4-20MA
FY5421
FS421 TO MCP
24VDC
FILTER OUT OF SERVICE
IL5301(OUT)
IL5301(IN)
FILTER IN SERVICE
RY1
WASHWATER FLOW CONTROLLER FIC5501
SEE DWG LL
HS5481 DUTY STDBY
HS5481 PUMP ALT
FIT7406
MOV7206
WASHWATER SUPPLY
FY7406
F7406 TO MCP
FILTER 1 EFFLUENT TURBIDITY AE5441
120 VAC
TURBIDITY AE/AIT5441
FILTER 1 EFFLUENT
AS441 TO MCP
AAY5441
IL5441(HIGH TURBIDITY)
DPIT3401
FILTER 1
L5401 TO MCP
FILTER 1 LOSS OF HEAD LI5401
LAY5401
IL5401(HIGH LOH)
LEGEND
FIELD WIRING
WILL PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28105
GLENVILLE LAKE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC
NONE
HRM
LOCAL FILTER CONSOLE 1 - LFC1
ELECTRICAL DIAGRAM
1/14/03
LFC1-1
2
AS BUILT
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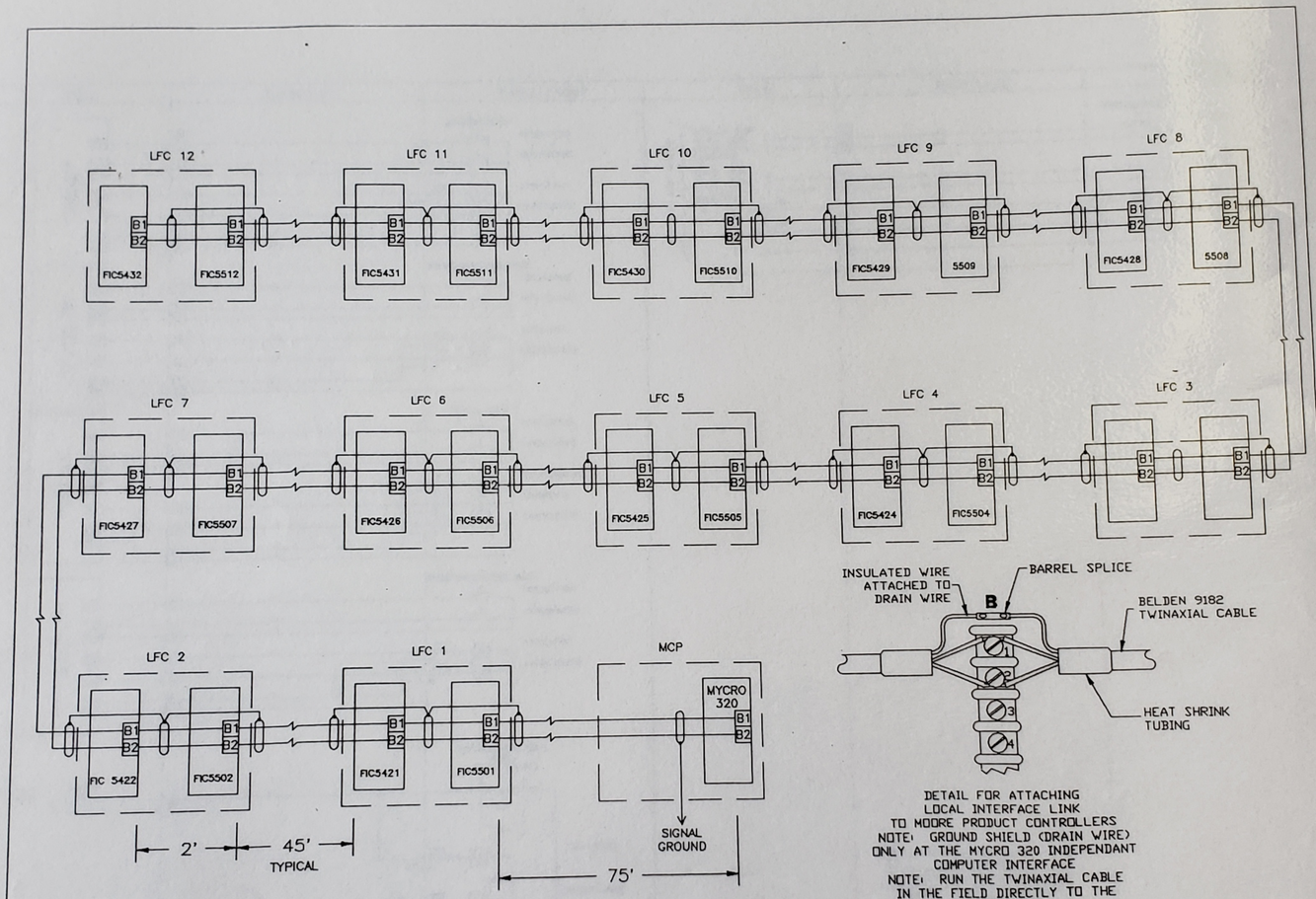

DETAIL FOR ATTACHING
LOCAL INTERFACE LINK
TO MOORE PRODUCT CONTROLLERS
NOTE: GROUND SHIELD (DRAIN WIRE)
ONLY AT THE MYCRO 320 INDEPENDANT
COMPUTER INTERFACE
NOTE: RUN THE TWINAXIAL CABLE
IN THE FIELD DIRECTLY TO THE
CONTROLLERS.

NPA NIX, PURSER & ASSOCIATES, INC.
MATTHEWS, N.C. 28106

SCALE: NONE	DRAWN BY: HRM	DESIGNED: HRM	PAGE:
DATE: 1/6/93	REVISED:	CHECKED:	AS BUILT:

GLENVILLE WTP UPGRADE & EXPANSION
CITY OF FAYETTEVILLE, NC

LOCAL INTERFACE LINK - DETAILS

DRAWING NUMBER: L-2

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