City of Milwaukee

Milwaukee Water Works

Safe, Abundant Drinking Water.

City of Milwaukee
Department of Public Works
Milwaukee Water Works

Specifications for

Official Notice No. 14-2011

Linnwood Purification Plant

WP-306: Ozone Cooling Water Booster Pump Replacement

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2/4/2011

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GENERAL REQUIREMENTS

PART 1 DEPARTMENT OF PUBLIC WORKS – GENERAL SPECIFICATIONS

The Department of Public Works General Specifications applies to all contracts. These specifications are in a separate booklet.

PART 2 SPECIFIC OFFICIAL NOTICE & GENERAL OFFICIAL NOTICE

The Specific Official Notice as it appears in The Daily Reporter and General Official Notice is part of these Contract Documents.

PART 3 SPECIFICATIONS

WP-306: Ozone Cooling Water Booster Pump Replacement

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JOB REQUIREMENTS

WP-306: OZONE COOLING WATER BOOSTER PUMP REPLACEMENT

JR-1 FORM OF BID Contractor shall submit a lump sum bid for furnishing the complete job in accordance with plans and specifications.

JR-2 JOB LOCATION Linnwood Purification Plant, 3000 North Lincoln Memorial Drive, Milwaukee, WI 53211.

JR-3 GENERAL DESCRIPTION OF WORK The work to be performed under the provisions of this contract and as set forth in these documents consists of the supply and installation of all materials, labor, supervision, inspection, and rentals for all work involved and described below.

JR-4 CONTRACT DRAWINGS The contract drawings upon which the proposal is to be based are listed hereunder:

DRAWING NUMBER	TITLE
WP-306-01	Title Sheet and Drawing Index
WP-306-02	Process and Instrumentation Diagram
WP-306-03	Removal/Demolition – Plan & Details
WP-306-04	Mechanical – Plan & Details
WP-306-05	Mechanical – Ozone Operations Building - Partial Plan
WP-306-06	Electrical – Plan

Above drawings are general in nature and are intended to indicate the relative locations of the equipment specified in the space provided. It shall be the responsibility of the successful bidder to ascertain the suitability of the specific equipment to be furnished in regard to the space allotted.

JR-5 PRE-BID MEETING A **MANDATORY** pre-bid meeting for all prospective bidders will be held on TUESDAY, MARCH 1, 2011 AT 10:00 AM in the Linnwood Purification Plant Conference Room, 3000 Lincoln Memorial Drive, Milwaukee WI, 53211. The City of Milwaukee will **ONLY** receive bids from prospective bidders who are in attendance at the **MANDATORY** Pre-Bid Meeting. The official envelope for submitting a bid, and Bid Bond Form will be available at the **MANDATORY** Pre-Bid Meeting. Bidder participation is urged to become familiar with all aspects of the project and bidding requirements.

JR-6 SITE VISIT A site visit will be available at the conclusion of the **MANDATORY** Pre-Bid Meeting.

JR-7 PRE-CONSTRUCTION MEETING After the Notice to Proceed is issued, a date shall be set for the pre-construction meeting to be held at the job site. Construction details of the project will be discussed in the meeting.

JR-8 JOB SCHEDULE Within ten (10) days after Notice to Proceed is issued; the contractor shall submit a construction schedule for approval. The schedule shall be made in sufficient detail to indicate dates of each significant operation. The schedule shall be such that the entire job will be completed within the specified completion time. Microsoft Project 2000 shall be used to create the schedule. Submit an electronic file and hardcopy of the schedule.

The contractor shall place all orders for materials promptly after award of the contract. With submittal of the construction schedule, he shall include a schedule of delivery of all major material and equipment required for the job.

The contractor shall immediately notify the City, in writing, of any problems with meeting this schedule. If the construction schedule cannot be met because of materials or equipment deliveries, the contractor shall be required to submit purchase orders and confirmations of delivery, showing the date the order was placed and the promised date of delivery.

JR-9 WORK DAYS AND TIMES Work shall take place between the hours of 7:00 AM to 3:30 PM. Work shall not be allowed on Sunday or City of Milwaukee holidays.

JR-10 START & COMPLETION DATE The Contractor shall not start work on the project site prior to April 2, 2011. Work on this project shall be complete by September 16, 2011.

JR-11 CHARGE FOR INSPECTION The Contractor will be charged $350.00 per day per inspector for each and every day inspection is required on this Contract after the date allowed for completion or after such extension of time as may have been granted. This charge is further defined in Section 2.5.11 of the Department of Public Works (DPW) General Specifications.

JR-12 PROGRESS PAYMENTS Within ten (10) days after the Notice to Proceed is issued, the contractor shall submit to the City for approval a schedule showing the breakdown of the contract with quantities and prices as a basis for checking and computing progress estimates. The values shown in the approved breakdown shall be used for pay purposes only and shall not be used as a basis for additions to or deductions from contract work.

When the contractor proceeds properly and with diligence to perform and complete the work on this contract, the Commissioner of Public Works may, from time to time as the work progresses, grant to the contractor an estimate of the amount already earned. In making such progress estimates, there shall be retained 5% of each progress estimate until final completion and acceptance of the work; except that after 50% of the work has been completed and the Commissioner finds that satisfactory progress is being made and all conditions complied with, he may authorize any of the remaining progress payments

to be paid in full to the contractor. Progress Payments are further defined in Section 2.9.14 of the Department of Public Works (DPW) General Specifications.

In accordance with Charter Ordinance 7.26 as amended 6-1-72, payment for materials delivered to the work or storage site may be authorized by the Commissioner of Public Works providing the following terms and conditions are met:

A. The work is progressing properly and such materials as specified are properly stored and suitable for permanent incorporation in the work.

B. Materials designated for pay in the next progress estimate after delivery shall be limited to fabricated or manufactured components which are assembled in final form ready for placement in the work

C. The following forms shall be submitted with requests for payment.

   1. Progress Estimate and Request for Payment for Fabricated Materials or Components Properly Stored.

   2. Certification of the Contractor or his duly authorized representative.

   Field Engineer shall verify that material is as specified and properly stored.

D. The contractor shall be responsible for the safeguarding of any such materials against loss or damage whatsoever, and in the case of any loss or damage, the contractor shall replace such lost or damaged materials at no cost to the City. The Commissioner shall reserve the right to deduct from ensuing progress estimates the value of any lost or damaged materials until such loss or damage is restored by the contractor.

E. The Commissioner may limit processing progress estimates to those cases where the amount earned in any pay period for work and materials is $5,000 or more.

F. Any materials for which payment has been made shall not be removed from the work or storage site without the specific written approval of the Commissioner of Public Works.

JR-13 <u>FORMAL CORRESPONDENCE</u> Formal correspondence shall be addressed to: Ms. Carrie M. Lewis, Superintendent of Milwaukee Water Works, 841 North Broadway, Room 409, Zeidler Municipal Building, Milwaukee, WI 53202. Formal correspondence shall include:

1. Request for Change Order.

2. Request for extension of Completion Date

3. Disputes concerning Payment or Field Issues.

4. Payment Requests.

5. Submittals.

END OF SECTION

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Contract description.
2. Specifications and standards.
3. Shop Drawings.
4. Warranty and guarantee.

1.02 CONTRACT DESCRIPTION

A. This contract includes the furnishing of all equipment, labor, supervision, materials and appurtenances for and in connection with the supply and installation of a skid-mounted water booster system.

B. The Work to be performed shall include but not be limited to the following:

1. Supply and installation of a skid-mounted water booster pumping system.
2. Supply and installation of required piping, supports and installation.
3. All electrical and instrumentation.
4. Demolition of old system.
5. Install new Reduced Pressure Zone (RPZ) back flow preventer.

NOTE: See Exhibit “A” Section 01010 for additional details.

1.03 SPECIFICATIONS AND STANDARDS

A. Materials, general design, design loads, allowable stresses, joint design, shop fabrication and field construction shall conform to the requirements of the following latest standard specifications of any technical society, organization, or association, or to codes of local or state authorities:

1. NEC, National Electric Code.

2. AWWA, American Water Works Association.

3. IEEE, Institute of Electrical and Electronic Engineers.

4. ANSI, American National Standards Institute.

5. SSPC, The Society for Protective Coatings.

6. ASTM, American Society for Testing and Material.

7. The Wisconsin Administrative Code.

8. OSHA, U.S. Department of Labor Occupational Safety and Health Act.

9. PA, United States Environmental Protection Agency.

10. NFPA 70 N.

B. The contractor shall be familiar with the requirements of the above agencies. Any conflict in the contract drawings, these specifications, the contractor's design or construction methods shall result in this contractor performing in a manner which conforms to the applicable requirements. Agencies and/or associations not specified above are referenced in individual specification sections as required.

1.04 SHOP DRAWINGS

See Exhibit "A" Technical Specifications Section 01300 for additional submittal details.

1.05 WARRANTY AND GUARANTEE

A. The Contractor shall furnish a written two (2) year warranty from the date of official acceptance against defective materials or workmanship before the final payment is made.

B. During the period of two (2) years from and after the date of the final acceptance by the City of the work embraced by this contract, the Contractor shall make all needed repairs arising out of defective workmanship or materials, or both, which in the judgment of the Commissioner of Public Works, shall become necessary during such period. The City will perform an inspection during the spring of the final year of the warranty. The Contractor is not required to attend this inspection. A written report summarizing the inspection and detailing any needed repairs will be provided to the Contractor. The Contractor shall make all repairs within 6 months of receiving the report.

C. Whenever defective equipment or materials are replaced, the warranty period for the replacement equipment or materials shall be the remaining warranty period for the original, replaced equipment or materials.

D. If within ten days after mailing of a notice in writing to the Contractor, or his agent, the said Contractor shall neglect to make, or undertake with due diligence to make, the aforesaid repairs, the City is hereby authorized to make such repair at the Contractor's expense; providing, however, that in case of an emergency where, in the judgment of the Commissioner, delay would cause serious loss or damage, repairs may be made without notice being sent to the Contractor, and the Contractor shall pay the cost thereof.

E. The Contractor shall also furnish written guarantees as required by each Section. Length of time and requirements of guarantees are specified in each Section. Each guarantee shall commence on the date of official acceptance. Final payment will not be paid until the City receives all guarantees.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.01 SECTION INCLUDES:

A. Coordination

B. Alterations

C. Cutting and Patching

D. Pre-construction Meeting

E. Pre-installation Meetings

F. Progress Meetings

1.02 COORDINATION

A. Coordinate scheduling, submittals, and Work on the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that the City requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements and installation of appurtenance, mechanical and electrical work. Follow routing shown for pipes, and conduit, as closely as practicable; place runs parallel with line of structure. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. Coordinate completion and clean up of Work of separate Sections in preparation for Substantial Completion.

E. Coordinate correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of the City of Milwaukee's activities.

1.03 ALTERATIONS

A. Materials: As specified in product Sections; match existing products and work for patching and extending work.

B. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.

C. Remove, cut and patch work in a manner to minimize damage and to provide a means of restoring products and finishes to original condition.

D. Refinish visible existing surfaces to original condition.

E. Where new work abuts or align with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

F. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to the City.

G. Patch or replace portions of existing surfaces that are damaged, lifted or discolored, or showing other imperfections.

H. Finish surfaces as specified in individual product Sections.

1.04 CUTTING AND PATCHING

A. Employ skilled and experienced installer to perform cutting and patching.

B. Submit written request in advance of cutting or altering elements which affects:

1. Structural integrity of element.

2. Integrity of weather-exposed or moisture resistant element.

3. Efficiency, maintenance or safety of element.

4. Visual qualities of sight-exposed elements.

5. Work of City of Milwaukee or separate contractor.

C. Execute cutting, fitting and patching to complete Work, and to:

1. Fit the several parts together, to integrate with other Work.

2. Uncover Work to install or correct ill-timed work.

3. Remove and replace defective and non-conforming Work.

4. Remove samples of installed Work for testing.

5. Provide openings in elements of Work for penetrations of mechanical and electrical Work.

6. Execute work by methods which will avoid damage to other Work, and provide proper surfaces to receive patching and finishing.

7. Cut rigid materials using masonry saw or core drill.

8. Restore Work with new products in accordance with requirements of Contract Documents.

9. Fit Work tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

10. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.

11. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

12. Identify and hazardous substance or condition exposed during the Work to the City.

1.05 PRECONSTRUCTION MEETING

A. The City will schedule a pre-construction conference after Notice of Award.

B. Attendance Required: City and Contractor.

C. Agenda

1. Submission of executed bonds and insurance certificates (unless previously submitted to DPW).

2. Submission of list of Subcontractor, list of products, Schedule of Values, and progress schedule.

3. Designation of personnel representing the parties in Contract.

4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.

5. Scheduling and reports.

6. Use of premises by City and Contractor.

7. Construction facilities and controls provided by City.

8. Temporary utilities and controls provided by City, if any.

9. Security and housekeeping procedures.

10. Procedures for testing.

11. Procedures for start-up of equipment.

12. Requirements for maintaining record documents.

13. Inspection and acceptance of equipment put into service during construction period.

14. Conflicts.

15. A review of Contract Documents shall be made and deviations or differences shall be resolved.

16. Establish which areas on-site will be available for use as storage areas and working area.

1.06 PRE-INSTALLATION MEETING

A. When determined by the City, convene a pre-installation meeting at work site prior to commencing work.

B. Require attendance of parties directly affecting, or affected by, work of the specific Section.

C. Notify all parties four days in advance of meeting date.

D. Prepare agenda, preside at meetings, record minutes, and distribute copies within three days after the meeting to participants, with one copy to the City.

E. Review conditions of installation, preparation and installation procedures, and coordination with related work.

1.07 PROGRESS MEETING

A. The City will schedule and administer meetings throughout progress of the Work as required.

B. The City will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within three days to the City, participants, and those affected by decisions made.

C. Attendance Required: Contractor’s general superintendent, major Subcontractors and suppliers, City, as appropriate to agenda topics for each meeting.

D. Agenda

1. Review minutes of previous meeting.

2. Review of Work.
3. Field observations, problems and decisions.
4. Field observations of problems that impede planned progress.
5. Review submittal schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding Work period.
10. Coordination of projected progress.
11. Maintenance of quality and Work standards of proposed changes on progress schedule and coordination.
12. Other business relating to work.

END OF SECTION

SECTION 01500

JOB SITE SECURITY, UTILITIES AND FACILITIES

PART 1 SCOPE

1.01 INDEX

A. Scope

B. Security and Safety

C. Occupancy During Construction

D. Electric Power

E. Water

F. Toilet Facilities

1.02 GENERAL CONDITIONS

A. All operations shall be carried on with a minimum of damage and disturbance. All damages shall be repaired to the original condition to the satisfaction of the Engineering Representative.

B. All removals become the property of the contractor and shall be disposed of off the site unless otherwise specified.

C. Disposal of all waste and debris generated during the removal and installation operations shall be conducted in accordance with the latest edition of all local, state and federal rules and regulations governing the waste product. Copies of any required certificates, forms, manifests, etc. required for proper disposal shall be submitted to the City in accordance with Section 01010, Submittals.

1.03 TEMPORARY VENTILATION

Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.04 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Protect non-owned vehicular traffic stored materials, site and structures from damage.

1.05 PROGRESS CLEANING

A. Waste materials, debris, and rubbish shall be removed daily after work. Maintain site in a clean and orderly condition.

B. Clean and repair damage caused by removals or installations.

C. Restore existing facilities used during construction to original condition.

PART 2 SECURITY AND SAFETY

2.01 GENERAL

The Milwaukee Water Works consists of a number of facilities to treat and deliver drinking water to the City and surrounding suburban communities. To insure the safety and security of drinking water, the Milwaukee Water Works has instituted protocols for visitors and contractors to control entry to these facilities. It is essential that contractors strictly comply with the security policy outlined in the specification section.

For this project, the contractor shall continuously coordinate building and site security measures, including accessing the site, with the designated Water Engineering representative or the Water Security Manager, Telephone # (414) 286-2934, facsimile # (414)-286-2672.

2.02 SCOPE

Any and all City agencies and contractors engaged for work at Milwaukee Water Works facilities shall be required to attend a "Pre-Construction Security Briefing" before any contracted work can be initiated. At this meeting, the contractor and sub-contractors shall have a detailed briefing with discussions regarding the following items:

A. Milwaukee Water Works site security policies and procedures

B. Contractor and sub-contractor obligations

C. Permit System

2.03 POLICIES

During the "Security Briefing" portion of the "Pre-Construction Meeting," Milwaukee Water Works Security staff shall provide the prime contractor with site polices to be reviewed by the rime and sub-contractors. These documents may include:

A. Lock-out/Tag-out Policy

B. Confined Space Entry Procedures

C. Evacuation Procedure for Propane, Lox and Ammonia Releases

D. Personal Protective Equipment Guidelines

E. No Smoking Policy

F. Prohibited Materials

Additionally, the contractor will be provided:

A. Contact Phone Numbers for MWW Staff

B. On-Site Parking Location and designated construction entrance

C. Site Security Policy and Procedures

The Prime Contractor shall be required to review these documents and is responsible for conveying the contents of these submittals to their employees, sub-contractors, and any other parties working directly or indirectly for them. These policies apply equally to all contractors. Failure to comply with established policies and procedures may result in access privileges being withdrawn.

MWW Staff shall provide a “walk-through” session with the contractor to review area layout and site plans as part of this orientation process and to establish the specific work areas necessary for the contractors to perform their scope of work. Topics covered in this session include: site overview with hazards, Material Safety Data Sheets (MSDS), fire extinguisher placement, and the storm water protection policy.

2.04 CONTRACTOR RESPONSIBILITIES

Contractors shall provide the following documents no less than 7 business days prior to the start of contracted work:

A. Scope of work to be performed;

B. Name of primary contractor's onsite representative;

C. Names of all companies sub-contracted to do work on the project;

D Completed "Contract Firm Registration Form" (see attachment 'A') for prime contract firm and every sub-contract firm;

E. A "Contractor Employee Registration Form" completed for the contractors and every employee who needs to be granted site access (see attachment 'B');

F. List of items to be stored on-site;

G. Material Safety Data Sheets for all chemicals to be used/stored on-site.

Note: It is the responsibility of the Prime Contractor to facilitate gathering and submittal of the "Contractor Employee Registration Form" for all sub-contractors working on the project. A sub-contractor is defined as an individual or firm hired by the primary contractor to perform a specific task as part of the overall project. This would not include an organization making deliveries of supplies or equipment to the job site; procedures for these firms are covered under Part 8, "DELIVERIES."

In the event it is necessary for the Prime Contractor to add additional employees to the list of approved personnel, a minimum of 72 hours, or 3 business days, must be allowed for processing of the request. Site access will be denied to the additional personnel until processing is complete.

Additionally, Contract Firms are obligated to notify MWW in a timely manner of any site-authorized staff that leaves the employ of the Contractor.

At no time should anyone but the Prime Contractor be contacting Milwaukee Water Works employees with issues or access requests. If a request for site access does not come from the Prime Contractor, the request will not be processed.

During the time period that the Contractor is on-site, they must agree to:

A. Notify the Plant Manager immediately of any significant chemical spills or leaks.

B. Maintain normal non-toxic breathable air quality, through adequate ventilation, at their work site.

C. Perform no equipment isolations or tie-ins without the signed approval of site management.

D. Restrict movement to the specific work areas within the site to perform contractors scope of work.

During the project, the contractor advised that the area surrounding the work site is to be kept as free as possible of dust contamination during removal operations. Contractor is also advised that the area is to be ventilated so that the presence of fumes from the installation operations is kept as low as possible. Additionally, the contractor is advised that all rules and regulations governing confined space are to be strictly adhered to.

2.05 CONTRACTOR SPECIAL WORK PERMITS

Contractors must notify Engineering/Site Management staff of any welding, torching, or potentially hazardous or operational impact request, prior to commencing such operations. Special permits shall be issued to the contractor, and these must also be displayed at the work site.

Failure to comply with the terms of the special work permits, or provisions that provide for MWW employee safety, shall be cause for revocation of such permits, and the contractor may be forced to discontinue activities at the Site.

2.06 CONTRACTOR IDENTIFICATION AND DAILY REGISTRATION

Every day, all contractors shall be required to show a valid picture ID card, to sign-in at the start of work, and sign out at the end of work. A MWW employee or designated security representative shall be on site to ensure compliance. Any identification tags or lanyards issued by MWW are to be worn while on site and returned to site management upon completion of contracted work.

2.07 CONTRACTOR GATE ACCESS & PARKING

Contractors must comply with the terms of entry for the site and park only in the areas designated for parking by the MWW site representative.

NOTE: Parking privileges may be rescinded at any time as site operational requirements dictate.

PART 3 CITY OF MILWAUKEE PERMITS

The contractor shall obtain the necessary permits for this project.

PART 4 OCCUPANCY DURING CONSTRUCTION

The Water Works facility shall be in continuous operation during this contract. Contractor and sub-contractors are to take any and all necessary precautions to insure there is no interference with daily operations or security. MWW personnel shall be continuously occupying the facility. All hours of contractor's operations shall be coordinated with the MWW site or engineering representative.

PART 5 ELECTRICAL POWER AND TELEPHONE SERVICE

On-site electrical service is available for contractor use during project duration. Contractor shall provide and maintain all necessary power cords, electrical lighting, heat, ventilation and telephone service and shall make all necessary connections in accordance with OSHA regulations. Contractor shall provide and pay for his own wireless telephone service.

PART 6 WATER

Water is available for the contractor at the site and may be obtained from the fixture(s) so designated by MWW staff or engineering representative. Contractor and sub-contractors must provide their own hoses, back flow preventer and any other connection appurtenances required for the contract.

PART 7 TOILET FACILITIES

On-site toilet facilities are available for contractor use during project duration. The specific location of these facilities will be transmitted to the contractor at the pre-construction meeting. However, if project requirements render the use of on-site facilities impractical, then contractor shall furnish portable facilities. If portable facilities are required, contractor shall maintain these toilet facilities in a sanitary condition throughout the duration of the project and shall remove them from site at the end of the project. The placement and location of the temporary portable toilets shall be coordinated with the Plant Manager and Engineering Representative.

PART 8 DELIVERIES

Contractor shall coordinate the delivery of all equipment, material, dumpsters, portable toilets (and their maintenance) and other required items required for the contract work

with the MWW staff. A minimum of 24 hours prior notice in advance of the desired delivery date shall be transmitted to the designated Water Engineering Representative. Contractor shall provide the following information in the notification:

1. Trucking/Delivery Company

2. Driver Name

3.. Truck License Plate Number

The driver of the delivery vehicle is required to display picture identification as a pre-requisite for entry to the MWW facility for the delivery. Failure to comply with the above will result in denial of project site access, requiring the contractor to re-schedule delivery.

END OF SECTION

Milwaukee Water Works

Safe, Abundant Drinking Water.

WP-306
Attachment "A"

FORM A

CONTRACT FIRM REGISTRATION FORM

CONTRACTOR:_____

PLANT/SITE:_____

CONTRACT/SERVICE ORDER No._____

WATER ENGINEERING PROJECT No._____

PRIMARY CONTACT PERSON:_____

OFFICE PHONE NUMBER:_____

CELL PHONE NUMBER:_____

REQUESTED WORK HOURS (00am – 00pm): _____

NUMBER OF EMPLOYEES TO BE WORKING ON-SITE: _____

Signature certifies receipt of the materials outlined in Contract Section 01500, Part 2 – Security and Safety, Section C, Policies.

SIGNATURE:_____ DATE:_____
PRIMARY CONTACT PERSON

Accompanying this form should be a complete listing of all equipment to be stored on site for the duration of the project.

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WP-306
Attachment "B"

FORM B

CONTRACTOR EMPLOYEE REGISTRATION FORM

Contract Firm:_____

Plant/Site/Project: _____

Employee Name (Printed): _____

This certifies that I have received the building site security and safety policies.

EMPLOYEE
SIGNATURE:_____ DATE: _____
Required

ONSITE PARKING

☐ I will always be driving a Company vehicle.
☐ I will always be a passenger in a vehicle.
☐ I will be driving my personal vehicle. If checked here complete and sign the next section.

Contractor Personal Vehicle Liability Waiver

EMPLOYEE VEHICLE
MAKE & MODEL:_____ LICENSE PLATE: _____

I, hereby agree to hold harmless the City of Milwaukee for any and all damage, loss or injury, which may occur as a result of utilizing the contractor onsite parking area.

EMPLOYEE
SIGNATURE:_____ DATE:_____
Required

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Products.
2. Transportation and handling.
3. Storage and protection.
4. Product options.
5. Substitutions.

1.02 PRODUCTS

A. Material, machinery, components, equipment, fixtures and system shall be new. Assure standardization and uniformity by using products from one manufacturer.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

C. Provide interchangeable components of the same manufacture for components being replaced.

1.03 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement or damage.

1.04 STORAGE AND PROTECTION

A. Store and protect Products in accordance with manufacturer's instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive Products in weather tight, climate controlled, enclosures in an environment favorable to Product.

D. For exterior storage of fabricated Products, place on sloped supports above ground.

E. Provide off-site storage and protection when site does not permit on-site storage or protection.

F. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of Products.

G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement or damage.

I. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

1.05 PRODUCT OPTIONS

A. Products specified by reference standards or by description only: Any Product meeting those standards or description.

B. Products specified by naming one or more manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products specified by naming one or more manufacturers with a provision for substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.06 SUBSTITUTIONS

A. City will consider requests for Substitutions only within 15 days after date established in Notice to Proceed.

B. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that the Contractor:

1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.

2. Will provide the same warranty for the Substitution as for the specified Product.

3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to City.

4. Waives claims for additional costs or time extension that may subsequently become apparent.

5. Will reimburse City for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure:

1. Submit two copies of request for Substitution for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data and certified test results attesting to the proposed Product equivalence. Burden of proof is on proposer.

3. The City will notify Contractor in writing of decision to accept or reject request.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01700
CONTRACT CLOSEOUT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Closeout Procedures.
2. Final Cleaning.
3. Adjusting.
4. Project Record Documents.
5. Operation and Maintenance Data.
6. Spare Parts and Maintenance Products.
7. Guarantee.

B. Related Sections

1. Section 01500 – Job Site Security, Utilities and Facilities: Progress cleaning.

1.02 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for City's review.

B. Provide submittals to City that is required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments and sum remaining due.

1.03 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean surfaces exposed to view; remove temporary labels, stains and foreign substances.

C. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

D. Remove waste and surplus materials, rubbish and construction facilities from the site.

1.04 ADJUSTING

A. Adjust operating appurtenances and equipment to ensure smooth and unhindered operation.

1.05 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Contract Drawings.

2. Specifications.

3. Addenda.

4. Change Orders.

5. Reviewed Shop Drawings, Product Data, and Samples.

6. Manufacturer's instructions for assembly, installation and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by City.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Contract Drawings and Shop Drawings: Legibly mark each item to record actual construction including:

1. Field changes of dimension and detail.

2. Details not on original Drawings.

F. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number.

2. Product substitutions or alternates utilized.

3. Changes made by Addenda or Change Orders.

G. Submit documents to City in the following manner:

1. Submit prior to final Application for Payment.

2. Documents shall be accompanied with a transmittal letter that includes the following:

a) Date.

b) City's project title and number.

c) Contractor's name and address.

d) Title and number of each record document.

e) Certification that each document as submitted is complete and accurate.

f) Contractor's signature or authorized representative.

3. Delete Consultant and City's title block from documents. Delete Engineer's seals from documents.

4. Submit two sets of documents.

5. Submit one set of reproducible "mylar" Contract Drawings.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit data bound in 8-1/2 x 11 inch text pages, three D-side ring binders with durable plastic covers. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches. Where reduction is not practicable, large drawings shall be folded separately and placed in an envelope that is bound into the manuals. Envelope shall bear suitable outside identification.

B. Prepare binder cover and spine with printed title "OPERATION & MAINTENANCE INSTRUCTION," title of project, project number and subject matter of binder when multiple binders are required.

C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

D. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, typed on 24 pound white paper, in three parts as follows:

1. Part 1: Directory, listing names, addresses, telephone numbers and e-mails of Architect/Engineer, Contractor, Subcontractors and major equipment suppliers.

2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, telephone numbers and e-mails of Subcontractors and suppliers. Identify the following:

   a) Significant design criteria.

   b) List of Equipment.

   c) Parts list and assembly drawings for each component.

   d) Operating instructions for start-up, normal operation, shutdown and emergency conditions.

   e) Maintenance instructions for equipment and systems.

   f) Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

   g) Troubleshooting Guide.

3. Part 3: Project documents and certificates, including the following:

   a) Shop drawings and product data.

   b) Air and water balance reports.

   c) Certificates.

   d) Photocopies of warranties.

E. Submit one draft copy of volumes 15 days prior to final inspection. This copy will be reviewed and returned with City comments. Revise content of all document sets as required prior to final submission.

F. Submit four sets of revised final volumes within 10 days after receipt of City's comments.

1.07 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance and extra Products in quantities specified in individual specification sections.

B. Deliver to Project site and place in location as directed; obtain receipt prior to final payment.

1.08 WARRANTY AND GUARANTEE

A. Provide duplicate notarized copies.

B. Execute and assemble transferable warranty documents from Subcontractors, suppliers and manufacturers.

C. Provide Table of Contents and assemble in binder with durable plastic cover.

D. Submit prior to final Application for Payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

EXHIBIT “A”

TECHNICAL SPECIFICATIONS

TECHNICAL PROJECT SPECIFICATIONS

FOR

WP-306: OZONE COOLING WATER BOOSTER PUMP SYSTEM REPLACEMENT LINNWOOD PURIFICATION PLANT MILWAUKEE WATER WORKS

PREPARED BY

SYMBIONT
6737 W WASHINGTON STREET
SUITE 3440
WEST ALLIS, WISCONSIN 53214

WISCONSIN
PATRICK W. CARNAHAN
E-27694
MILWAUKEE, WI
PROFESSIONAL ENGINEER

12-22-2010

DECEMBER 22, 2010

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NOT USED

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Section 01010
SUMMARY OF WORK AND SUBMITTALS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Description of Work.

B. Work by Owner.

C. Contractor use of facilities.

D. Work Sequence.

E. Owner occupancy.

F. Field verification of drawing information.

G. Submittal procedures.

H. Construction progress schedules.

I. Proposed products list.

J. Product data.

K. Shop drawings.

L. Samples.

M. Test reports.

N. Certificates.

O. Manufacturer's instructions.

P. Manufacturer's field reports.

1.2 DESCRIPTION OF WORK

A. Work on the Project will be performed under a single prime contract.

B. When completed, this project will provide the Owner with a new cooling water booster pump system and modification to the house water supply and the ozone system cooling water flow control operation.

C. The major facilities or components of the Project include, but are not limited to the following. To determine the full scope of the Project, refer to the entire Contract Documents:

1. House water backflow preventer and piping connections to the existing booster pump skid system discharge pipe to the Ozone Building
2. Ozone cooling water pump skid
3. Ozone cooling water piping and valve modifications

1.3 WORK BY OWNER

A. Control system monitoring and signal programming will be performed by the Owner on the existing plant control system.

1.4 CONTRACTOR USE OF SITES

A. Confine operations at sites to areas permitted by:

1. Plant Operations
2. Contract Documents.

B. Owner will occupy the existing water treatment plant site and maintain treatment plant operations. Contractor shall coordinate construction operations to allow Owner continued operation of existing treatment plant.

C. Assume full responsibility for protection and safekeeping of material and products stored on or off premises.

D. Move any stored material or products which interfere with operations of Owner or other Contractors.

E. Obtain and pay for use of additional storage or work areas needed for operation.

F. Time Restrictions for Performing Work: As stated in Section 01011 – Schedule and Sequence of Operations.

1.5 WORK SEQUENCE

A. The Contractor is required to determine his own method of construction and detailed work sequence, within the terms of the Contract, so long as the constraints defined in Section 01011 – Schedule and Sequence of Operations, and those shown on the Plans are observed and the milestones and the overall project completion time are achieved.

B. The ozone cooling water improvements shall be tested and commissioned as a system in accordance with Section 01820 – System Demonstration.

1.6 OWNER OCCUPANCY

A. The Owner will occupy the existing treatment plant site during entire period of construction to conduct normal operations.

B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

C. Schedule the Work to accommodate this requirement.

1.7 FIELD VERIFICATION OF DRAWING INFORMATION

A. The Contractor shall field verify the size and location of existing structures, equipment, and piping depicted on the Drawings. Information on the Drawings is based upon available plant record drawings. No attempt has been made to verify the accuracy of the record drawings. Contractor shall be responsible for locating all pipelines and utilities. Notify Engineer immediately of any discrepancies between locations shown and actual locations.

1.8 SUBMITTAL PROCEDURES

A. No equipment or material for which listings, drawings, or descriptive material are required shall be fabricated, purchased, or installed until the Engineer has on hand copies of such approved lists and the appropriately stamped final shop drawings.

B. Transmit each submittal with Engineer accepted form. Submit only one specification section per transmittal.

C. Submit all items specified in a particular specification section at the same time.

D. Sequentially number the transmittal forms. Revise submittals with original number and a sequential alphabetic suffix.

E. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing and detail number, and specification Section number, as appropriate.

F. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents. **Submittals that have not been reviewed by the Contractor will be rejected.**

G. Schedule submittals to expedite the Project, and deliver to the Engineer at business address. Coordinate submission of related items.

H. For each submittal for review, allow 21 calendar days excluding delivery time to and from the contractor.

I. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

J. Identify product data sheets and product description literature with equipment tag

numbers, specification section, paragraph and sub-paragraph numbers.

K. Clearly mark the selected product by use of arrows, underlines, or circles where more than one product is shown. Use of highlighters to identify the selected product is not acceptable. Fax copies are not acceptable and will be rejected.

L. Provide space for Contractor and Engineer review stamps.

M. When revised for resubmission, identify all changes made since previous submission.

N. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

O. Submittals not requested will not be recognized or processed.

P. Delays caused by the need for resubmittals shall not constitute reason for an extension of Contract time.

Q. Comply with submittal procedures detailed in the Project Manual.

1.9 CONSTRUCTION PROGRESS SCHEDULES

A. As specified in Section 01011 – Schedule and Sequence of Operations.

1.10 PROPOSED PRODUCTS LIST

A. Within 21 days after date of Owner-Contractor Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.11 PRODUCT DATA

A. Product Data for Review:

1. Submit to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
2. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01700 – Contract Closeout.

B. Product Data for Information: Submitted for the Engineer's knowledge as contract administrator or for the Owner.

C. Product Data for Project Close-out: Submitted for the Owner's benefit during and

after project completion.

D. Submit the number of copies which the Contractor requires, plus six copies which will be retained by the Engineer.

E. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

F. Indicate Product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

G. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01720.

1.12 SHOP DRAWINGS

A. Shop Drawings for Review:

1. Submit to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
2. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01700 – Contract Closeout.

B. Shop Drawings for Information: Submitted for the Engineer's knowledge as contract administrator or for the Owner.

C. Shop Drawings for Project Close-out: Submitted for the Owner's benefit during and after project completion.

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

E. Submit the number of opaque reproductions which Contractor requires, plus four (6) copies which will be retained by Engineer.

F. Shop drawings shall be accurate, distinct, and complete, and shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the Contract Drawings and Specifications.

G. Shop drawings shall be submitted only by the Contractor. The review of such shop drawings and catalog cuts by the Engineer shall not relieve the Contractor from responsibility for correctness of dimensions, fabrication details, and space requirements, or for deviations from the Contract Drawings or Specifications, unless the Contractor has called attention to such deviations in writing by a letter

accompanying the shop drawings, and the Engineer approves the change or deviation in writing at the time of submission; nor shall review by the Engineer relieve the Contractor from the responsibility for errors in the shop drawings.

H. Shop drawings include shop drawings, product data and other submittals for both shop and field-fabricated items. Submit, as applicable, the following for all prefabricated or manufactured structural, mechanical, electrical, plumbing, process systems, and equipment:

1. Shop drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.
2. Catalog information and cuts, with the applicable, specific information clearly marked or underlined (highlighters not acceptable). Faxed copies are not acceptable and will be rejected.
3. Installation or placing drawings for equipment, drives and bases.
4. Supporting calculations for equipment and associated supports specified to be designed by equipment manufacturers or suppliers.
5. Wiring and control diagrams of systems and equipment.
6. Complete manufacturer's specifications, including materials description and paint system.
7. List of special motor features being provided (i.e., space heaters, altitude corrections, thermal protectors, etc.).
8. Complete motor rating for all motors 5 HP and larger, including motor no-load, starting, and full-load current at rated voltage; full-load speed and full-load current at 110 percent voltage; motor efficiency and power factor at 1/2, 3/4, and full load at rated voltage.
9. Performance data and pump curves.
10. Suggested spare parts list with current price information.
11. List of special tools required for checking, testing, parts replacement, and maintenance (special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics).
12. List of special tools furnished with the equipment.
13. List of materials and supplies required for the equipment before and during startup.
14. List of materials and supplies furnished with the equipment.
15. Samples of finish colors for selection.
16. Special handling instructions.
17. Requirements for storage and protection before installation.
18. Requirements for routine maintenance required before plant startup.
19. List of all requested exceptions to the Contract Documents.
20. Installation instructions.

1.13 SAMPLES

A. Samples for Review:

1. Submit to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

2. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01720 – Project Record Documents.

B. Samples for Information: Submitted for the Engineer's knowledge as contract administrator or for the Owner.

C. Samples for Selection:

1. Submit to Engineer for aesthetic, color, or finish selection.
2. Submit samples of finishes from the full range of manufacturers' standard colors, or in custom colors selected, textures, and patterns for Engineer selection.
3. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01700 – Contract Closeout.

D. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

E. Include identification on each sample, with full Project information.

F. Submit the number of samples specified in individual specification sections; one of which will be retained by Engineer.

G. Reviewed samples which may be used in the Work are indicated in individual specification sections.

H. Samples will not be used for testing purposes unless specifically stated in the specification section.

1.14 TEST REPORTS

A. Submit for the Engineer's knowledge as contract administrator or for the Owner.

B. Submit test reports for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.15 CERTIFICATES

A. When specified in individual specification sections, submit certification by the manufacturer to Engineer, in quantities specified for Product Data.

B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer.

1.16 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.17 MANUFACTURER'S FIELD REPORTS

A. Submit reports for the Engineer's benefit as contract administrator or for the Owner.

B. Submit report in duplicate within 30 days of observation to Engineer for information.

C. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.18 ERECTION DRAWINGS

A. Submit drawings for the Engineer's benefit as contract administrator or for the Owner.

B. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by the Engineer or Owner.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

Not used.

END OF SECTION

Section 01011
SCHEDULE AND SEQUENCE OF OPERATIONS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Progress of the work

B. Sequences and constraints

C. Preconstruction conference

D. Definitions

E. Overall construction schedule

F. Detailed network diagram

G. Activities

H. Contingency

I. Float

J. Submittal of schedules

K. Project and progress review meetings

L. Delays and recovery

1.2 PROGRESS OF THE WORK

A. General: The work shall be performed at such times and in or on such parts of the project and with such forces, materials and equipment to prevent any delay to the completion of the project within the time limits stated in the Contract and the conformance with the overall Construction Schedule specified herein, and in accordance with the sequences and constraints specified herein.

B. Work Hours:

1. The Contractor may, with written approval from the Owner and acquisition of all necessary permits, and at the Contractor's own expense carry on work outside regular hours of 7:00 a.m. to 3:30 p.m., Monday through Friday excluding holidays. To obtain Owner consideration of work outside the above-mentioned hours, or on Saturdays, Sundays or holidays, he shall submit a written request, with reasons, to the Engineer and Owner and shall allow 48 hours for written approval and satisfactory

arrangements to be made for observing the work in progress. The Contractor shall comply with all applicable requirements of the Owner.

2. Such permission, however, may be revoked if the Contractor fails to maintain adequate equipment and supervision for the proper execution and control of the work.

1.3 SEQUENCES AND CONSTRAINTS

A. The existing water treatment facilities must be maintained in operation during construction. The Contractor shall plan, schedule and coordinate his work such that the degree of treatment during construction shall be equal to or exceed the degree of treatment of the plant prior to construction. Necessary coordination with the plant operating staff will be done through the Engineer and the Owner's On-site Representative. The Contractor shall be responsible for scheduling his work in conformance with the Contractual Milestones, sequences and constraints specified herein.

B. The Contractor shall perform all work in a manner so as not to interfere with potable water supply and treatment operations. All construction activities shall be coordinated and scheduled with the Owner so as to minimize conflicts with ongoing operations.

C. Required removals and relocations of existing utilities shall be coordinated with the utility owner.

D. Contractor shall be responsible for all temporary piping and pumping required to keep utilities and plant processes in service. Minimal downtime of certain utilities and/or process pipes may be allowed with Owner's approval.

E. Before any shutdown coordination will be allowed to take place, all equipment, materials, and other necessary items required for shutdown work must be on-site and prepared for installation. Prefabricate as much of this work as possible for accurate and proper installation.

F. Any modifications to existing equipment, piping, electrical, etc. required to remove and/or install new equipment shall be approved by the Engineer and performed at the sole expense of the Contractor.

G. The following Contractual Milestones, sequences, and constraints are those essential to maintaining operational treatment plant facilities during construction and the completion of this project.

1. General:

a. Unless otherwise specified, the Contractor shall provide the Engineer with written notice a minimum of 14 days prior to the time when existing facilities are required to be taken out of service to complete work. This notice is hereinafter referred to as the Notice of Need. The Contractor shall provide evidence to the Engineer that all necessary equipment items are on hand or on

site at the time of the request for the Notice of Need. Plant outages will be contingent on operational conditions.

b. Owner reserves right to place facilities taken out of service back into service on emergency basis upon notification to Contractor.

c. Unless specified otherwise, draining, cleaning, and dewatering of tanks, channels, conduits, piping, and other facilities shall be performed by Contractor as required to complete Work. Unless specified otherwise, Owner will not drain, clean, and dewater facilities to enable Contractor to complete Work. It is the Contractor's responsibility to provide temporary pumping to pump any residual water into an appropriate area of the treatment plant, as directed by the Engineer. Once drained, it is the Contractor's responsibility to maintain a drained channel or basin as necessary to do the work. This includes control and pumping of any leakage from existing valves or gates as well as water any other source.

d. The Contractor shall be fully responsible for providing all temporary piping, bulkheads and plugs to block flow, plumbing, electrical hook-ups, heating, ventilating, air conditioning, lighting, temporary structures, and related work to maintain water treatment operations. All details of temporary piping and temporary construction are not necessarily shown on the Drawings or covered in the Specifications. However, this does not relieve the Contractor of the responsibility to maintain water treatment.

e. All utilities shall be located and marked prior to construction.

f. Testing and commissioning of the Work shall be in accordance with the descriptions and requirements in Section 01010 – Summary of Work, Section 02675 – Disinfection, and Section 01820 – System Demonstration.

2. Construction Sequence:

Milwaukee Water staff have indicated that limited shutdowns to the ozone cooling water system can be accommodated during the construction process. The contractor shall coordinate these system shutdowns with plant staff at least one week in advance. The contractor shall prepare and submit their procedure for performing the ozone cooling water work along with testing as a technical submittal in accordance with Section 01300, SUBMITTALS DURING CONSTRUCTION and as further defined in this Section.

a. Modifications to the existing house water and ozone cooling water system will require temporary isolation and shutdown of the normally operating system. Both the new house water ozone cooling water supply connection and the new ozone booster pump skid shall be prepared for tie in while the facilities operate using the existing ozone cooling water booster system.

The City's preferred sequence of connections are for the new house water connection and supply to the existing ozone building supply be performed and tested before the installation and testing of the new cooling water booster skid.

The testing of the new cooling water booster skid shall include demonstration of initiation and operation for all of the specified control sequences within the cooling water booster skid specification.

Only after both the new house water connection and new ozone cooling water booster skid systems have satisfactorily passed testing requirements and have been turned over to the Owner shall the existing ozone cooling water system be demolished and removed.

During removal of the existing booster pump skid, the suction piping to the new cooling water skid shall be replaced as shown o the plans.

3. Civil/Electrical and Controls:
   a. Demolition:
      1) Existing water stand pipes near the new ozone cooling water booster skid can be removed prior to installation of the new ozone cooling water improvements.
      2) Existing ozone cooling water booster pumping skid components including electrical and controls signals shall not be removed until all necessary replacement house water supply piping and new ozone cooling water booster pump system components are constructed and operational.

1.4 PRECONSTRUCTION CONFERENCE

A. Before beginning the work and after the Contract has been awarded, the Engineer will conduct a Preconstruction Conference to discuss construction schedules and procedures, development of a plan for utility protection and reconstruction, arrangements for orderly movement of traffic, Contractor's use of the site, Contractor's use of existing facilities, Owner's regulations, and other matters deemed relevant to the effective performance of the work.

B. The conference shall be attended by:

1. Contractor's Authorized Representative.
2. Contractor's General Superintendent.
3. Any subcontractor's or supplier's representatives whom the Contractor may desire to invite or the Engineer may request.

C. Representatives from the following agencies will also be invited to attend:

1. The Owner.
2. Wisconsin DNR.
3. Utility Companies.
4. Local agencies.

1.5 DEFINITIONS

A. Overall Schedule: Schedule of the entire project involving the work of all Contractors. The Overall Schedule is prepared by the Contractor based on information from all subcontractors engaged on this project.

B. Critical Path Method (CPM): The Critical Path Method (CPM) of schedule development and maintenance consists of a network diagram in either Precedence (PDM) or Arrow (ADM) and associated date calculations.

1.6 OVERALL CONSTRUCTION SCHEDULE

A. The Overall Schedule shall show the sequence and interdependence of activities required for complete performance of all items of work. The Overall Schedule shall begin with the date the Owner issues the Notice to Proceed, conclude with the date of Final Completion of the Contract, and include all interface points between Contractors. Failure to submit the Contractor's schedule information will be considered cause for withholding of any partial payments otherwise due under the Contract in accordance with the GENERAL CONDITIONS.

1.7 DETAILED NETWORK DIAGRAM

A. General:

1. The Overall Schedule shall contain a time-scaled network diagram. The network diagram shall be in the Critical Path Method (CPM) format and shall show the description, duration in days, sequence and interdependence of activities required for complete performance of all items of work.
2. Sufficient care shall be exercised to produce a legible and accurate diagram.
3. Activities related to a specific physical area of the project shall be differentiated from corresponding tasks for other specific physical areas of the project.

1.8 ACTIVITIES

A. An activity is defined as a time and/or resource consuming element of work. The activities selected for inclusion in the Overall Schedule shall be discrete. All dependency relationships must be shown. When necessary, discrete activities shall be subdivided into smaller, discrete activities so that the dependency relationships may be shown. The level of detail shall be sufficiently fine to enable the Engineer to determine that the project has been adequately planned and to facilitate the determination of real progress as the work is prosecuted.

B. Activity durations exclusive of those for "Submittal Preparation by the Contractor," "Review by the Engineer," and "Material Fabrication and Delivery," shall not be less than one or more than 21 days, unless otherwise approved by the Engineer. Allowance for inclement weather shall be factored into each activity where appropriate.

C. The schedules shall indicate the description, duration, sequence and interdependency of work activities. They shall include, but not be limited to, the following items, as appropriate to each Contract:

1. Mobilization and move in.
2. Conferences and meetings.
3. Install dewatering system(s).
4. Excavation, backfill, grading, paving, seeding, and similar earthwork and surface restoration.
5. Submittal preparation by the Contractor and review by the Engineer. See Section 01300 - Submittals.
6. Order, manufacture, delivery, and installation of critical material and major equipment.
7. Concrete placement sequence.
8. Structural steel, miscellaneous steel, masonry, equipment installation, piping work.
9. Various demolition and related removals or relocations work.
10. Various plumbing activities.
11. Various heating, ventilating and air conditioning activities.
12. Various electrical activities.
13. Construction of various facilities.
14. All other major construction activities.
15. Subcontractor's items of work, including Disadvantaged Business Enterprises (DBE) participation.
16. Performance tests and supervisory service activities.
17. Delivery and installation of Owner supplied equipment and material.
18. All Contract stipulated milestone dates, substantial completion date, and final completion date.
19. Final cleanup.

1.9 CONTINGENCY

A. Any contingency within the schedule (i.e., a difference in time between the

project's early completion and required Contract completion date and float in the Overall Schedule) will belong to the Project and not to any of the parties to the Contract.

1.10 FLOAT

A. The Contractors shall not be permitted to sequester shared float through such strategies as extending duration estimates to consume available float time or extensive crew/resource sequencing, etc.

1.11 SUBMITTAL OF SCHEDULES

A. Within 15 days after the Notice to Proceed, the Contractor shall submit the Overall Schedule to the Engineer for review and/or rejection as appropriate. After review, resubmit required revised data within 10 days. If rejected the Overall Schedule must be resubmitted until the review comments are resolved.

B. Whenever under any Contract Documents the Engineer is given the right of review or rejection of Contractor's schedules or changes thereto, such right is for the benefit and protection of the Engineer and the Owner, and not a benefit for or service to the Contractor. Comments made by the Engineer on the schedule, or lack of such comments, or rejection or non-rejection of the Contractor's schedule does not relieve the Contractor from compliance with requirements of the Contract Documents, nor do they create any responsibility or duty for scheduling owed from the Owner or the Engineer to the Contractor. This review, whether accompanied by comments, rejection, or neither, is only for general conformance with the schedule concept of the project and general compliance with the information given in the Contract Documents.

C. One (1) reproducible and two (2) copies of the Overall Schedule Detailed Network Diagrams shall be submitted to the Engineer.

D. Detailed Network Diagrams and subsequent updates of the schedules shall be signed by all subcontractors to signify their concurrence with the schedules.

E. Failure to submit the Detailed Network Diagrams or subsequent updates of the schedules shall be considered cause for withholding any partial payments otherwise due under the Contract, in accordance with the GENERAL CONDITIONS.

1.12 PROJECT AND PROGRESS REVIEW MEETINGS

A. The Contractor will conduct Project Meetings for the purpose of discussing and resolving matters concerning the various elements of the work. In addition, once each month the Contractor will conduct a Progress Review Meeting for coordination of schedules.

B. The time and place for both meetings will be as directed by the Owner. The Contractor's Authorized Representative and Superintendent shall attend all

meetings. The Engineer will direct whether any subcontractors are required to attend, and the Contractor shall comply with these attendance requirements and shall also require, if necessary, his subcontractors to attend.

C. Prior to the Progress Review Meeting, the Contractor shall obtain from his subcontractors and staff, the necessary information as required reflecting progress to date. An updated Schedule containing the following information shall be available for review at the meeting.

1. For activities started and/or completed during the previous period: start and completion dates, and duration.
2. For activities begun but not yet completed: the percentage complete to date, the remaining duration of the work and the estimated completion date.
3. For activities not yet started: revised durations and the estimated start and completion dates as necessary.
4. For authorized Modification Orders: Add authorized Modification Orders and revised durations where required.

D. Update status information shall be annotated on the Contractor's Overall Schedule in a manner that the Detailed Network Diagrams shall depict the current status of the work.

E. The monthly submittal to the Engineer shall be accompanied by a Narrative Report. Both the monthly schedule submittal and Narrative Report shall be required until Substantial Completion has been issued by the Engineer. The Narrative Report shall:

1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
3. Define problem areas, anticipated delays, and impact on Schedule.
4. Report corrective action taken, or proposed, and its effect including the effect of changes on schedules of separate contractors.

1.13 DELAYS AND RECOVERY

A. If at any time during the project, the Contractor fails to complete any activity by its latest scheduled completion date, he shall, within seven (7) days, submit to the Engineer a written statement as to how and when he will reorganize his work force to return to the Overall Schedule.

B. Once the Contractor starts on any part of the work which affects public convenience, health, or safety, he shall diligently and expeditiously prosecute such work until it is no longer in any respect a public inconvenience, health or safety hazard.

C. Whenever it becomes apparent from the current monthly progress evaluation and updated schedule data that any milestone interface completion dates and/or contract completion dates will not be met, the Contractor shall take some or all of the following actions:

1. Increase construction manpower in such quantities and crafts as shall substantially eliminate the backlog of work.
2. Increase the number of working hours per shift, shifts per work day, work days per week, or the amount of construction equipment, or any combination of the foregoing sufficient to substantially eliminate the backlog of work.
3. Reschedule work items to achieve concurrency of accomplishment.

D. The addition of equipment or construction forces, increasing the working hours or any other method, manner or procedure to return to the current Overall Schedule shall not be considered justification for a Change Order or treated as an acceleration order.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

Not used.

END OF SECTION

Section 01610
MANUFACTURERS' SERVICES

PART 1. GENERAL

1.1 SCOPE

A. This Section covers the services of manufacturers' representatives and special coordinating services required of the Contractor that shall apply during construction, facilities startup, and training of the Owner's personnel for facilities operation.

B. The Contractor shall inform all subcontractors, suppliers, and manufacturers of the requirements herein and include the following services in their costs for the work specified in these Contract Documents. Where a minimum amount of time is stated in the Specifications for manufacturers' services, any additional time required to perform the specified services shall be at no additional cost to the Owner.

1.2 DEFINITIONS

A. Construction Period: For the purposes of this Section, the "construction period" is defined as the time period from the Contractor's equipment purchase order date to the date of certification by the manufacturer that the equipment is installed correctly, inspected and is ready for startup and operation.

B. Startup Period:

1. The "Startup Period" of the entire facility or any portion thereof is defined as including coordinated operation of the facilities by the Contractor, its subcontractors, the Owner's operating personnel, and manufacturer's representatives for equipment items and systems.
2. Startup of the entire facility or any portion thereof shall be considered complete when, in the opinion of the Engineer, the facility or designated portion has properly operated for seven (7) continuous days without significant interruption. This seven (7)-day period shall be in accordance with Section 01820 – Systems Demonstration where applicable and is in addition to any training, functional, or performance test periods specified elsewhere.

C. Operation Period: The "Operation Period" shall be considered initiated when the facility has been successfully started up as defined under STARTUP PERIOD.

D. Mandays: One "Manday" is defined as equal to one person for 8 hours straight time, exclusive of Saturday, Sunday, or holidays, on-site, excluding travel time.

1.3 SUMBITTALS

A. In accordance with Section 01300.

1.4 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Only those manufacturers' services receiving prior approval by the Engineer shall act to fulfill the specified minimum manday requirements for such services. All requests for prior approval shall (1) be in writing; (2) be submitted not less than 10 days prior to the providing of the subject services; (3) state the service to be provided; and (4) state the reason(s) why the timing of the service is appropriate. Requests made to the Engineer less than 10 days prior to the providing of manufacturers' services may not receive consideration and response prior to the times the services are provided. The Contractor is advised that the Engineer reserves the right to disapprove the above requests for fulfillment of the specified minimum manday requirements. All responses to the Contractor, approving or disapproving requests for prior approval, will be in writing. Visits of manufacturers and their representatives to the jobsite or training classroom without prior approval as provided herein will not act to fulfill the specified minimum manday requirements.

1.5 SERVICES DURING CONSTRUCTION

A. General: Competent and experienced technical representatives shall represent the manufacturers of the respective equipment and systems with as many mandays as may be necessary to resolve assembly or installation problems at the worksite which are attributable to, or associated with, the equipment furnished. This requirement applies to manufacturers of all equipment furnished, whether or not this technical representation is specifically set forth in the other Sections of the Specifications.

1.6 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. Where a manufacturer's certificate is called for in the Specifications, the manufacturer's representative shall provide a certificate stating that the equipment or system has been installed in accordance with the manufacturer's recommendation and has been inspected by a manufacturer's authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, that all couplings and drives have been properly aligned, and that the proper electrical and mechanical connections have been made. This certification shall be provided to the Engineer prior to start-up.

1.7 FUNCTIONAL TESTING ASSISTANCE

A. Where functional (or run) testing is called for in the Specifications, the manufacturer's representative shall assist with the initial test, which shall include checking for proper rotation, alignment, speed, excessive vibration, and noisy operation. Initial equipment and system adjustment and calibrations shall be performed in the presence of and with the assistance of the manufacturer's

representative. The previously specified Manufacturer's Certificate of Proper Installation shall include the statement that proper adjustments have been made and that the equipment or system is ready for Plant startup and operation.

B. The Contractor, as applicable to the equipment furnished, shall state in writing that all necessary hydraulic structures, piping systems, and valves have been successfully tested; that all necessary equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate that they are all operational; that the systems and subsystems are capable of performing their intended functions; and that the facilities are ready for startup and intended operation.

C. Manufacturer shall demonstrate that the installed equipment has been aligned properly. Final acceptance of equipment will not be granted until manufacturer has demonstrated to the Engineer that acceptable alignment tolerances have been achieved.

1.8 PERFORMANCE TESTING AND PLANT STARTUP SERVICES

A. Where performance testing and Plant startup services are called for in the Specifications, or when technical assistance is necessary due to any malfunction of the equipment or system furnished, the manufacturer's representative shall provide such services. He shall also conduct and/or assist with final performance and demonstration testing, as required by the Specifications. These services shall continue until such times as the applicable equipment or system has been successfully tested for performance and has been accepted by the Owner for full-time operation.

B. Unless otherwise specified, all equipment for which performance testing is required shall be tested using the Plant fluid or media that the equipment is designed to handle during normal operation.

C. Start-up of equipment and plant shall be in accordance with Manufacturer’s instruction, Section 01650 – Starting of Systems, and Section 01820 – System Demonstration.

1.9 CONTRACTOR RESPONSIBILITIES DURING PLANT STARTUP

A. The Contractor shall designate and provide one or more persons to be responsible for coordinating and expediting his startup duties. The person or persons shall be present during all prestartup meetings and shall be available to the Owner's personnel at all times during the startup period.

B. When Plant startup has commenced, the Contractor shall schedule his remaining work so as not to interfere with or delay the completion of Plant startup. The Contractor shall support the startup activities with adequate staff to prevent delays, process upsets, and similar Plant impacting conditions. This staff shall include, but not be limited to, major equipment and system manufacturers' representatives, subcontractors, electricians, instrumentation personnel, millwrights, pipefitters, and plumbers.

C. Where Plant startup services are called for in the Specifications, the Contractor shall supply and coordinate the specified manufacturers' services for the Plant startup period.

D. The Contractor shall conduct equipment startup and field performance tests on all equipment, systems, and subsystems. These tests shall meet all requirements specified in other Sections of these Contract Documents.

E. The Contractor shall be responsible for adjustments, repairs, and corrections necessary to complete Plant startup.

F. After the Plant is operating, the Contractor shall continue the performance testing of those items of equipment, systems, and subsystems which could not be or were not adequately or successfully tested prior to the Plant startup.

1.10 TRAINING OF OWNER'S PERSONNEL

A. Where training of Owner's personnel is called for in the Specifications, the manufacturer's representative shall provide detailed instructions to the Owner's personnel for operation and maintenance of the specified equipment. These training services shall be in accordance with Section 01810 – Instructional Services and as stated in the individual equipment or product Specifications.

1.11 PROCEDURE

A. The Contractor shall designate and provide one or more persons to be responsible for coordinating and expediting his training duties. The person or persons shall be present at all training coordination meetings with the Owner.

B. The Contractor shall submit to the Owner an Installation Complete Schedule to be used by the Owner for scheduling the training of his operating personnel by equipment manufacturers. This schedule shall list the estimated completion dates for the installation of all equipment and systems requiring the services of manufacturers' representatives, as stated in the Specifications.

C. The Installation Complete Schedule for each equipment item or system shall be submitted not less than 21 days prior to the time that the associated equipment is installed and in an operating condition suitable for use in training the Owner's personnel.

D. The Contractor shall coordinate the prestartup training periods with Owner’s operating personnel and manufacturers' representatives. All prestartup training shall be completed 14 days prior to actual Plant startup.

E. Where post-startup training is called for in the Specifications, the Contractor shall supply and coordinate the specified manufacturers' services and Contractor personnel for post-startup training of the Owner's operating personnel. All post-startup training shall be completed within two months of substantial completion.

END OF SECTION

LINNWOOD OZONE COOLING WATER
BOOSTER SYSTEM REPLACEMENT
MILWAUKEE WATER WORKS

CERTIFICATE OF PROPER INSTALLATION

Project _____

Equipment _____

Specification Section _____

Contract _____

I hereby certify the equipment supplier/manufacturer has inspected this equipment and that it has been properly installed, adjusted, and calibrated. I further certify this equipment may now be operated for test purposes and/or normal use.

MANUFACTURER'S REPRESENTATIVE

Signature

Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature

Date _____

Name (print) _____

Title _____

This form shall be completed and submitted to the Engineer prior to plant start-up.

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Section 01650
STARTING OF SYSTEMS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Starting equipment and systems.

B. Plant start-up.

1.2 STARTING EQUIPMENT AND SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems. Contractor shall provide a start up and testing plant 90 days prior to the requested start up and testing period.

B. Notify Engineer 14 days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions.

G. Require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 01610 – Manufacturers Services that equipment or system has been properly installed and is functioning correctly.

I. Coordinate start up activities with the requirements of Section 01011 – Schedule and Sequence of Operations.

J. Where applicable, starting of systems shall be coordinated with the requirements of Section 01820 – Systems Demonstration.

1.4 PLANT START-UP

A. Start-up shall not commence until:

1. Manufacturer's Certificates of Proper Installation have been provided for all installed equipment.
2. Pipeline pressure tests have been completed.
3. Equipment has been lubricated in conformance with the manufacturer's recommendations.
4. All functional testing has been completed.
5. All performance testing has been completed, except for testing that the Engineer accepts to be performed during the clear water test.
6. The process instrumentation and control systems Operational Readiness Test has been substantially completed and documented.
7. All tests, adjustments, and settings have been performed on electrical equipment.
8. All operations and maintenance manuals have been approved by the Engineer.

B. Water Systems Start-up Period:

1. Start-up of the new facilities with water includes coordinated operation of the facilities by the Contractor(s), his subcontractors, Owner-operating personnel, and manufacturer's representatives for equipment items and systems.
2. The Contractor(s) shall provide the following services.
   a. Provide the coordinated services of all subcontractors and equipment suppliers to correct any and all observed and experienced deficiencies in the specified services completed or yet to be performed.
   b. Complete pump performance, field tests, and other tests approved by the Engineer on specified items, such as pumps, screens, other process equipment, and coordinate with the Owner's operation of such equipment.
   c. Complete the instrumentation system functional acceptance test.
   d. Provide the services of a project superintendent to manage any contract change orders during start-up.
3. The Contractor(s) shall designate and provide one or more persons to be responsible for coordinating and expediting his start-up duties. The person or persons shall be present during all prestart-up meetings and shall be available to the Owner's personnel at all times during the wastewater startup period.
4. Where start-up services are called for in the Specifications, the Contractor(s) shall supply and coordinate the specified manufacturers' services for the start-up period.
5. The Contractor(s) shall conduct performance tests on all equipment, systems, and subsystems not previously tested and approved by the Engineer.
6. The Contractor(s) shall be responsible for adjustments, repairs, and corrections of specified work.
7. The Owner will provide and pay for the necessary electrical service, fuel, chemicals, and other consumables to be used during the water startup and operation periods. The Contractor(s) shall coordinate the procurement and delivery of such items with the Owner.

8. Following the successful start-up of plant facilities on water, the owner will assume full responsibilities for all operations, maintenance and process adjustments. The Contractor(s), subcontractors, and equipment manufacturers shall only be responsible for specified warranty work, uncompleted work and remaining training services.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

Startup of the ozone cooling water improvements shall be coordinated with the Owner to ensure continued operation of the existing water treatment plant.

END OF SECTION

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Section 01700
CONTRACT CLOSEOUT

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Starting of systems.

D. Testing and adjusting.

E. Protecting installed construction.

F. Project record documents.

G. Spare parts and maintenance products.

1.2 RELATED SECTIONS

A. Section 01650 – Starting of Systems.

B. Section 01785 – Operation and Maintenance Data.

C. Section 01820 – System Demonstration.

1.3 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Owner will occupy portions of the site prior to acceptance of entire work.

1.4 STARTING OF SYSTEMS

A. Notify Engineer seven days prior to testing and/or start up of systems.

1.5 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Prohibit traffic from landscaped areas.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:

1. Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other modifications to the Contract.
5. Reviewed Shop Drawings, Product Data, and Samples.
6. Manufacturer’s Instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Failure to properly maintain record documents may be reason to delay a portion of progress payments until records comply with Contract Documents.

F. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and modifications.

G. The Contractor shall maintain one set of blueline full size prints on the jobsite, designated "Record Drawings". The Contractor shall contemporaneously maintain the set in a condition which reflects the current status of the construction work. The set shall be available to the Engineer and Owner for inspection and copying during the progress of the work. All markings shall be neatly performed with red pencil.

H. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction and all deviations from the original contract including:

1. Measured depths of foundations in relation to finish first floor datum.

2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
4. Field changes of dimension and detail.
5. Details not on original Contract drawings.
6. Changes resulting from minor field adjustments, field orders, and Contract Modifications.

I. Changes should be drawn after the respective construction work is completed and all new locations, dimensions, and elevations shall be shown. Where larger scale presentation is required, the Contractor shall prepare additional drawings and attach them to the appropriate blueline prints.

J. Submit documents to Engineer with claim for final Application for Payment.

OPERATION AND MAINTENANCE DATA

A. As specified in Section 01785 – Operation and Maintenance Data.

1.7 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance, and extra Products in quantities specified in individual specification sections.

B. Deliver to Project site and place in location as directed; obtain receipt prior to final payment.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

Not used.

END OF SECTION

Section 01785
OPERATION AND MAINTENANCE DATA

PART 1. GENERAL

1.1 SUMMARY

A. To aid the continued instruction of OWNER'S operating and maintenance personnel, and to provide a positive source of information regarding products incorporated into the Work, furnish and deliver the Operation and Maintenance (O&M) data described in this Section and as specified in other sections of these Specifications.

B. ENGINEER'S review and acceptance of O&M data will be only for conformance with requirements of this section, for form of submittal and organization of data and completeness of information provided, but not for technical content or coordination between individual suppliers. ENGINEER will be sole judge of completeness of data.

1.2 PAYMENTS

A. Progress payments for equipment delivered, stored or installed under these Contract Documents will not be made until copies of O&M data delivered to and approved by ENGINEER.

B. Progress payments for control systems packaged with equipment will not be made until O&M data incorporated into equipment and control system manual delivered to and approved by ENGINEER.

1.3 PAPER COPY SUBMITTALS

A. Submittals:

1. Each submittal shall consist of complete O&M data, bound in white three-ring binders bearing suitable identification on the front and spine of the binder.
2. Submit two (2) copies for review within 30 days after CONTRACTOR receives approved Shop Drawings for equipment. Engineer will review draft and return one copy with comments.
3. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
4. Submit two (2) copies of completed volumes 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.

5. Submit three (3) sets of revised final volumes in final form plus two (2) copies in PDF electronic format on CD disks within 15 days after final inspection.
6. Submit in accordance with Section 01300 – Submittals.

B. Format:

1. Size: 8-1/2 inch x 11 inch, or 11 inch x 17 inch folded, with standard three (3)-hole punching.
2. Paper: 20-lb minimum, white.
3. Text: Manufacturer's printed data or typewritten.
4. Drawings:
   a. Bind in text.
   b. Fold larger drawings and place in text page-size envelope bound into binder. Place identification on outside of envelope.
5. Provide tabbed section dividers.
   a. Provide title of section on divider.
   b. Provide tab index in Table of Contents.
6. Cover: Label each submittal cover with "OPERATION AND MAINTENANCE INSTRUCTIONS" and following:
   a. Project Title: City of Milwaukee, Wisconsin - Linnwood Ozone Cooling Water Booster Pump Project.
   b. Names of applicable buildings or structures as shown on Drawings in which equipment is located.
   c. Name of equipment as set forth in Contract Documents.
   d. Specification section number for equipment as set forth in Contract Documents.
7. Binders:
   a. Bind each submittal into a white D-ring commercial quality binder, 2-inch (50 mm) maximum ring size, with durable and cleanable plastic covers.
   b. Filled to not more than 75 percent of capacity.
   c. When multiple binders used, contents shall be organized into related groupings and each binder cover shall bear identification of specific content.
8. Page number submittals.
9. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.

1.4 ELECTRONIC COPY SUBMITTALS

A. Submit two (2) compact discs containing complete O&M data. The electronic formatted data shall contain all the information bound in O&M manuals. The information provided shall comply with the following requirements:

1. The text of the O&M manual shall be in the most current MS Word Format.
2. All general arrangement drawings shall be in AutoCAD 2010 or newer Format.

3. Subcomponent equipment (e.g., electric motors, gear reducers, etc.) O&M data shall be scanned and readable in .PDF format with Adobe Acrobat software.

B. CD Label: Label each CD submitted with "OPERATION AND MAINTENANCE INSTRUCTIONS" and following:

1. Project Title: City of Milwaukee, Wisconsin - Linnwood Ozone Cooling Water Booster Pump Project.
2. Name of equipment as set forth in Contract Documents.
3. Specification section number for equipment as set forth in Contract Documents.

C. CD Cover: Label each CD cover submitted with "OPERATION AND MAINTENANCE INSTRUCTIONS" and following:

1. Project Title: City of Milwaukee, Wisconsin - Linnwood Ozone Cooling Water Booster Pump Project.
2. Name of equipment as set forth in Contract Documents.
3. Specification section number for equipment as set forth in Contract Documents.

D. Submit in accordance with Section 01300 – Submittals.

1.5 QUALITY ASSURANCE

A. In preparing data required by this section, use only personnel thoroughly trained and experienced in operation and maintenance of the described items, completely familiar with the requirements of this section, skilled in technical writing to the extent needed for communicating the essential data, and skilled in drafting to prepare required drawings.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

3.1 GENERAL

A. Review O&M submittal and complete Form 1 to Section 01785 – Contractor Submittal Form, in its entirety indicating requirements of this section have been met. ENGINEER will reject submittals without completed Form 1.

3.2 GENERAL CONTENT OF DATA

A. Each submittal shall contain equipment data pertaining to not more than one (1) Specification section number indicated in Contract documents.

B. Title Sheet: First page inside cover listing following:

1. Title: OPERATION AND MAINTENACE INSTRUCTIONS.
2. Project Title: City of Milwaukee, Wisconsin - Linnwood Ozone Cooling Water Booster Pump Project.
3. Names of applicable buildings or structures as shown on Drawings in which equipment is located.
4. Name of equipment as set forth in Contract Documents.
5. Specification section number for equipment as set forth in Contract Documents.
6. CONTRACTOR'S name, address, and telephone number.
7. Subcontractor's name, address, and telephone number if equipment provided by Subcontractor.
8. Purchase order number, manufacturer's shop order number or other such number required for parts and service.
9. Manufacturer's name, address, and telephone number.
10. Name, address, and telephone number for local source of parts and service.

C. Product List: Immediately after title sheet. List of each product and major components, indexed to content of submittal, and identified by product name and model number as set forth by manufacturer and Specification section and article number.

D. Table of Contents: Immediately following product list. Arrange in logical, systematic order and shall be at minimum a tabbed section index. Provide each tabbed section with table of contents for section.

E. Product Data Sheets: Provide specification and catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets shall show project specific information with inapplicable information deleted by removal. Insert in tabbed sections.

F. Drawings:

1. Supplement text with drawings to clearly illustrate following:
   a. Product and components.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
2. Drawings to be actual drawings of equipment from manufacturer. "Typical" drawings not acceptable, unless they accurately illustrate actual equipment.
3. Do not use Project Record Documents as maintenance drawings.

G. Special Information:

1. Provide explanation of interrelationships of equipment and components, and effects one component has on another or system.

2. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
3. Provide glossary of special terms used by manufacturer.
4. Organize in consistent format under separate headings for different procedures.
5. Provide logical sequence on instructions for each procedure.

H. Warranty, Bond, or Service Contract.

1. Provide copy of each issued.
2. Provide information sheets to explain proper procedures in event of failure or malfunction to prevent voiding warranty or bond, and instances affecting validity of warranty or bond.

3.3 SPECIFIC CONTENT OF DATA

A. Specific content, for each unit of equipment and system, shall include following:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, and tests as applicable.
   c. Complete nomenclature and commercial number of replacement parts.
   d. Complete nameplate data.
   e. P&ID numbers for equipment as set forth in Contract Documents.
2. Operating Procedures:
   a. Startup, break-in, and normal operating instructions.
   b. Regulation, control, stopping, shutdown, and emergency instructions.
   c. Summer and winter operating instructions.
   d. Special operating instructions.
3. Maintenance Procedures:
   a. Routine maintenance operations.
   b. Guide to troubleshooting.
   c. Disassembly, repair, and reassembly instructions.
   d. Alignment, adjusting, and checking instructions.
4. Servicing and Lubrication Schedule:
   a. List of lubricants required and quantity to be applied.
   b. Schedule of lubrication.
   c. Schedule for other routine maintenance.
5. Manufacturer’s printed instructions regarding safety precautions for both protection of personnel and prevention of damage to equipment.
6. Description of sequence of operation of controls.
7. Manufacturer’s parts list, illustrations, assembly drawings, and diagrams required for maintenance.
8. Recommended spare parts to be stocked, and quantity.
9. Predicted life of parts.

10. Control diagrams (ladder diagrams, instrumentation loop diagrams, and electrical schematics as appropriate).
11. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
12. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
13. Include test and balancing reports as specified in Section 01400 – Quality Requirements.
14. Bill of material.
15. Completed EQUIPMENT DATA FORM typewritten on copy of Form 2 to Section 01785 – Operation and Maintenance Data. (Example of completed form is Form 3 to Section 01785 – Operation and Maintenance Data.)
16. Other data as required under pertinent section of Specifications.
17. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

B. Specific content for each electric and electronic system, as applicable to equipment.

1. Description of System and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, rating tables, and tests as applicable.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Complete nameplate data.
   e. P&ID numbers for equipment as set forth in Contract Documents.
2. Circuit Directories of Panelboards:
   a. Electrical service.
   b. Controls.
   c. Communications.
3. Include color coded wiring diagrams as installed.
4. Complete instrumentation loop diagrams with tabulated listing of components in each control circuit or loop.
5. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Sequences required.
   c. Special operating instructions.
6. Maintenance Procedures:
   a. Routine maintenance operations.
   b. Guide to troubleshooting.
   c. Disassembly, repair, and reassembly instructions.
   d. Adjustment and checking instructions.
7. Manufacturer’s printed instructions regarding safety precautions for both protection of personnel and prevention of damage to equipment.
8. Recommended spare parts to be stocked, and quantity.
9. Other data as required under pertinent sections of Specifications.

C. Specific content for materials and finishes, as applicable.

1. Building Products, Applied Materials, and Finishes:
   a. Product data, with catalog number, size, composition, and color and texture designations.
   b. Information for re-ordering custom manufactured Products.
2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendations for cleaning agents and methods.
   b. Precautions against detrimental agents and methods.
   c. Recommended schedule for cleaning and maintenance.
3. Moisture Protection and Weather Exposed Products:
   a. Product data listing applicable reference standards, chemical composition, and details of installation.
   b. Recommendations for inspections, maintenance, and repair.
4. Additional Requirements:
   a. As specified in individual Product specification sections.
5. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

D. Prepare and include additional data when need for such data becomes apparent during instruction of OWNER’S personnel.

END OF SECTION

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Section 01810
INSTRUCTIONAL SERVICES

PART 1. GENERAL

1.1 SUMMARY

A. Section includes:

1. Training manuals.
2. Classroom instructions.
3. Field hands-on training.
4. Other activities to provide comprehensive training program.

1.2 SUBMITTALS

A. Training Program:

1. Submit two copies of proposed training program, including student training manual and instructor guide, for review by ENGINEER.
2. After training program is approved by ENGINEER, and at least 30 days prior to training, submit five student training manuals, one reproducible student training manual, and one instructor guide.
3. The reproducible student-training manual shall be non-bound and not folded for reproduction in a standard copy machine. The reproducible manual shall be packaged under a protective cover; all pages shall be paper clipped together, in order, using appropriately sized binder clips.

B. Resumes:

1. Submit resumes, including three outside references, for each instructor proposed for training program.
2. ENGINEER will review resumes. Based upon review of resumes, and contacts with references, ENGINEER will approve, request additional information, or reject proposed instructors for training program.
3. If proposed instructor is rejected, CONTRACTOR shall submit resume and references on an alternate instructor for acceptance.

C. Submit in accordance with Section 01300 – Submittals.

D. Prior to scheduling prestart-up or operator training, the Contractor shall have submitted an operation and maintenance manual in accordance with Section 01785 – Operation and Maintenance Data that has achieved a “no exceptions noted” status

E. Provide “Certificate of Instructional Services” cosigned by OWNER and instructor, verifying training accomplished to satisfaction of all parties. Use the form in Appendix and furnish two copies to ENGINEER.

PART 2. PRODUCTS

2.1 TRAINING PROGRAM

A. Instruct and train OWNER'S personnel in maintenance and operation of equipment and systems supplied and installed under this Contract.

B. Incorporate following maintenance and operational data and training services into training program.

1. Shop Drawings.
2. Equipment Manuals.

C. Prepare instruction materials and objectives, student notes and guides, and tests required for complete classroom and field hands-on training. Sufficient materials shall be provided for fifty (50) employees.

D. Field hands-on training shall be conducted with a maximum of five students for each instructor.

2.2 INSTRUCTORS

A. Preparation of training materials and conduct of training shall be performed by personnel:

1. Trained and experienced in maintenance and operation of equipment and systems installed under this Contract.
2. Familiar with training requirements of OWNER'S personnel, that is, understand OWNER'S personal training needs.

2.3 FORM OF TRAINING MANUALS

A. Prepare training packages in form of an instruction manual for use by OWNER'S personnel.

B. Provide one pdf copy of the training manual on a compact disc for future reference and retraining.

C. Format:

1. Size: 8-1/2 inch x 11 inch.
2. Paper: 20-pound minimum, white, for typed pages.
3. Text: Manufacturer's printed data, or neatly typewritten, including:
   a. Table of Contents.
   b. Learning Objectives.
   c. General Operation, Theory, Specific Equipment Information.
   d. Test.
4. Drawings:
   a. Provide reinforced, punched binder tabs, bind in with text.
   b. Reduce larger Drawings and fold to size of text pages, not larger than 11 inch x17 inch.

5. Cover: Identify each volume with typed or printed title “Training Manual; NAME OF EQUIPMENT.”
   a. Title of Project.
   b. Identify separate structure or system as applicable.
   c. Identify general subject matter in Manual.

D. Binders:

1. Commercial quality binder with durable and cleanable plastic covers. Binders shall include title pockets for holding notes. Binders shall not be filled more than 75 percent capacity.
2. When multiple binders are used, correlate information into related consistent groupings.

2.4 VIDEOTAPED TRAINING

A. OWNER shall have the right to videotape or otherwise electronically or photographically record CONTRACTOR’S classroom and field hands-on training.

PART 3. EXECUTION

3.1 FACILITIES FOR TRAINING

A. Use OWNER’S designated training facilities for specific classroom and field hands-on training.

B. Facilities include installation sites, which shall be used for hands-on training programs.

C. Coordinate use of OWNER’S facilities with OWNER and ENGINEER.

3.2 SCHEDULE

A. Coordinate training periods with ENGINEER and Supplier’s representatives.

1. Notify ENGINEER at least 14 days before training sessions are to begin so ENGINEER can make arrangements with OWNER’S operating personnel.
2. Reschedule canceled training sessions 14 days in advance.
3. Failure of instructors to appear for scheduled training, failure to notify ENGINEER 48 hours in advance of need to cancel training session, or failure to arrive within 30 minutes of start of scheduled training session shall result in reimbursement to OWNER for time lost by OWNER’S personnel in waiting for arrival of instructor.

B. Provide training after completion of application software programming by Designer and before the start of Systems Demonstrations specified in Section 01820 – System Demonstration. See Section 01011 – Schedule and Sequence of Operations for sequencing and constraints.

C. OWNER'S personnel will require training, both for operating and maintenance functions. A total of three training sessions each lasting 2 hours in duration shall be conducted over multiple days.

3.3 MAINTENANCE OF PROCESS EQUIPMENT

A. Training Requirements:

1. Describe functions of process equipment.
2. Component preventative and corrective maintenance activities required to keep unit equipment in good operating conditions.
3. Instruct trainees in locating probable source of equipment malfunctions, determining symptoms of trouble, establishing probable cause, and effecting solution.

B. Course Materials:

1. Pertinent portions of operation and maintenance manuals as well as alignment tolerances, lubrication schedules, vibration analysis instructions and parameters, and special calibration test and procedures.
2. Detailed course outlines and troubleshooting guides for each piece of equipment. Troubleshooting guides shall include symptoms, probable causes, and solutions for trouble described during training program.
3. Course outlines shall include objectives that indicate information to be learned. The objectives shall state the answers to the test questions. Example of objective: "Students shall identify the points and frequency of grease lubrication on the machine."
4. Provide a 15 to 20 question test of the objectives being taught.
5. The objectives shall be equally divided between operation and maintenance and cover the subjects listed in 3.4 and 3.5.

C. Method of training maintenance personnel shall include CONTRACTOR using OWNER'S equipment to demonstrate troubleshooting, preventative and corrective maintenance procedures.

3.4 OPERATION OF PROCESS EQUIPMENT

A. Training Requirements:

1. Describe Functions of equipment including how components of system are controlled together and what effects of control methods are on system and on other upstream and downstream processes.
2. Being able to implement start-up and shutdown procedures for each piece of equipment individually, as well as start-up and shutdown of systems comprising equipment. This instruction shall include normal operation, alternative operations, and emergency operations.
3. Understand functions of instrumentation, describing individual components and how each component is used in monitoring and/or controlling equipment and/or processes.

4. Understand operating modes possible as result of modifications and installations.
5. Locating probable source of system inefficiency, determining symptoms, establishing probable cause, and restabilizing system efficiency for systems.
6. In taking necessary precautions for safe operation of equipment, instrumentation, and control system installed under this Contract.
7. Emergency procedures for equipment and systems during pump malfunction, chemical spills, and other extreme conditions.

B. Course Materials:

1. Pertinent portions of operation and maintenance manuals, including start-up and shutdown procedure; descriptions of equipment and instrumentation functions and modes of operations, control, and monitoring; troubleshooting instructions and process control instructions.
2. Detailed course outlines and troubleshooting guides for equipment and processes for field use. Operations guides shall include general operating procedures, start-up and shutdown procedures, optimization procedures, and emergency operating procedures.
3. Course outlines shall include objectives that indicate information to be learned. The objectives shall state the answers to the test questions. Example of objective: “Students shall identify the points and frequency of grease lubrication on the machine.”
4. Provide a 10 to 20 question test of the objectives being taught.
5. The objectives shall be equally divided between operation and maintenance and cover the subjects listed in 3.4 and 3.5.

C. Methods of training OWNER’S operating personnel shall include field-training program at OWNER’S site consisting of classrooms and field hand-on training using OWNER’S equipment and systems.

3.5 FIELD QUALITY CONTROL

A. Training Effectiveness:

1. Effectiveness of training operations personnel shall be assessed through written and in-the-field skill evaluation of trainees. Evaluations shall be designed to determine trainees’ ability to control processes, as well as their ability to operate and maintain equipment.
2. Unsatisfactory evaluations shall include recommendations for corrective action.

END OF SECTION

CERTIFICATE OF OPERATOR TRAINING

Project _____

Equipment _____

Specification Section _____

I hereby certify the equipment supplier/manufacturer has instructed Owner's personnel in the start-up operation and maintenance of this equipment as required in the specifications.

MANUFACTURER'S REPRESENTATIVE

Signature _____ Date _____

Name (print) _____

Title _____

Representing _____

CONTRACTOR

Signature _____ Date _____

Name (print) _____

Title _____

OWNER

I hereby certify that my operating personnel received _____ days instruction from _____ for start-up, operation, and maintenance of this equipment.

Signature _____ Date _____

Name (print) _____

Title _____

Section 01820
SYSTEMS DEMONSTRATION

PART 1. GENERAL

1.1 DESCRIPTION

A. Before Substantial Completion is considered, Contractor shall demonstrate satisfactory operation of specific equipment systems and associated facilities. Conduct demonstrations on systems listed below. Each system shall include facilities listed and associated structures, channels, conduits, piping, valves, gates, electrical, instrumentation, water, and other utilities necessary for system operation.

1. System 1 – House Water Connection to the Ozone Cooling Water Supply
   a. Backflow preventer and pressure regulation systems
2. System 2 – New Ozone Cooling Water Booster Pump Skid:
   a. All components and sequence of operation requirements

B. Preliminary:

1. Before Contractor begins Systems Demonstrations, the following Work shall be complete:
   a. Process control system and Electrical systems testing as specified in Divisions 13 and 16.
   b. Installation services specified in Section 01610.
   c. Operation and maintenance (O&M) data in accordance with Section 01785 has been submitted to and approved by Engineer.
   d. Instructional Services specified in Section 01810 – Instructional Services.
2. Contractor shall provide services of qualified, certified representatives of Suppliers to be present at Project Site as necessary to successfully complete Systems Demonstrations.
3. Contractor shall submit evidence of the representative's certification and qualifications to the Engineer for review and approval 30 days prior to the start of Systems Demonstrations.

C. Coordination:

1. Designate representative of Contractor to be responsible for Systems Demonstrations.
2. Contractor shall submit schedule of Systems Demonstrations for review by Engineer and Owner 30 days prior to Systems Demonstrations.
3. Notify Engineer at least 7 days before Systems Demonstrations are to begin.
4. Reschedule cancelled Systems Demonstrations 7 days in advance.

1.2 SUBMITTALS

A. Reports:

1. Prepare report for each system on results and activities encompassing system demonstration. Submit report within two working days of completion of System Demonstration.
2. Report shall describe operational conditions; daily results of systems operation; dates and names of people involved and observing operation; and statement regarding system ability to meet operational criteria.

B. Submit in accordance with Section 01300 – Submittals.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION

3.1 SYSTEMS DEMONSTRATIONS

A. Demonstrate operation and performance of each system for 7 consecutive days.

1. Where no specific performance requirements are stated in Specifications, demonstrate to show equipment operates in accordance with acceptable industry standards for application of equipment.
2. System Demonstration shall show equipment operates within manufacturer's tolerances for noise and vibration, equipment is responsive to manual and automatic controls, control and protective devices are properly set, and equipment operates on controlled or intermittent basis when such operation is intended.
3. Demonstrate proper function and process control for each control point, alarm, and safety lockout system.
4. The pump skid system shall see stable pressure operation within the acceptable ranges for the duration of the demonstration.

B. Temporary facilities and services are Contractor's responsibility. Contractor shall provide temporary facilities and services as required to complete testing and systems demonstrations.

C. For each system, Engineer will consider system demonstration successful and complete when system operates properly for 7 consecutive days without significant interruption.

D. If, in Engineer's opinion, system is not operating properly at any time during System Demonstration, Contractor shall stop demonstration and adjust, calibrate, or replace material and equipment as required to correct problem. After corrections have been made, restart System Demonstration and operate system for 7 consecutive days without significant interruption.

3.2 SUBSTANTIAL COMPLETION

A. Engineer will not consider Work substantially complete until Systems Demonstrations have been successfully completed.

END OF SECTION

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Section 02050
DEMOLITION

PART 1. GENERAL

1.1 SECTION INCLUDES

A. This Section covers the work necessary for, but not limited to, the following items as specified and shown on the Plans.

1. Disconnection and removal of existing booster pump skid and associated support, electrical, and piping.
2. Removal of existing standpipes and repair of floor penetrations.

1.2 WORK INCLUDES

A. Demolition and removal work includes, but is not limited to, the following items as specified or shown on the Plans.

1. Cutting, moving or removal of items as shown on Plans.
2. Cutting, moving or removal of items as necessary to provide access to allow alterations and new Work to proceed.
3. Cutting, moving or removal of items not shown to be cut, moved or removed, but which must be cut, moved or removed to allow new Work to proceed.
4. Patching or reinstalling Work or items which are to remain in finished Work.
5. Removal of existing surface finishes as needed to install new Work and finishes.
6. Removal of abandoned items.
7. Salvage of material and equipment as noted.
8. Demolition of structures.
9. Removal of portions of structures or utilities.
10. Abandonment of utilities.

B. Also included is the disconnection and removal of all designated material, equipment, electrical controls and debris stored or located within the area of work boundaries shown on the plans.

C. Demolition shall include identification of utilizes, disconnection, complete removal, and disposal of designated items unless noted otherwise and restoration of existing surfaces as required to provide a complete installation of new work.

1.3 GENERAL

A. See CONDITIONS OF THE CONTRACT and Division 1, GENERAL REQUIREMENTS, which contain information and the requirements that apply to the work specified herein and are mandatory for this project.

1.4 RESPONSIBILITY

A. The Contractor shall be responsible for determination of the full extent and nature of the work involved in disconnecting and removing existing materials and equipment by careful review of the Plans and Specifications and by conducting a thorough inspection of the demolition areas and surrounding areas prior to submitting a bid. Failure to do this shall not relieve the Contractor of responsibility to complete this work for the bid price submitted.

B The Contractor shall be responsible for the repairs and associated costs in connection with damage resulting from work under this Section.

C The Contractor shall be responsible for turning off the power and disconnecting all electrical feeds to equipment to be demolished and removed under the Contract.

D Contractor shall be responsible for referring to all of the Plans and Specifications for other trade's details for facility equipment disconnects and which affect the work covered under this Section.

1.5 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent buildings, building areas, and other site work.

B. Cease operations in the area of the work immediately if any structure appears to be in danger and notify the Owner's Representative. Do not resume operations in that area until approved by the Owner's Representative.

C. Elements designed, furnished and installed by the Contractor for stability and safety during construction are not shown on the Plans.

1.6 SAFETY REQUIREMENTS

A. Contractor shall take measures to ensure the safety and protection of plant operating personnel, visitors and the Owner's other personnel engaged on the premises.

B. Notify the Owner's Representative prior to any activities associated with the work under this Section which may affect Plant personnel or operation of the plant.

C. All work shall be done in conformance with the rules and regulations pertaining to safety established by OSHA, the Wisconsin Administrative Code, and all local codes and requirements.

D. Maintain protected egress and access to the work.

E. Provide temporary barricades around demolition work area to prevent the Owner's personnel and vehicles from entering the vicinity when unsafe conditions exist.

F. Maintain clean, uncluttered work area. Collect and dispose of debris periodically to ensure safety of personnel during demolition work.

G. Procure and pay for all permits, bonds, insurances, licenses, approvals, certificates and authorization necessary for the prosecution and completion of the work.

H. Promptly notify the respective departments or official bodies when work is ready for inspection and perform all work required to remove any violations or to comply with inspections, without additional charge to the Owner.

I. Perform the demolition work in accordance with the applicable requirements of the Safety Requirements for Demolition, American National Standard A10.6.

J. All work shall be conducted in a manner to ensure the safety of workmen and the general public.

1.7 RELATED WORK

A. Specified under other sections and applicable to this section: The applicable materials and workmanship specified in the following Sections are included by reference in this Section:

1. Section 01100 – Summary of Work.

1.8 SUBMITTALS

A. Submittals during construction shall be in accordance with Section 01300 - Submittals in Division 1 – GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:

1. Schedule of all demolition work, including requirements for notification of Owner in accordance with the Specifications.
2. Details regarding methods of demolition to be used.
3. Repair methods and materials for patching all materials damaged or otherwise affected during the work, and for surface restoration.
4. Certification that all hazardous materials have been handled and disposed of in accordance with these Specifications and all current applicable governing codes and regulations.
5. Results of field condition surveys.

1.9 REGULATORY REQUIREMENTS

A. Conform to applicable codes for demolition work, safety of structure and personnel, dust control, disposal of demolition wastes, and procedures applicable when hazardous or contaminated materials are discovered and handled.

B. Obtain required permits from authorities having jurisdiction for the work type.

C. Notify affected utility companies before starting work and comply with their requirements.

D.

E. Do not disable or disrupt building fire or life safety systems without 5 day prior written notice to the Owner and approval by appropriate regulating agency. Do not obstruct egress to exits.

F. Do not close or obstruct roadways, sidewalks, and/or hydrants on the site without permission of the Owner.

1.10 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of capped utilities, and subsurface obstructions.

1.11 SEQUENCING

A. Sequence work under the provisions of Section 01011 – Schedule and Sequence of Operations.

1.12 SCHEDULING

A. The Contractor will be required to schedule demolition work in such a manner as to maintain plant operations and to coordinate schedule with concurrent and contiguous site work contracts. See Section 01010 – Summary of Work.

B. Describe demolition removal procedures and schedule.

1.13 EXISTING CONDITIONS

A. General:

1. Survey and record condition of existing facilities to remain in-place that may be affected by Work. After Work is complete, survey conditions again and restore facilities to original condition at no additional cost to Owner. Conduct surveys in presence of Owner's Representative.
2. Some existing conditions may not be shown. Bidders are advised to carefully inspect the existing site before preparing their proposals. The removal of minor obstructions encountered that are not shown on the drawings, but could have been foreseen by visual inspection of the site prior to bidding, shall be anticipated and accomplished without a cost adjustment to the contract, even though not shown or specifically mentioned.
3. Major obstructions encountered that are not shown on the drawings, or could not have been foreseen by visual inspection of the site prior to bidding, should immediately be brought to the attention of the Owner's Representative. The Owner's Representative will make a determination before proceeding with the Work. If the Owner's Representative finds that the obstruction adversely affects the Contractor's costs or schedule for completion, a proper adjustment to the contract will be made.

4. The location of the existing items to be demolished or removed is shown on the drawings. All demolition shall be coordinated between the specifications and all drawings. Demolition requirements identified on the drawings are not limited to “demolition” and/or “removal” drawings.

PART 2. PRODUCTS

2.1 GENERAL

A. The Contractor shall provide all materials and equipment in suitable and adequate quantities as required to accomplish the work shown, specified herein, and as required to complete the project. Hoses, ladders, and other tools or equipment belonging to the Owner shall not be used to accomplish this work.

B. If Owner tools or equipment obstruct the work, Contractor shall notify the Owner’s Representative and request that the Owner temporarily relocate such items until such time as work has been accomplished. If Owner tools or equipment are missing or damaged during the duration of the work, Contractor shall be responsible for replacement or repair to a condition that existed prior to the commencement of the work.

C. All tools, materials and equipment shall be clearly labeled with names of Contract and Contractor. Containers of materials and equipment shall also include labeling indicating contents.

D. The use of explosives and jack hammer shall not be allowed for demolition work. Saw cutting, core drilling, flame-cutting, sandblasting, and welding operations shall be limited and shall require express permission of the City of Milwaukee and the Owner’s Representative.

2.2 REPAIR OF DAMAGE

A. Material for repair of facilities damaged or disturbed by the demolition shall be equal to that existing prior to the start of the demolition.

2.3 REMOVAL OF WASTE

A. Contractor shall be required to dispose of all waste, including any universal or hazardous waste.

B. Contractor shall supply any universal or hazardous waste shipping documents, bill of ladings, and manifests as required for the project.

PART 3. EXECUTION

3.1 GENERAL

A. The location of the equipment, structures piping, and miscellaneous items to be demolished are indicated on the Plans or specified herein.

B. Provide all protection, barricades, etc., which may be required by Federal, State and Municipal laws and maintain all lights, signals and protection of all kinds for the full period of operation. Maintain this protection and remove same when directed.

C. Operations shall be done in such manner as to avoid hazards to persons and property and interference with the use of adjacent areas or interruption of free passage to and from such areas. Care shall also be taken to prevent the spread of dust and flying particles. Keep area sprinkled if necessary to control dust.

D. Take whatever precautions are necessary to prevent any settlement, collapse of or other damage to existing building elements which are to remain, and promptly repair any such damage resulting from such operations.

E. Cease operations and notify the Owner's Representative immediately if adjacent structures appear to be endangered. Do not resume operations until corrective measures have been taken.

F. Debris shall not be allowed to accumulate. Excess debris and waste material shall be removed from the site daily as the work progresses.

G. Where new Work is to be installed or suspended concealing existing surfaces or spaces, Contractor shall remove foreign substances such as grease, sludge, and odoriferous material before starting Work.

H. Where surfaces are to remain exposed, Contractor shall remove foreign substances such as grease, sludge, and odoriferous material.

3.2 DEMOLITION REQUIREMENTS

A. Perform demolition work so as not to interfere with normal Water Treatment Plant operations unless suitable alternative operation methods are in place and have been approved by the owner.

B. Perform demolition work so as not to interfere with the work of other contracts at the Water Treatment Plant.

C. Contractor shall inform Owner's Representative at least 3 days prior to any demolition work. Contractor shall obtain consent from the Owner to proceed with the demolition work. After work is started it shall be continued to completion.

D. Unless noted otherwise, all existing utility lines requiring connection to new lines or demolition shall be expected to be in service. Prior to demolition or connection, all shutdowns shall be coordinated with the Owner and utility owner. Keep such shutoffs to minimum number and length. Once Work has started on temporary shutoff, continue until Work is complete. Make no shutoffs without prior approval.

E. Inspect existing conditions of work, including elements subject to movement or damage during cutting, patching, excavating, and backfilling. After uncovering work, inspect conditions affecting installation of new work.

F. Saw cutting for concrete demolition shall be done whenever possible. Chip where not accessible to saw. Do not overcut at corners.

G. Demolition equipment shall be selected and operated such that structures, utilities, and other existing works that are to remain will not be damaged and cause injury to workers.

H. Provide temporary shorings, bracings, and other means to insure safety of workers during demolition and removal.

I. Provide and maintain continuous electrical, plumbing, and HVAC services to functioning portions of facilities during hours normally in use.

1. Temporary outages are permitted during cutover work at such times and places as can be pre-arranged with Owner's Representative and Owner. Keep such outages to minimum number and length. Make no outages without prior approval.
2. Remove temporary equipment and materials when no longer required.

3.3 PROTECTION OF PROPERTY

A. Provide, erect and maintain temporary barriers or barricades, as required, around the demolition work area to protect property, to prevent the Owner's personnel and vehicles from entering the vicinity and to prevent spread of dust, odors, and noise.

B. The Contractor shall protect all existing buildings, and property, in the vicinity of the demolition work from damage. Prevent movement or settlement of adjacent structures. The Contractor shall provide bracing and shoring as necessary. The Contractor shall also protect other miscellaneous items, such as manholes and piping, which are not to be demolished.

C. The Contractor shall protect existing property, roads, walks, equipment, or vehicles, and other miscellaneous materials such as piping which are not shown to be demolished, which may be in the vicinity of the demolition work.

D. Perform Work with trades qualified to perform Work in manner causing least damage to each type of Work.

E. Dust, dirt, and debris shall be controlled to protect existing equipment and operations from shutdown.

F. Erect and maintain weatherproof closures for exterior openings and provide cold weather protection for existing and new equipment and construction.

G. Contractor shall provide watertight and dust-tight enclosures for existing equipment that may be affected by operation of concrete saws, drills, or other demolition activities. Contractor shall ensure that protective enclosures do not shut down equipment due to excessive heat accumulation.

H. Give special attention to fire protection in areas where welding will be performed. Flame cutting shall not be permitted without special approval by the Owner's Representative. Protect combustible materials. Provide dry chemical extinguisher and train workmen in their use.

I. Provide appropriate temporary signage, including signage for exits or building egress.

J. Maintain in service and protect from damage and leakage, all existing utilities that are not to be demolished or abandoned.

3.4 TEMPORARY ELECTRICAL AND MECHANICAL SERVICES

A. Electrical:

1. Maintain existing electrical service to existing equipment until removed from service.
2. Provide temporary electrical connections to new equipment if permanent wiring is not complete and equipment is required to be placed into service to continue operation of facility.
3. Provide temporary electrical connections to temporary equipment or existing equipment that has been relocated, but is required to continue operation of facility.

B. Mechanical:

1. Maintain existing interior work area above 60°F.
2. Provide weather protection, waterproofing, heat, and humidity control to prevent damage to remaining existing and new Work.

3.5 UTILITIES AND PROCESS PIPING

A. Unless otherwise noted, the Contractor shall assume that all process piping and electrical wiring is in service. Prior to demolition or disconnection, all shutdowns shall be coordinated with the Owner's Representative, appropriate utilities notified, and all lines shall be isolated, drained and/or pumped until emptied. Do not drain or pump lines into existing drains or treatment system without the written approval of the Owner's Representative.

B. The Contractor shall be responsible for the turning off or unhooking of all-utilities and process piping before starting the demolition work. Remove all utility lines, including electrical services and process piping that are exposed by demolition excavation.

C. The Contractor shall not operate any valve or disconnect any utility, piping, or electrical service until he has notified and coordinated effort with the Owner's Representative.

D. Where interference with facilities occurs, cooperate with owner of utility and, if necessary, alter utility or facility to eliminate interference.

3.6 ABANDONMENT OF UTILITIES, PROCESS PIPING, AND ELECTRICAL DUCT

A. All utilities, process piping and electrical duct that are exposed by demolition excavation and to be abandoned that are not removed shall be plugged with a concrete plug or a 12-inch thick solid masonry wall bulkhead to prevent soil infiltration into the pipes, unless shown otherwise on the Plans, at the cut ends. Where the abandoned, utility, process piping, sewer or duct connects to a manhole or other structure, the pipe or duct shall be plugged with a concrete plug or 12-inch thick solid masonry wall unless shown otherwise on the Plans, at the manhole walls. The concrete plug shall be at least 1 foot long or 6 inches longer than the diameter of the pipe, whichever is greater and shall fill the entire area of the pipe. The plug shall extend inside the manhole a minimum of 3 inches. Gates and other devices attached to or obstructing sewers and utilities to be abandoned and plugged shall be removed prior to the installation of the plug. Perform demolition and removal work so as not to interfere with the Owner's operations; see Section 01011 – Schedule and Sequence of Operations. All construction operations, including demolition and removals, which may cause disruption of utility service or plant operations shall be scheduled with and approved by the Owner's Representative. Contractor shall notify the Owner a minimum of 5 days prior to disruptions of service or operations due to construction activities.

3.7 SALVAGE

A. Unless otherwise noted within the Bidding Documents or directed by the Owner's Representative, other equipment, material, and piping within the limits of the demolition, excavations, and backfills, will become the property of the Contractor and shall be removed from the project site. The salvage value of this equipment, materials, and piping shall be reflected in the Contract price of the demolition work.

B. Salvage sufficient quantities of cut or removed material to replace damaged Work of existing construction or patch new Work when material not readily obtainable on current market.

C. Deliver salvaged materials and equipment to location designated by Owner on site.

E. The Contractor shall not setup a market at the project site for the sale or barter of salvaged items.

3.8 RESTORATION

A. Existing structures and surfaces which are damaged during the course of the work shall be restored to the condition that existed prior to the commencement of the work.

B. Restoration shall be done with new materials and appropriate methods as specified for new work of similar nature; or, if not specified, best recommended practice of manufacturer or appropriate trade association and industry standards.

C. Restore damaged work such that new work and old work are fastened together securely. Restored surfaces shall be finished to such planes, shapes, and textures that no transition between new and old work is evident in finished surfaces of like materials. Where change of plane of 2 inch or more occurs, notify Owner's Representative and request direction.

D. After demolition, restore all remaining surfaces to a condition acceptable for the installation of new work as governed by the Specifications for new material. Any remaining surfaces damaged by demolition shall be restored to match existing adjacent surfaces.

E. Refinish patched portions of painted or coated surfaces to produce uniform color and texture over entire surface.

F. When existing surface finish cannot be matched, refinish entire surface to nearest intersection.

G. When new Work abuts or finishes flush with existing Work, transition shall match existing adjacent Work in texture and appearance so patch or transition is not visible at a distance of 6 feet.

H. Clean and repair damage caused by installation or by use of temporary facilities.

1. Remove foundations and underground installations used for construction aids.
2. Grade areas affected by temporary installations to required elevations and slopes.

3.10 MECHANICAL DEMOLITION

A. Demolition of mechanical equipment and materials shown on the Plans and required herein shall include the demolition of all support systems, including equipment pads, unless required for stability of remaining materials or equipment or unless specifically required to support new work. Prior to dismantling equipment or piping, Contractor shall verify with the Owner's Representative where equipment is to be disconnected.

B. All piping and equipment remaining after demolition which will not be incorporated into the new work shall be capped and resupported in a manner acceptable to the Owner's Representative.

C. Unless shown otherwise, remove all exposed raceway systems, wiring, and piping from removed or disconnected system equipment back to the source equipment.

D. All piping and equipment shall be drained or pumped prior to removal. Exposed ends of piping and utility lines shall be suitable capped. Maintain in service and protect from damage or leakage all existing utilities and piping indicated to remain.

E. Remove all unused wall and floor sleeves in areas where piping or equipment is to be demolished, including cases where a pipe has been previously removed from the sleeve. All holes shall be patched in accordance with Section 01470 – Cutting and Patching.

F. Electrical equipment in the vicinity of piping modifications shall be protected from water in accordance with applicable codes and regulations.

G. Where existing materials and equipment are removed or relocated, remove all materials no longer used such as studs, straps, conduits, and wires. Remove or cut off concealed or embedded conduit, boxes, or other materials and equipment to a point at least ¾ inch below the final finished surface.

H. Where existing raceways are designed “Abandon” or “Abandon in Place,” remove conductors and plug or cap ends to prevent entrance of water into raceway system. Provide individual raceways with threaded waterproof cap, or with 12 inch minimum length concrete plug filling entire area of raceway.

I. Voice warning system and fire alarm system wiring is supervised by circuits that will initiate an alarm on an open, short, or ground. De-activate supervision equipment for wiring to be removed before removing any wiring. Supervision wiring to remain in place shall remain active at all times, except for short temporary outages.

J. The Owner will provide one copy of the existing voice warning system and fire alarm system operation and maintenance manual at no charge within 10 days of the Contractor’s written request. Manuals shall remain the property of the Owner, and shall be returned after supervised wiring is removed.

K. Repair affected surfaces, which are to remain in place, to conform to the type, quality, and finish of the surrounding surface in a neat and workmanship manner.

3.14 DISPOSAL OF DEMOLITION MATERIALS, EQUIPMENT AND DEBRIS

A. Where existing materials, equipment and debris are to be removed, Contractor shall be responsible for removal and disposal. Disposal shall be in accordance with all applicable codes and regulations. Remove demolished materials from the site as work progresses. Leave areas in clean condition upon completion of the work. Remove all temporary work.

B. No burning of combustible materials will be permitted. Remove all demolition debris from the work site and dispose of in accordance with local laws, codes, and ordinances.

C. Do not bury concrete, asphalt, or other debris in areas to be backfilled with gravel or earth material in the demolition areas.

3.15 CLEANING

A. Perform periodic cleaning and final cleaning as specified in Section 01710 – Cleaning.

1. Clean Owner occupied areas daily.
2. Clean spillage, overspray, and heavy collection of dust in Owner occupied areas immediately.

B. At completion of alteration and demolition Work in each area, provide final cleaning and return space to condition suitable for use by Owner.

END OF SECTION

Section 02675
DISINFECTION OF POTABLE WATER PIPING AND EQUIPMENT

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Disinfection of potable water piping connections and new piping installations.

B. Flushing of potable water piping connections and new piping installations.

C. Bacteriological testing and reporting results.

Note: Leakage and pressure testing shall be done after disinfection has been completed according to Section 15000.

1.2 RELATED SECTIONS

A. Section 11000 – Ozone Cooling Water Booster Pump Skid
B. Section 15001 – Piping General
C. Section 15018 – Galvanized Steel Pipe and Malleable Iron Fittings
D. Section 15100 - Valves

1.3 REFERENCES

A. AWWA B300 - Standard for Hypochlorites.

B. AWWA B301 - Standard for Liquid Chlorine.

C. AWWA B303 - Standard for Sodium Hypochlorite.

D. AWWA C651 - Standards for Disinfecting Water Mains.

1.4 PROJECT RECORD DOCUMENTS

A. Disinfection Report:

1. Type and form of disinfectant used.
2. Date and time of disinfectant injection start and time of completion.
3. Test locations.
4. Initial and 24 hour disinfectant residuals (quantity in treated water) in parts per million (ppm) for each outlet tested.
5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.

B. Bacteriological Report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.

5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of the Owner.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651 and in accordance with requirements of the Owner.

B. Approved disinfection procedures are the continuous feed method, slug method and tablet method.

C. Work shall be conducted under supervision of governing local or state authorities.

D. Disinfection process shall be done only by a company specializing in water treatment, having experienced operators, and appropriate equipment.

E. Water samples will be collected and tested by the Owner.

1.6 REGULATORY REQUIREMENTS

A. Conform to applicable code or regulation for performing the work of this Section.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of water system.

PART 2. PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals: Approved forms of chlorine shall be calcium hypochlorite, sodium hypochlorite.

PART 3. EXECUTION

3.1 EXAMINATION

A. Verify that piping system has been cleaned.

B. Perform scheduling and disinfecting activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 EXECUTION

A. Provide and install required equipment to perform the work of this Section.

B. Leakage and pressure testing shall be done after disinfection has been completed.

C. Water main shall be flushed by Contractor or prior to disinfection except when the tablet method is used.

D. When tablet method is used, water main shall be disinfected for period of not less than 24 hours.

E. Chlorine dosage shall not be less than 50 parts per million.

F. Maintain disinfectant in system for 24 hours.

1. If less than 25 parts per million (ppm) residual is shown at end of first 24-hour period, add chlorine until a residual of not less than 25 ppm is shown after subsequent 24-hour period.

2. Remove chlorinated water from mains and fill mains with water, ready for bacteriological testing.

3. Samples will be taken after mains have been satisfactorily chlorinated.

G. Flush, circulate, and clean until required cleanliness is achieved for period of not less than 2 hours; use municipal domestic water. Maintain the following minimum flows for a period of time consistent with length of pipe:

1. 2 inch, 25 gpm

H. Flush chlorinated water from system, following a contact period, with clear water until residual chlorine content is not greater than 0.2 part per million.

I. Open and close all valves in disinfected water lines at least four times during sterilization period.

J. Flushing velocities shall not be less than 2.5 feet per second. Contractor shall provide all fire hose, taps, flushing plugs, pipe and fittings as needed for flushing.

K. Replace permanent system devices removed for disinfection.

L. Refer to Section 15000 for pressure test and leakage test.

M. All mains and water services larger than 2 inches require two consecutive "safe" samples, taken at least 24 hours apart. Normal sequence and time requirements for testing are:

1. Flush
2. Chlorinate, 24 hours
3. Flush
4. Wait, 24 hours
5. Bacteriological sample, 24 hours

6. Pressure test
7. Wait, 24 hours
8. Bacteriological sample, 24 hours

N. Samples will be collected and analyzed by the Owner in accordance with AWWA C651.

END OF SECTION

Section 03300
CAST-IN-PLACE CONCRETE

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Elevated slabs.

1.2 REFERENCES

A. American Concrete Institute:

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 301 – Specifications for Structural Concrete.
3. ACI 302 – Guide for Concrete Floor and Slab Construction.
4. ACI 304 – Guide for Measuring, Mixing, Transporting and Placing Concrete.
5. ACI 305R – Hot Weather Concreting.
6. ACI 306R – Cold Weather Concreting.
7. ACI 308 – Guide to Curing Concrete.
8. ACI 318 – Building Code Requirements for Reinforced Concrete.
9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures.

B. American Society of Testing and Materials:

1. ASTM C33 – Standard Specification for Concrete Aggregates.
2. ASTM C94 – Ready Mixed Concrete.
3. ASTM C150 – Standard Specification for Portland Cement.
4. ASTM C260 – Air Entraining Admixtures for Concrete.
5. ASTM C330 – Light Weight Aggregates For Structural Concrete.
6. ASTM C494 – Chemicals Admixtures for Concrete.
7. ASTM C618 – Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.3 SUBMITTALS

A. Schedule and Sequence of Placing Concrete.

B. Drawings Showing Location of Construction Joints, if different from that shown.

C. Concrete Mix Design and Trial Mix Laboratory Reports.

D. Certification for Aggregate Quality, including a statement from an independent laboratory that the aggregates to be used are not reactive.

E. Product Data: Provide data on joint devices, attachment accessories and admixtures.

F. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.

1.4 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of embedded utilities and components that are concealed from view.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 117, 301 and 304.

B. Maintain one copy of document on site.

C. Acquire cement and aggregate from same source for all work.

D. Conform to ACI 305R when concreting during hot weather.

E. Conform to ACI 306R when concreting during cold weather.

PART 2. PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement:

1. Portland Cement Type I or Type II conforming to ASTM C150, including the low alkali provisions of Table 1 A of that specification. In addition, the tricalcium aluminate content of Type I cement shall not exceed 12 percent.
2. Type I or Type II cement, at the Contractor's option, may be used for non-hydraulic above-grade structures.
3. For all hydraulic and below-grade structures and sewers, use Type II cement (i.e., Portland cement meeting the requirements of ASTM C150, Type II) or, at Contractor's option, use the combination of Type I mixed with fly ash. At Contractor's option, fly ash may be used in combination with any cement as long as all requirements of these Specifications are met. The fly ash may be combined at the batch plant or during the production of the cement (Type IP cement). For the combination fly ash and cement, the cement and fly ash shall comply with these Specifications.

B. Aggregates:

1. Natural aggregates, free from deleterious coatings, conforming to ASTM C33, together with all referenced ASTM Standard Specifications, except as modified herein. Aggregates shall not be potentially reactive as defined in Appendix XI of ASTM C33. The Contractor's attention is directed also to paragraph X1.1 of Appendix XI of ASTM C33 since

evidence of reactive problems on existing structures shall be used also to prove that sources of aggregates are reactive and cannot be used. The Contractor shall be responsible for meeting these Specifications and shall import non-reactive aggregates if local aggregates are reactive. Aggregates shall be thoroughly and uniformly washed before use.

2. Local aggregates not in compliance with the soundness and durability requirements of this standard shall not be used except with prior written approval of the engineer and provided it can be shown by special testing or a record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C88 using a sodium sulfate solution.
3. Fine Aggregates: Conform to ASTM C33. Materials finer than the 200 sieve shall not exceed 4 percent. Use only clean, sharp, natural sand.
4. Coarse Aggregate: Use only natural gravels, a combination of gravels and crushed gravels, crushed stone, or a combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension). Materials finer than the 200 sieve shall not exceed 0.5 percent.
5. Combined Gradation: Provide submittal for aggregates showing percent of fine and coarse aggregates and the combined calculated total percent passing from 2-inch size to No. 200 sieve.

C. Water: Clean and free from oil, acid, alkali, organic matter, or other deleterious substances.

2.2 ADMIXTURES

A. Air Entrainment: ASTM C260:

1. Daravair AT30, manufactured by Grace Construction Products.
2. MB-AE 90 or Micro Air, manufactured by BASF, Inc.
3. Catexol A.E. 260, manufactured by Axim Italcementi Group.
4. Approved equal.

B. Chemical: ASTM C494:

1. Type A – Water Reducing;
   a. WRDA with Hycol or WRDA 64, manufactured by Grace Construction Products
   b. Catexol 1000 N, manufactured by Axim Italcementi Group.
   c. Pozzolith 80, manufactured by BASF, Inc.
   d. Approved Equal.
2. Type D – Water Reducing, Set Retarder;
   a. Daratard 17, manufactured by Grace Construction Products
   b. Pozzolith 80, manufactured by BASF, Inc.
   c. Approved Equal.
3. Type F (or G) – High-Range Water Reducing;
   a. Daracem 100, manufactured by Grace Construction Products.
   b. WRDA manufactured by Grace Construction Products.

c. PolyHeed 1025, manufactured by BASF, Inc.
d. Approved Equal

C. Fly Ash: ASTM C618; Class C providing increased sulfate resistance equivalent to or better than Type II cement

2.3 ACCESSORIES

A. Bonding Agent:

1. EVA-POX BONDER No. 1, manufactured by E Poxy Industries.
2. Duralprep A.C., manufactured by Euclid Chemical Company.
3. Armatec 110, manufactured by Sika
4. Daraweld C, manufactured by Grace Construction Products
5. Approved Equal.

B. Grout – See Specification Section 03600.

C. Foundation insulation shall be extruded polystyrene foam with a minimum R value of 5.4 per inch of thickness. Use Dow Chemical Company “Styrofoam SM” or approved equal.

2.4 JOINT DEVICES AND FILLER MATERIALS

A. Joint Filler: As specified in Section 03251 – Expansion and Contraction Joints.

2.5 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94, Alternative No. 2. No job site mixing without approval of Engineer.

B. Select proportions for normal weight concrete in accordance with ACI 301 Method 3.

C. Use of calcium chlorides or admixtures containing calcium chloride will not be allowed.

D. Provide concrete to the following criteria:

Minimum Strength 28 days	**Maximum Size Aggregate**	**Max Slump**	**% Air Content**
Interior Elevated Slabs: 4000 psi	1”	4”	None

Water/cementitious materials (maximum): 0.40 by weight (mass)
Admixture: Water reducing type
Fly Ash Content: Maximum 25 percent of cement content.

E. Accelerating admixtures shall not contain any chloride ions. Accelerating admixtures are permitted in cold weather only when approved by Engineer. Use of admixtures will not relax cold weather placement requirements.

F. Use set retarding admixtures during hot weather only when approved by Engineer.

G. Add air entraining agent to normal weight concrete mix for work exposed to exterior.

H. Combined Aggregate Grading: Aggregate for concrete shall be combined in proportions that will provide a mixture within the grading units shown below:

	Percentage Passing			
Sieve Sizes	**1-1/2 inch Max.**	**1 inch Max**	**3/4 inch Max**	**Sand for Grout**
2 inch	100	---	---	---
1-1/2 inch	95 – 100	100	---	---
1 inch	65 – 85	90 – 100	100	---
3/4 inch	55 – 75	70 – 90	92 – 100	---
1/2 inch	---	---	68 – 86	---
3/8 inch	40 – 55	45 – 65	57 – 74	---
No. 4	30 – 45	31 – 47	38 – 57	95 – 100
No. 8	23 – 38	23 – 40	28 – 46	80 – 100
No. 16	16 – 30	17 – 35	20 – 36	50 – 85
No. 30	10 – 20	10 – 23	14 – 25	25 – 60
No. 50	4 – 10	2 – 10	5 – 14	10 – 30
No. 100	0 – 3	0 – 3	0 – 5	2 – 10
No. 200	0 – 2	0 – 2	0 – 2	---

2.6 CONCRETE SLURRY

A. Concrete slurry where shown on the drawings shall have a specified compressive strength of 3,000 psi at 28 days using 3/4-inch aggregate and a 4-inch maximum slump and 0.49 water cement ratio. Use water reducers as hereinbefore specified.

PART 3. EXECUTION

3.1 EXAMINATION

A. Verify requirements for concrete cover over reinforcement.

B. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush or, (where indicated on the plans) by scarification to a minimum of 1/4 inch, and applying bonding agent in accordance with manufacturer's instructions.

B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, clean holes, insert and grout steel dowels into concrete using foil-fast epoxy injection system as manufactured by the Rawlplug Company, or approved equal. Hole size and use of epoxy in accordance with manufacturer recommendations.

C. Before placing concrete, all equipment for mixing and transporting shall be cleaned; all debris, water and ice shall be removed from the spaces to be occupied by concrete; forms shall be thoroughly wetted (except in freezing weather) or oiled; and the reinforcement shall be thoroughly cleaned of ice, rust scale or other foreign material.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 304, ACI 301, ACI 350, and ACI 318.

B. Notify Engineer minimum 24 hours prior to commencement of operations.

C. Ensure reinforcement, inserts, embedded parts, and formed expansion and contraction joints, are not disturbed during concrete placement.

D. Install vapor barrier under interior slabs-on-grade. Lap joints minimum 6 inches and seal watertight by sealant applied between overlapping edges and ends and also taping edges and ends.

E. Repair vapor barrier damaged during placement of concrete reinforcing. Repair with vapor barrier material; lap over damaged areas minimum 6 inches and seal watertight.

F. Separate slabs-on-grade from vertical surfaces with 1/2-inch thick joint filler or as indicated on the drawings.

G. Place joint filler in floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.

H. Extend joint filler from bottom of slab to within 1/2-inch of finished slab surface.

I. Install joint devices in accordance with manufacturer's instructions.

J. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

K. Place concrete continuously between predetermined expansion, control, and construction joints.

L. Do not interrupt successive placement; do not permit cold joints to occur.

M. Place floor slabs in checkerboard pattern indicated.

N. Saw cut joints within 24 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.

3.4 CONCRETE FINISHING

A. Finishes

1. Provide formed concrete surfaces to be left exposed with smooth rubbed finish.
2. Finish concrete floor surfaces in accordance with ACI 301. See Specification section 03346 for floor finishing requirements.

B. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Cure concrete floor surfaces to requirements of Section 03370 – Concrete Curing.

3.6 FIELD QUALITY CONTROL

A. General Contractor shall retain a qualified inspection and testing agency to ensure quality concrete materials and execution of work. The inspection and testing agency shall meet the requirements of ASTM C1077.

B. General Contractor shall provide free access to Work and cooperate with appointed firm.

C. Use of testing services will not relieve the Contractor of the responsibility to furnish materials and construction in full compliance with the contract documents.

D. General Contractor shall provide adequate means for the safe storage and proper creation of required test specimens.

E. The testing agency will inspect, sample, and test materials and production of concrete as required to determine whether or not the concrete materials and methods are in conformance with ACI standards and the Contract Documents

F. Field inspection and testing will be performed in accordance with ACI 301.

G. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.

H. Tests of cement and aggregates may be performed to ensure conformance with specified requirements.

I. Compression strength tests shall be made in accordance with the following procedures:

1. Quantity of specimens shall conform to the requirements of ACI 301, with a minimum of three concrete test cylinders will be taken for every 75 or less cubic yards of each class of concrete placed.
2. Cast specimens in conformance with ASTM C31. Each test shall consist of at least 3 cylinders.
3. Test cylinders in conformance with ASTM C39. One cylinder shall be broken at 7 days and two cylinders shall be broken at 28 days, per test.
4. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

J. One slump test and one air entrainment test will be taken for each set of test cylinders taken.

1. Slump tests shall be conducted in conformance with ACI 301 and ASTM C143.
2. Determine the air content of air entrained concrete in conformance with ASTM C173 or ASTM C231.

3.7 PATCHING

A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

C. Patch imperfections in accordance with ACI 301. Use non-shrink non-metallic grout.

D. Plug all tie holes with non-shrink grout unless stainless steel ties are used in accordance with ACI 301. Avoid smearing the fill material on the surface of the concrete.

3.8 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Engineer.

C. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.9 FOUNDATION INSULATION

A. Foundation insulation shall be installed as shown on plans and as required by local and state building codes.

B. Foundation insulation shall be installed per manufacturer’s specifications.

END OF SECTION

Section 09900
PAINTING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. This section covers surface preparation, furnishing, and application of architectural paint and special protective coatings, complete.

B. It is the intent that all interior and exterior wood, masonry, metal, and submerged metal surfaces be painted, whether specifically mentioned or not, except as modified herein. Interior concrete surfaces in finished areas will be painted. Exterior concrete surfaces will not be painted unless specifically indicated hereinafter.

C. Concealed structural steel surfaces shall receive prime coat only unless modified herein.

D. Abbreviations:

ANSI	American National Standards Institute
AWWA	American Water Works Association
FRP	Fiberglass Reinforced Plastic
HCL	Hydrochloric Acid
MDFT	Minimum Dry Film Thickness
MDFTPC	Minimum Dry Film Thickness Per Coat
mil	Thousandths of an Inch
MIL-P	Military Specification – Paint
OSHA	Occupational Safety and Health Act
PSDS	Paint System Data Sheet
SFPG	Square Feet Per Gallon
SFPGPC	Square Feet Per Gallon Per Coat
SP	Surface Preparation
SSPC	Steel Structures Painting Council

1.2 SURFACES NOT REQUIRING PAINTING

A. Unless otherwise specifically indicated in the Technical specifications or on the Drawings, the following areas of items will not require painting:

1. Nonferrous, corrosion-resistant metals such as aluminum and stainless steel, except where:
   a. Required for electrical insulation between dissimilar metals.
   b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
   c. Color coding of equipment and piping is required.
   d. Architectural finish coating is required.

B. Nonmetallic materials such as glass, PVC, FRP, porcelain, and plastic except as required for architectural painting or color coding.

C. Prefinished electrical and architectural items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches, acoustical tile, cabinets, elevators, building louvers, wall panels, prefinished metal roofing, etc., except where specified. Electric motors shall be painted with the driven equipment for color coding.

D. Items specified to be hot-dip galvanized after fabrication unless specifically required elsewhere in these Specifications or subject to immersion; manufactured items and materials that are "factory" galvanized shall be prepared and coated as specified hereinafter for the exposure condition of the item and for architectural purposes unless otherwise specified herein; specifications for repair of damaged galvanized surfaces are contained hereinafter.

1.3 REFERENCES

A. ASTM D16 – Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.

B. ASTM D4442 – Standard Test Method for Direct Moisture Content Measurement of Wood and Wood-Based Materials.

C. SSPC – Steel Structures Painting Manual; Steel Structures Painting Council.

1.4 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this Section.

1.5 SUBMITTALS

A. Submit product data under provisions of Section 01330 – Submittals.

B. Data Sheets: For each paint system used herein, the Contractor shall obtain from each paint manufacturer for submittal to the Engineer, a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. The required information shall be submitted on a system-by-system basis. The Contractor shall also provide copies of the paint system submittals to the coating applicator. A sample PSDS form is appended at the end of this section. Indiscriminate submittal of manufacturer's literature only will not be accepted.

C. Submit manufacturer's application instructions under provisions of Section 01330 – Submittals.

1.6 QUALITY ASSURANCE

A. Product Manufacturer: Company specializing in manufacturing quality paint and finish products with at least five years experience.

B. Applicator: Company specializing in commercial painting and finishing with 3 years experience and approved by product manufacturer.

C. Quality Assurance: The paint manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and these Specifications, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.

D. Inspection: The Contractor shall give the Engineer a minimum of three (3) days advance notice of the start of any surface preparation work or coating application work. All such work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such work in his absence.

For all coatings subject to immersion, full cure must be obtained for the completed system. Consult the coatings manufacturer's written instructions for these requirements. The coating shall not be immersed for any purpose until completion of the curing cycle.

Inspection by the Engineer, or the waiver of inspection of any particular portion of the work, shall not be construed to relieve the Contractor of his responsibility to perform the work in accordance with these Specifications.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable codes for flame and smoke rating requirements for finishes.

B. All painting and coating systems in contact with potable water systems shall be NSF 61 approved.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 01600 – Materials and Equipment.

B. Store and protect products under provisions of Section 01600 – Materials and Equipment.

C. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.

D. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirement, color designation, and instructions for mixing and reducing.

E. Paint materials: Store at minimum ambient temperature of 45°F and a maximum of 90°F, in well ventilated area, unless required otherwise by manufacturer's instructions.

F. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 45°F for 24 hours before, during, and 48 hours after application of finishes, unless required otherwise by manufacturer's instructions.

B. Do not apply exterior coatings during rain or snow, or when relative humidity is above 60 percent, unless required otherwise by manufacturer's instructions.

C. Minimum Application Temperatures for Latex Paints: 50°F unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperature for Varnish Finishes: 65°F unless required otherwise by manufacturer's instructions.

E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

1.10 EXTRA MATERIALS

A. Provide one (1) 1-gallon container of each color and surface texture to owner. Provide 1-gallon of each component of multi-component paint systems.

B. Label each container with color, type texture, room locations, in addition to the manufacturer's label.

PART 2. PRODUCTS

2.1 PAINT AND COATINGS SUPPLIERS

A. Products as manufactured by Tnemec Company have been used in this section by product number to establish a level of quality and performance. Manufacturers submitting paint and coatings as equal to those manufactured by Tnemec Company shall submit a complete product data sheet for the proposed equivalent coating along with a letter identifying the specific criteria where the proposed product meets or exceeds the specified Tnemec product. The Engineer’s determination of equivalence shall be final.

1. Acceptable Coating Suppliers:
   a. Tnemec Coatings, Kansas City, MO
   b. Or Equal

2.2 PAINT MATERIALS

A. General: All materials of a paint system, including primer and finish coats, shall be produced by the same paint manufacturer. Thinners, cleaners, driers, and other additives shall be as recommended by the paint manufacturer of the particular coating.

B. Coatings: Ready mixed, except field catalyzed coatings. Prepare coatings:

1. To a soft paste consistency as recommended by the manufacturer, capable of being readily and uniformly dispersed to a homogeneous coating.
2. For good flow and brushing properties.
3. Capable of drying or curing free of streaks or sags.

C. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified shall be of commercial quality.

D. All products submitted shall conform to federal, state and local requirements limiting the emission of volatile organic compounds.

E. The following paint products are listed according to their approximate order of appearance in the paint systems. Alternate coatings deviating from specified coating systems must be submitted 10 business days prior to bid date. Alternate submittals require a $250.00 non refundable product comparison fee which does qualify for approval of alternate coating system. Approval for alternate coating products requires an “equal or exceeding” performance criteria.

Product	Definition
Polyamidoamine Epoxy: Tnemec Series L69 HI-Build Epoxoline II	VOC .80 lbs/gallon, HAPS 0.00 lbs/gal solids, 66% solids
Cycloaliphatic Amine Epoxy Tnemec Series 104 H.S. Epoxy	AWWA C 210, VOC .80 lbs/gallon, HAPS 1.60 lbs/gal solids, 82% solids
Hybrid Aliphatic Polyurethane Tnemec Series 740 Endura Shield	VOC .77 lbs/gallon, HAPS 0.00 lbs gal, 73% solids, high gloss
Novolac Vinyl Ester Tnemec Series 120-5001 Vinester	VOC .64 lbs/gallon, 89% solids
Novolac Vinyl Ester Tnemec Series 120-5002	VOC .59 lb/gallon, 89% solids
Modified Polyamido Amine Epoxy Tnemec Series 135 Chembuild	VOC 72 lbs/gallon, HAPS 1.29, 84% solids
Polyamine Epoxy Tnemec Series 435 Perma Glaze	VOC .23 lbs/gallon, HAPS .11, 100% solids
Polyamine Epoxy Tnemec Series 201 Epoxoprime	VOC .24 lbs/gallon, HAPS 0.0, 100% solids

Product	Definition
Polyamine Novolac Epoxy Tnemec Series 281 Tneme Glaze	VOC .13 lbs/gallon, 100% Volume Solids
Inorganic Waterborne Epoxy Tnemec Series 1254 Epoxoblock WB	VOC 0.0 lbs/gallon, HAPS 0.0, 100% solids
Silane/Siloxane Blend Tnemec Series 633 Prime A Pell H2O	VOC .16% lbs/gallon
Acrylic Polymer Tnemec Series 617 Conformal Stain WB	VOC 29% lbs/gallon, HAPS .46
Polyamine Epoxy Tnemec Series 215 Surfacing Epoxy	VOC 0.0 lbs/gallon, HAPS 0.8, 100% solids
Aromatic Polyurethane Tnemec Series 406 Elasto Shield	VOC 0.0 lbs/gallon, HAPS 0.0, 100% solids, NSF/ANSI 61
Modified Cementicious Mortar Tnemec Series 218 Mortar Clad	VOC .15 lbs/gallon, 100% solids
Fiberreinforced Polyamine Epoxy Tnemec Series 436 Perma Shield FR	VOC .23 lbs/gallon, 100% solids
DP Acrylic Polymer Tnemec Series 1028 Endruatone	VOC .79 lbs/gallon, .HAPS .35, 39.5% solids
Waterborne Epoxy Amine Adduct Tnemec Series 287 Enviro Pox	VOC .05 lbs/gallon, 51% solids
Waterborne Cementicious Acrylic Tnemec Series 130 Envirofill	VOC .59 lbs/gallon, 68% solids
Modified Waterborne Acrylate Tnemec Series 156 Envirocrete	VOC .41 lbs/gallons, 51% solids

2.3 COLORS

A. Colors to be used are shown on the Drawings and designated hereinafter.

B. Colors shall be formulated with colorants free of lead, lead compounds, or other materials which might be affected by the presence of hydrogen sulfide or other gases likely to be present at the project.

C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.

D. Equipment Colors:

1. In general, mechanical equipment will be shop primed and field finished after installation. Equipment shall be meant to include the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits. All non-submerged portions of equipment shall be painted the color as chosen by the Owner, except as itemized below:

Equipment	Color
Dangerous parts of equipment and machinery	OSHA Orange
Fire protection equipment and apparatus	OSHA Red
Physical hazards in normal operating area	OSHA Yellow

2. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as specified.

E. Pipe Colors:

1. Process pipe shall be painted in accordance with the following color scheme for identification:

Type of Pipe	Color
Raw Sewage	Gray
Sludge	Gray
Drain	Black
Natural Gas	Orange
Digester Gas	Red
Potable Water	Blue
Non-Potable Water	Yellow
Chlorine	Yellow
Compressed Air	Green
Water Lines for Heating	Gray

2.4 LABELS FOR EQUIPMENT

A. New equipment such as pumps, tanks, HVAC equipment, and other such equipment that require proper labeling, shall be provided with identification labels that bear the full equipment name and tag number as specified on the Plans and as approved by the Engineer. Labels shall be similar to the type and style as the LABELS FOR PIPING identified below. The length of the color field, size of the letters, and location of the labels shall be similar to the existing labels, and approved by the Engineer.

2.5 LABELS FOR PIPING

A. Identification labels bearing the full piping system name or appropriate abbreviation as shown in the piping schedule shall be applied to piping and to the exterior covering of insulated piping at all connections to equipment, valves or branching fittings, at wall boundaries, and at intervals along the piping not greater than 18 feet on center. At least one label shall be applied to each exposed run of pipe. Directional flow arrows shall be applied adjacent to each pipe marker. The

directional arrows shall be printed directly on roll banding tape which shall be applied at both ends of the label, wrapping around the pipe so that the tape overlaps itself and the label.

B. The above requirements for identification labels and flow arrows shall be repeated for application to the exterior covering of insulated piping.

C. The labels shall be printed on vinyl, vinyl or acrylic cloth, or acrylic general purpose pressure sensitive adhesive backed tape as manufactured by W.H. Brady Company, Milwaukee, WI; Sign Line Limited, Milwaukee, WI; or equal.

D. Identification labels for piping containing materials for fire quenching such as sprinkler systems and for other piped fire fighting or fire prevention equipment shall be white letters on a red color field. All other labels shall be black letters on a yellow color field. The directional flow arrows and color field shall match the adjacent label.

E. The size of the labels and the lettering shall conform to the following:

Outside Diameter of Pipe or Covering (inches)	**Length of Color Field (inches)**	**Size of Letters (inches)**
3/4 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

F. Pipe Identification Painting:

1. All non-submerged metal piping except electrical conduit shall be color coded. Metal fittings and valves shall be painted the same color as the pipe or a color chosen by the Owner.
2. Piping color coding shall be in accordance with the Piping Schedule.
3. Fiberglass reinforced plastic (FRP) pipe and polyvinyl chloride (PVC) pipe will not require painting, except as noted.

PART 3. EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished before commencement of work. Report any condition that may potentially affect proper application.

C. Test shop applied primer for compatibility with subsequent cover materials.

3.2 PROTECTION OF MATERIALS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process. Openings in motors shall be masked to prevent paint and other materials from entering the motors.

B. Provide drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.

3.3 ENVIRONMENTAL CONDITIONS

A. Paint shall not be applied in temperatures exceeding the manufacturer's recommended maximum and minimum allowable, nor in dust, smoke-laden atmosphere, damp or humid weather.

B. Abrasive blast cleaning shall not be performed whenever the relative humidity exceeds 85 percent, nor whenever the surface temperature is less than 5°F above the dew point of the ambient air.

3.4 SAFETY

A. Painting shall be performed in strict accordance with the safety recommendations of the paint manufacturer; with the safety recommendations of the National Association of Corrosion Engineers contained in the publication, Manual for Painter Safety; federal, state, and local agencies having jurisdiction.

3.5 PREPARATION

A. Remove electrical plates, hardware, light fixture trim, and fittings before preparing surfaces or finishing.

B. Correct minor defects and clean surfaces which affect work of this Section.

C. Shop Blast Cleaning:

1. Notify Engineer at least 7 days before start of shop blast cleaning to allow the Engineer or his representative to inspect the work during surface preparation and shop application of paints. The work shall be subject to the Engineer's approval before shipment to the jobsite.
2. Items such as structural steel, metal doors and frames, metal louvers, and similar items as reviewed by the Engineer may be shop prepared and primed at the option of the Contractor. All work shall be blast cleaned and primed in accordance with these Specifications.
3. Finish painting at the jobsite shall be as specified herein. If the manufacturer of the finish coating differs from that of the shop primer,

Contractor shall provide the Engineer with manufacturer's written confirmation that the materials are compatible.

D. Field Sandblasting: Perform sandblasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures, and safety equipment for personnel shall conform to the Steel Structures Painting Council.

E. Metal Surface Preparation:

1. All workmanship for metal surface preparation as specified shall be in strict conformance with the current Steel Structures Painting Council (SSPC) Specifications as follows:

Solvent Cleaning	SP	1
Hand Tool Cleaning	SP	2
Power Tool Cleaning	SP	3
White Metal Blast Cleaning	SP	5
Commercial Blast Cleaning	SP	6
Brush-Off Blast Cleaning	SP	7
Pickling	SP	8
Near-White Blast Cleaning	SP	10

2. Wherever the words "solvent cleaning," "hand tool cleaning," "wire brushing," or "blast cleaning," or similar words of equal intent are used in these Specifications or in paint manufacturer's Specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.
3. Hand tool clean areas that cannot be cleaned by power tool cleaning.
4. All oil, grease, welding fluxes, and other surface contaminants shall be removed before blast cleaning. Pre-blast cleaning methods shall use steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
5. Small isolated areas shall be cleaned as above or solvent cleaned with suitable solvents and clean cloths.
6. The type of equipment and speed of travel shall be such that the specified degree of cleanliness is obtained. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendations for the particular primer to be used. Only dry blast cleaning methods will be permitted. The abrasive shall not be reused.
7. The Contractor shall comply with all applicable federal, state, and local, air pollution and environmental control regulations for blast cleaning, and disposition of spent aggregate and debris.
8. Alternatives to standard abrasive blast cleaning methods may be permitted for special circumstances subject to a review by the Engineer.
9. All surfaces shall be cleaned of all dust and residual particles of the cleaning operations by dry (no oil or water vapor) air blast cleaning or other method before painting. Enclosed areas and other areas where dust settling is a problem shall be vacuum cleaned and wiped with a tack cloth.

10. Surfaces shall be painted the same day they are sandblasted. Surfaces that have started to rust before they are painted shall be re-blasted.

F. Concrete Surface Preparation:

1. Surface preparation shall not begin until 30 days after the concrete has been placed unless specifically permitted by the coating manufacturer.
2. Removal all grease, oil, dirt, salts or other chemicals, loose materials or other foreign matter by solvent, detergent, or other suitable cleaning methods.
3. Concrete surfaces shall be brush-off blast cleaned to remove all curing compounds and loose concrete to provide a tooth for binding. If brush-off blasting is impractical, surface may be acid etched with muriatic acid solution.
4. Unless otherwise required for proper adhesion, surfaces shall be dry before painting.

G. Masonry Surface Preparation:

1. Masonry construction shall be completed and cured for 14 days or more before surface preparation work is started as defined in the manufacturer's application instructions.
2. All oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter shall be removed by solvent, detergent washing, or other suitable cleaning methods.
3. Masonry surfaces shall be cleaned of all mortar and grout spillage and other surface deposits using either (1) non-metallic fiber brushes and commercial muriatic acid followed with rinsing with clean water, or (2) brush-off blasting, or (3) water blasting.
4. Care shall be taken to avoid damage to the masonry mortar joints or adjacent surfaces.
5. Surfaces shall be clean and, unless otherwise required for proper adhesion, shall be dry before painting.
6. Masonry surfaces which are to be painted shall have a uniform texture and be free of surface imperfections which would impair the intended finished appearance.
7. Masonry surfaces which are to remain uncoated, or are specified to receive a clear coating, shall be free of discolorations and be uniform in texture after cleaning.

H. Plastic Surface Preparation: All plastic surfaces to be coated shall be hand sanded with a medium grit sandpaper to provide tooth for the coating system. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so the surface is roughened without removing excess material.

A. Preparation of Existing Coated Surfaces:

1. Existing primed surfaces to be final coated shall be washed with detergent followed by a clean, fresh water rinse. Loose, abraded, or damaged coatings shall be cleaned to substrate by the method recommended by the coating manufacturer. Surrounding intact coating shall be feathered. One (1) spot coat of the specified primer shall be applied to bare areas overlapping the prepared existing coating. One (1) complete finish coat of the specified finish coat(s) shall be applied overall. Pre-primed ductile iron pipe will require an application of a seal coat prior to the application of a cosmetic finish coat.
2. Brush-off Blast Cleaning: The equipment, procedure, and degree of cleaning shall conform to the Steel Structures Painting Council Surface Preparation 7, Brush-off Blast Cleaning. The abrasive shall be dry blasting sand, grit, or nut shell. The various surface preparation parameters such as size and hardness of the abrasive, nozzle size, air pressure, and nozzle distance from the surface shall be selected such that the surface is cleaned without pitting, chipping, or otherwise damaging the surface. The Contractor shall verify his parameter selection by blast cleaning a trial area that will not be exposed to view. The trial blast cleaned area shall be subject to the approval of the Engineer and shall be used as a representative sample of the surface preparation.

B. Acid Etching: After pre-cleaning, the following solution is spread by brush or plastic sprinkling can: 1 part commercial muriatic acid reduced by 2 parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCL. Workmen shall be equipped with necessary protective equipment and clothing. The application rate shall be approximately 2 gallons per 100 square feet. Work the acid solution into the surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained. The acid will react vigorously for a few minutes, during which time brushing is continued. After the bubbling has subsided (10 minutes), hose down the remaining slurry with high pressure clean water. Rinsing must be done immediately to avoid formation of salts on the surface which are difficult to remove. Thorough rinsing is necessary to remove any residual acid surface condition which can impair adhesion. The surface shall be completely dry before coating is applied. After etching, the surface shall be "grainy" to the touch. If not, repeat the treatment.

C. Solvent Cleaning: Solvent cleaning shall consist of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by the use of solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action. This method conforms with Steel Structures Painting Council SP 1.

D. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

E. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish: Remove foreign particles to permit adhesion of finishing materials. Apply compatible sealer or primer.

F. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

3.6 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry.
C. Apply each coat to uniform finish.

D. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.

E. Sand surfaces lightly between coats to achieve required finish.

F. Allow applied coat to dry before next coat is applied.

G. Multiple-component coatings shall be prepared using all of the contents of the container for each component as packaged by the paint manufacturer. No partial batches will be permitted. Multiple-component coatings that have been mixed shall not be used beyond their pot life. Only the components specified and furnished by the paint manufacturer shall be mixed. No intermixing of additional components for reasons of color or otherwise, even within the same generic type of coating, will be permitted.

H. Shop Primed or Factory Finished Surfaces: All shop primed or factory finished items shall be inspected at the jobsite for compliance with these Specifications. Schedule such inspection with the Engineer in advance. Abraded areas on factory finished items shall be repaired in strict accordance with the equipment manufacturer's directions. Repaired areas shall be carefully blended into the original finish.

I. Film Thickness:

1. Coverage is listed as either total minimum dry film thickness in mils (MDFT) or the spreading rate in square feet per gallon (SFPG). Per coat determinations are listed as MDFTPC or SFPGPC. The number of coats is the minimum required irrespective of the coating thickness. Additional coats may be required to obtain the minimum required paint thickness, depending on method of applications, differences in manufacturer's products, and atmospheric conditions. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.
2. Film thickness measurements and electrical inspection (Holiday Testing) of the coated surfaces shall be performed with properly calibrated instruments. Recoat and repair as necessary for compliance with the Specifications. All coats will be subject to inspection by the Engineer and the coating manufacturer's representative.

3. Concrete, nonferrous metal, plastic, and wood surfaces shall be visually inspected to ensure proper and complete coverage has been attained.
4. Particular attention shall be given edges, angles, flanges, etc. Where insufficient film thicknesses are likely-to be present, ensure proper millage in these areas.

J. Porous Surfaces: Porous surfaces such as concrete, masonry, etc., may have the prime coat thinned to provide maximum, penetration and adhesion. Type and amount of thinning shall be determined by the paint manufacturer and is dependent upon the surface density and type of coating.

K. Damaged Coatings:

1. Damaged coatings, pinholes, and holidays shall have the edges feathered and repaired in accordance with the recommendation of the paint manufacturer, as reviewed by the Engineer.
2. All finish coats, including touchup and damage repair coats shall be applied in a manner that will present a uniform texture and color-matched appearance.

L. Unsatisfactory Application:

1. If the item has an improper finish color, or insufficient film thickness, the surface shall be cleaned and top coated with the specified paint material to obtain the specified color and coverage. Specific surface preparation information to be secured from the coating manufacturer and the Engineer.
2. All visible areas of chipped, peeled, or abraded paint shall be hand- or power-sanded, feathering the edges. The areas shall then be primed and finish coated in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required by the Engineer.
3. Work shall be free of runs, bridges, shiners, laps, or other imperfections. Evidence of these conditions shall be cause for rejection.
4. Any defects in the coating system shall be repaired by the Contractor per written recommendations of the coating manufacturer.
5. Leave all scaffolding and ladders in place until the Engineer has inspected the surface or coating. Scaffolding and ladders removed before approval by Engineer shall be replaced.

3.7 CLEANING

A. As Work proceeds, promptly remove paint where spilled, splashed, or spattered.

B. During progress of Work maintain premises free of unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Collect cotton waste, cloths,, and material that may constitute a fire hazard, place in closed metal containers and remove daily from site.

D. Repair damage to other surfaces caused by work of this Section.

E. Remove empty paint containers from site.

3.8 PAINT APPLICATION SCHEDULE

A. Unless otherwise indicated in the Specifications or on the Drawings, the work shall be painted or coated in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from the Engineer before starting the work in question.

1. Pipe labels per Piping Schedule.

(See PSDS form following this section)

END OF SECTION

PAINT SYSTEM DATA SHEET

Attached products' Technical Data Sheet (if applicable) to this sheet for each paint system submittal.

Paint System Number (from spec.) _____

Paint System Title (from spec.) _____

Coatings Supplier _____

Representative _____

Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Costs Coverage

Section 11000
OZONE COOLING WATER BOOSTER PUMP SKID SYSTEM

PART 1. GENERAL

1.1 SCOPE

A. This section covers the work necessary to furnish and install the ozone cooling water booster pump skid system shown on the drawings and described herein. The booster pump skid system shall be a fully operational, automatic and prefabricated pumping system. Design, fabrication, testing, and service shall be the sole responsibility of the pumping skid system manufacturer. The pump system shall provide the required water volume while simultaneously maintaining a constant discharge pressure by using variable frequency drive controlled pumps for pressure regulation under varying flow conditions up to the maximum specified capacity. See the system mode of operation description in this Section for additional details.

See CONDITIONS OF THE CONTRACT and Division 1, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

B. Intent of Plans: Plans are partly diagrammatic. They are intended to show general routing and location of equipment. Contractor shall field verify existing conditions prior to fabrication and installation of piping, equipment, supports, wiring, and controls.

C. Sections to Which this Specification Applies:

The work specified in the following Sections affects or is dependent on the work of this Section. Refer to those Sections for additional information.

01011, SCHEDULE AND SEQUENCE OF CONSTRUCTION
02050, DEMOLITION
09900, PIPING
15001, PLANT PIPING – GENERAL
15260, PIPE INSULATION
DIVISION 16 – ELECTRICAL

1.2 SUBMITTALS

A. SUBMITTALS DURING CONSTRUCTION

1. Submittals during construction shall be made in accordance with Section 01300.
2. In addition to the requirements of Section 01300, submit the following:
   a. Manufacturer's records that equipment has been factory checked, tested, and started.
   b. Test Outlines and Procedures Submittal: It is required that this be a two-step submittal, outlines first followed by specific test descriptions. Test descriptions shall be of sufficient detail to fully describe the specific method for conducting the test that demonstrates conformance with this Specification.
   c. Submit equipment warranties

B. Departures from Plans and Specifications: Submit in writing to the Engineer for review, details of any proposed departures from these Contract Documents, and the reasons therefore. Submit such requests as soon as practicable and within 30 days after the Notice to Proceed. Make no such departures without prior written acceptance of the Engineer.

C. Substitution of Materials: The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with GENERAL CONDITIONS.

D. Shop Drawings:

1. Complete performance data that will indicate full compliance with the Specifications.
2. Detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt their materials to the arrangement or details shown.
3. Operating and maintenance manuals and equipment data and maintenance summary forms shall be submitted in accordance with Section 01300, for the equipment specified herein.

E. Coordination: Coordinate with the Electrical Division work requirements.

F. Permits and Inspections: The Contractor shall obtain all permits and arrange all inspections required by codes applicable to this Section and shall submit written evidence to the Engineer that required permits, inspections, and code requirements have been secured.

G. Accepted Manufacturers:

1. Watertronics of Hartland, WI.
2. Metropolitan Industries
3. Or approved equal.

PART 2. MATERIAL

2.1 MECHANICAL REQUIREMENTS

A. The prefabricated pump system shall have a minimum capacity and discharge pressure at skid discharge connection as described below. The pumps shall operate at no more than 3,500 RPM. The system shall be completely electrically wired, hydraulically piped, and flow tested to full system capacity at the factory prior to shipment to job site. Documentation of dynamic test shall be submitted prior to equipment shipment.

B. Pumps: Pumps shall be of a horizontal, multistage, centrifugal design. The pumps shall be installed in one horizontal pipe system where the suction and discharge ports are in the same horizontal plane and have the same pipe dimensions. Motors shall be inverter duty type, TEFC, and shall be heavy duty 2 pole NEMA C frame with heavy duty bearings.

1. Pumps furnished under this specification shall be capable of sustained (24 hours per day) and intermittent operation at all conditions between full and minimum speed outlined below.
2. Condition A: Design Point
   a. Capacity: 300 GPM
   b. Total Head: 185.5 FT
   c. NPSHA: 15 FT
   d. Efficiency: Minimum 71%
3. Condition B: At Run Out
   a. Capacity: 425 GPM
   b. Total Head: 120 FT
   c. NPSHA: 22 FT
   d. Efficiency: Minimum 57%
4. Condition C: At Shut Off
   a. Capacity: 0 GPM
   b. Total Head: 230 FT
   c. NPSHA: N/A
   d. Efficiency: N/A

C. Each pump shall be sized for the following design point: 300 GPM at 80 PSI. Pump motor shall be minimum 25 HP.

D. Hydropneumatic Pressure Tank: An ASME code, NB stamped, 200 PSI rated, bladder type pressure tank shall be provided to maintain stored pressure in the system during no flow and low flow period. The bladder shall be able to expand to the full size of the tank and shall be field replaceable. Tank volume shall be determined by manufacturer based on the described mode of operation and the design conditions. Tank shall be prefabricated and provided as part of the pump skid system.

E. Recirculation Line: A recirculation line shall be provided to allow continuous pump operation in low and no flow periods. The recirculation line shall be equipment with a modulating control valve to vary the flow returned to the suction side of the pumps.

F. Piping: All fabricated piping shall conform to ASTM specifications A53 B welded or seamless galvanized pipe. Piping 8” and above shall be a minimum of Schedule 10. Piping 6” and smaller shall be Schedule 40. All welded flanges shall be forged steel slip-on or weld neck type. All welded fittings shall be seamless, conforming to ASTM Specification A234, with pressure rating not less than 150 PSI. All fasteners shall be stainless steel.

Piping shall be insulated and labeled per Specification Sections 15001 and 15260.

G. Drains: Drains are to be provided from all low points in the system and are to be equipped with 3/8” or 1/4" brass valves. Drains shall include but are not limited to a drain for each check valve and discharge piping prior to system isolation valve.

F. Pump Check Valve: Pump check valves shall be bolted directly to the pump discharge heads and sized per manufacturer’s recommendations. They shall be of the silent operating type that begins to close as soon as forward velocity diminished and be fully closed at zero velocity preventing flow reversal. Valve bodies shall be cast from ASTM-126C cast-iron or better and shall be free from blow holes, sand holes, and other impurities. The valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe diameter. Internals shall be machined bronze disc, seat, and stem guide. Valves shall be sized to permit full pump capacity to discharge through them without exceeding a pressure drop of 2.5 PSI. Valves 4” and smaller to be pressure rated for 250 PSI, 6” to 10” to be pressure rated to 150 PSI. Valves 12” and larger shall be globe style with 150 PSI rating with iron bodies and bronze trim.

G. Actuated Valve: Electric Actuator Manufacturer shall be AUMA or Rotork. All electric actuators shall conform to the requirements of AWWA Standard C540-93. Operator shall be furnished and sized by valve supplier. Unit shall be a self-contained, packaged-unit designed for modulating service. Operator shall consist of electric actuator, integral motor controls, gearbox, geared limit switches, torque switches, and manual override with de-clutching lever. Operator rated torque output shall be no less than 1.5 times the required valve operating torque. Operator shall be self-locking with actuator removable from gearbox without taking valve out of service, and designed for mounting and running in any position. The motor shall be specifically designed for actuator service. The motor shall be of the induction type with class F insulation and protected by means of thermal switches imbedded in the motor windings. Operator shall have a mechanical visual position indicator. Provide NEMA 4X, and IP67 rated. Valves shall be ball type, rated for 150 PSI working pressure. Valves shall be end

entry type, reduced bore ports, Teflon seats, and hand lever operators.

H. Isolation Valves: Each pump shall be isolated by means of a grooved valve after the check valve and before the discharge manifold and between the suction manifold and the pump intake flange. Pump isolation valves shall be gate type, rated for 150 PSI working pressure. Valves shall be iron body, bronze mounted with double disc gate, rising or nonrising bronze stem. Skid isolation valves shall be ball type, rated for 150 PSI working pressure. Valves shall be end entry type, reduced bore ports, Teflon seats, and hand lever operators.

I. System Air Release: Individual pump column air shall be purged prior to entering the pump system inlet and/or discharge manifold. Separation reservoirs or tanks with air/water balance controls shall not be accepted.

J. Pressure Gauges: Pressure gauges shall be located on the discharge and inlet manifold for the purposes of measuring regulated suction and discharge pressure. Pressure gauges shall be 304 stainless steel case and bezel construction. Gauges shall be 4” diameter, liquid filled. Pressure sensing connection shall be 1/4" NPT lower gauge connection.

K. Skid Construction: The pump skid shall be assembled from corrosion resistant composite materials. The structural profiles shall be manufacturer with a premium grade polyester or vinyl ester resin with fire retardant additive to meet Class I flame rating of ASTM E84 and the self extinguishing requirement of ASTM D635. All structural profiles will contain a UV inhibitor. Structural fiber reinforced polymer composite member composition shall consist of a glass fiber reinforced polyester or vinyl ester matrix, approximately 50% resin-to-glass ration. A synthetic surface veil shall be the outermost layer of the exterior surfaces. Continuous glass strand roving will be internally used for transverse strength.

L. Painting: Painting of the pump skid, less composite skid materials, shall consist of a multi-step coating system including metal preparation, a rust prohibitive epoxy prime coat, and a two part ultraviolet insensitive polyurethane finish having a total dry film thickness not less than 5 mils. Each coat swill be applied and baked for one half hour at 165°F. All metallic pump system components including manifolds, isolation and relief valves, grooved clamps, and supports shall be painted potable water blue. All electrical enclosures and accessory panels and tanks shall be appliance white.

2.2 ELECTRICAL REQUIREMENTS

A. The pumping system electrical controls shall be mounted in a self-containing NEMA 4X enclosure fabricated from not less than 12 gauge epoxy coated steel or stainless steel. Door gasket seals shall be neoprene sponge, sufficient to protect interior components from weather and dust. The electrical panel doors shall be constructed from 12 gauge steel with integral latches.

B. All external operating devices shall be NEMA 4 or greater as specified. All internal components of the enclosure shall be mounted on a removable back panel. Mounting screws for components shall not be tapped into the enclosure wall. No pressure gauges, pressure switches, water activated devices, or water lines of any sort shall be installed in any electrical control panel.

C. The control panel shall be designed, built, tested and U.L. listed by the pump system manufacturer. All electrical equipment shall comply with the requirements of NFPA 70.

D. Main Service Disconnects:

1. Two three-pole, main disconnects shall be contained within the NEMA 4X control enclosure. Disconnects shall be non-fused and isolate all power to the control enclosure. The disconnects shall have an operating handle mounted in the enclosure door, mechanically interlocked to prevent entry while disconnects are in ON position.
2. Skid shall have two 480 volt power sources from two different power grids. The control transformer, VFD for pump 1, and VFD for pump 2 shall be fed by the primary power source. The VFD for pump 3 shall be fed by the secondary power source. There shall be no interconnection between the two power sources, except for ground. See Figure E-1 for details.
3. All electrical components shall be factory mounted and wired. No field wiring will be accepted.

E. Circuit Breakers: Each VFD shall be protected on each power leg by a circuit breaker of the appropriate amperage. Further protection shall include sensitivity to current imbalance and single phase conditions.

F. Variable Frequency Drives:

1. The variable frequency drives (VFDs) shall be IGBT based with selectable carrier frequency up to 10 KHZ. The VFDs shall include terminals for incoming power, motor output power and control terminals.
2. The VFDs shall generate a sine-coded, variable voltage/ frequency, three phase output for optimum speed control. The VFDs shall incorporate power loss ride-through for a minimum of 2 seconds. VFD protective features shall include current limit, auto restart, short circuit protection, electronic motor overload protection and ground fault protection.
3. The VFDs shall have a push button programming display for easy access to operation parameters. The VFDs shall be protected on the primary side by circuit breakers of the appropriate amperage. Overload capacity: 110% rated output current for one minute. Voltage Fluctuation: +10%, –10%. Sine wave PWM with full range, automatic torque boost. Accuracy: Digital, 0.01Hz, Analog .4%. Motor overload protection, Class 10 protection with speed sensitive response.

4. VFDs shall be Allen Bradley Powerflex 70 IP 66, NEMA UL Type 4X/12. VFDs shall be mounted directly on skid framework, not in any control panel.
5. Pumps shall have individual NEMA 4X lockable disconnect switches between the VFDs and the motors, for lock out-tag out purposes.
6. VFDs shall be controlled by the control panel PLC. The PLC shall contain logic for automatic and manual control capability for each VFD and to be monitored by the plant SCADA network. When a VFD is in Manual or Off, the PLC shall bypass that particular unit when rotating through the pumps' lead designation process.
7. VFDs shall have a hardwired Hand / Off / Auto switch with accompanying speed potentiometer dial for manual speed control mounted on each VFD enclosure. These controls shall bypass the PLC and control transformer entirely, for use when PLC is offline or control power source is off. PLC shall monitor the status of these Hand / Off / Auto switch and bypass a pump in rotation accordingly when a VFD is in Hand or Off.

G. Control Transformer: A control transformer shall provide 120 volt power to the pump system controls and skid supplied instruments (e.g. flow and pressure transmitters). The control transformer shall be protected on primary and secondary sides with appropriately sized circuit breakers. No load other than the pump controls shall be supplied by the control transformer.

H. Premium Lightning Arrestor: Surge suppressor shall meet or exceed the following criteria: Minimum single impulse current rating: 80,000 amperes per phase. Duty cycle testing: 2,500 10KA impulses with less than 10% drift. Response time: <5ns. Suppressors shall consist of solid-state components and operate bi-directionally. Minimum continuous operating voltage of the suppressor shall be greater than 110% of the nominal system voltage.

I. Secondary Control Circuit Breakers: Single pole secondary distribution circuit breakers with appropriate ratings shall supply power to the control system and to other circuits as specified.

J. Main Power Phase Disconnect: The incoming power shall be protected by a phase loss/low voltage system dropout relay to de-energize the pump system control circuit if a phase failure, phase reversal or low voltage condition occurs. If after attempted automatic re-starts the phase failure/low voltage alarm condition remains, the alarm must be manually reset.

K. Corrosion Inhibiting Modules: Corrosion inhibiting modules shall be installed in all electrical enclosures in accordance with the manufacture's recommendations.

L. Control Logic PLC: The control panel pump sequence controller shall be an Allen Bradley Micrologix 1100 programmable Logic Controller (PLC) equipped with Ethernet communication interface.

M. Automatic Pressure Regulation Based On Variable Flow: The pump system controls shall be capable of maintaining the regulated downstream pressure set point while in operation. The pump system controls shall also be capable of up to six user-adjustable pressure regulation set points based on discharge flow or one additional set point based on a discrete input. In addition to adjustment of downstream pressure, the controls shall be capable of up six pressure regulation algorithms to insure accurate pressure regulation regardless of regulated pressure, discharge flow or connected pump combination.

N. Lead Pump Selection: Lead selection of equal horsepower pumps shall be accomplished by total accumulated pump running time. The pump with the lowest accumulated running time shall be the next pump started in the sequence. Alternating logic for selection of lead pump shall not be accepted. A pump that is under manual control shall be excluded from the selection sequence.

O. Alarms: Controls shall shut down the pump system in the event of the following alarm conditions. The controls shall attempt to restart the system after alarm condition is cleared and the system is called to operate or loss of power. After a user adjustable number of attempts to re-pressurize the system, the controls will go into hard shut down and remain there until manually reset. Skid shall have a local red flashing LED alarm light. Skid shall not have a separate control panel mounted alarm horn or silence / acknowledge button. These functions will be handled through the operator interface.

1. Low discharge pressure cutout. Pressure remains 20 PSI below regulate set point for set time delay.
2. High discharge pressure cutout. Pressure remains 11 PSI above regulate set point for set time delay.
3. Phase/voltage cutout. High or low voltage, loss of phase, or phase reversal.
4. Low inlet pressure cutout. Pressure remains below set point for set time delay.
5. VFD fault and VFD bypass status.

P. Operator Interface:

1. Operator interface shall be an Allen Bradley, full color TFT active matrix LCD display unit mounted in the enclosure door, with either touch screen or button input. Operator interface shall be used for logical display of all pump system functions. The operator interface shall be NEMA 4 rated. The operator interface shall have intuitive on-screen user instruction for ease of operator use. The use of off-screen user instructions shall not be permitted. The operator interface shall be LCD color display type with no less than 240 x 320 pixel resolution, with viewing area measuring not less than 5.7" diagonal. User memory for storing critical pump operation data shall not be less than required for up to 3 months of data.
2. The operator interface shall allow the user to view and modify all pertinent operation parameters. The operator interface shall incorporate password

protection for modification of critical pump system parameters. The operator interface capabilities shall include but are not limited to the following:

a. Overview screen showing pump system configuration. Screen shall show if each individual pump is enable or disabled, the number of running hours on each pump, system flow and pressure design criteria.

b. System screen with information on current regulation pressure, set point, regulation pressure, system status, restarts remaining, VFD reference speed, pressure regulation method and adjust settings button. Adjust settings button will allow changing parameters after entering password.

c. Settings menu to allow changes to pressure regulation settings, power saver mode, VFD manual mode, analog calibration, flow calibration, program or register settings.

d. Flow screen will display pressure in PSI, flow in GPM and total gallons pumped in thousands of gallons. Separate display for total gallons pumped since last reset.

e. Alarm status with time stamping, display of pump system conditions at shutdown and restart. Alarms will be displayed in red when activated and a separate listing will be displayed in green when the alarm is reset. Alarms will be logged to a compact flash disk allowing the service technician to upload data to a spreadsheet type program.

f. Full control of and capability of monitoring, adjusting and viewing any options present such as filtration, chemical injection, or liquid tank levels. Adjustment of automatic/manual pressure regulation set points.

g. Graphing capability for up to 1 full year detailing flow rate and pressure. Graphing function shall give option to graph and plot a point every minute. The graph function will be selectable by day, month and year as well as the time of desired graph. All data will be logged to a compact flash disk allowing the service technician to upload data to a spreadsheet type program.

3. System settings will be password protected in the local HMI.

Q. SCADA Requirements:

1. Owner intends to control the ozone cooling water booster pump skid exclusively from an existing plant Allen Bradley FactoryTalk SE HMI / SCADA network. A digital copy of the booster pump system PLC program shall be delivered on a CD-ROM along with the skid. It shall not be locked or considered proprietary beyond standard usage license agreements. PLC program shall come with sufficient documentation to allow an experienced operator interface programmer to develop an operator interface application for the ozone cooling water booster pump application. Relevant data points and PLC / HMI interaction points shall be clearly tagged and described.

2. Control panel shall contain a free Ethernet port for connection of the control panel PLC to the plant SCADA network.
3. PLC program shall contain at least the following data points to be displayed by the plant SCADA network, in engineering units.
   a. Flow Meter Flow (0 – 1,000 US gpm)
   b. Flow Meter Total (displays up to at least 2 million gallons)
   c. System Pressure (0 to 160 psi)
   d. Pressure Set Point (0 to 160 psi)
   e. Individual Pump Run Timers (hours)
   f. Individual Pump Status (Auto / Hand / Off)
   g. Individual Pump Run (on/off, as output to VFD)
   h. Individual Pump Speed (% speed, as output to VFD)
   i. Individual Pump “Is Running” Status (on/off, as read from VFD)
   j. Individual Pump “VFD Fault” Status (on/off, as read from VFD)
   k. Individual Pump Running Amps (amps, as read from VFD)
   l. ESTOP Status (stop/OK)
   m. Alarm Light Status (alarm/no alarm)
   n. Alarms (Allen Bradley FactoryTalk SE compatible format)

System settings, such as analog signal scaling settings, PID loop settings, etc. shall be tagged and clearly described within the PLC program so they are easy to find. They will not necessarily be displayed on any HMI screens.

PLC program shall contain at least the following interaction points for the plant SCADA network, in engineering units.

1. Flow Meter Totalizer Reset Bit
2. Pressure Set Point Write Word (0 to 160 psi)
3. Pressure Set Point Written Bit
4. Individual Pump Go To Manual Bit
5. Individual Pump Go To Auto Bit
6. Individual Pump Manual Speed Write Word (0 to 100%)
7. Alarm Acknowledge Bit

R. System Stop: Skid control panel shall have a mushroom style, push to stop, pull to start E-STOP button. This button shall be hardwired in series with VFD control signals to shutdown all three VFDs directly when pushed. PLC shall monitor the status of this button and register an alarm for the plant SCADA network to display.

S. Pressure Transducer: A solid state pressure transducer shall provide a noise free, linear output proportional to discharge pressure. Transducer shall be solid-state, strain gauge type with integral voltage regulation and output accuracy not less than 0.5%. Transducer shall be constructed of stainless steel and rated for the pump system discharge pressure called out in the technical specifications.

T. Magnetic Flow Sensor:

1. The pump system shall have a flow sensor installed, which shall be utilized to control and display the pump system flow rate and to display total gallons pumps through the touch screen operator interface device mounted on the control panel door. The flow meter shall be electromagnetic design comprising of two major components, a primary head and a signal converter. The flow meter signal converter shall produce two separate signals: pulse for flow totalization and 4-20 ma in linear proportion to flow rate. Flow meter shall read flows from 0-40 fps, with a worst-case inaccuracy of ±0.5% of reading with ±0.2% repeatability. Flow meter shall be sized so that maximum system flow lies between 16 and 24 fps through the meter. The primary meter head shall incorporate a straight-thru flow design with no moving parts or pressure loss, low maintenance and high accuracy. Meter shall be installed according to manufacturer's recommendations.
2. The flow tube shall be an ANSI B16.5 class 150 flanged for sizes less than 24". Wetted liner shall be hard rubber. Liner shall extend beyond the ends of the flow tube and over the flanged faces. The electrodes shall be Hastelloy.
3. The signal converter shall be a NEMA 4 rated, and shall house the microprocessor-based electronics required for magnet excitation and flow measurement.
4. The meter shall be calibrated during the pump system full run functional testing while at the factory prior to shipment. The magnetic flow sensor on the pump system shall be calibrated against a master meter.
5. The meter shall transmit to the PLC an analog signal for flow rate and a pulse signal for flow totalization.

U. Skid Wiring:

1. Skid wiring shall conform to National Electrical Code Standards. All wiring from control panels to motors shall be in metal reinforced, water tight, flexible conduit with copper conductors rated not less than 600 volts and of proper size to carry the full load amperage of the motors without exceeding 70% capacity of the conductor. Flexible conduit runs shall not exceed six feet in length. A grounding cable sized to National Electrical Code requirements shall be included in the flexible conduit. There shall be no splices between the motor starters and the motor connection boxes.
2. Wiring to flow sensors and pressure transducer shall be multi-conductor, shielded cable suitable for Class II low voltage controls. Wiring to motor operated valves, (option available for VFD systems), shall be in flexible conduit with TFFN No. 18 gauge copper conductors rated not less than 600 volts.

V. Junction Boxes: All off skid devices requiring control interface shall be terminated in a junction box. This junction box shall be located at the skid edge nearest the installation point of the off skid device. Chemical and monitoring

systems shall be terminated in a NEMA 4 junction box located on the exterior of the main controls enclosure to allow user connection.

2.3 SEQUENCE OF OPERATION

A. Normal Operation: Under normal operation, cooling water will be provided to the ozone building by the House Water distribution main. See the project drawings that are part of the contract documents for illustrations of the proposed system. This main has a typical pressure of 120 PSI. A newly installed reduced pressure principal backflow preventer, pressure reducing valve, and associate piping installed on the House Water main will connect the House Water supply to the existing ozone building water supply main. The House Water supply has sufficient capacity to provide the required pressure and water flow to the ozone building under most operating conditions. The pressure of the House Water supply will be reduced from 120 PSI to 90 PSI, which is above the new booster skid's set point of 80 PSI. A new pressure transmitter, PE-1, will sense the cooling water pressure and serve as the parameter that will start and stop the new booster pump skid. Therefore, during this mode the new packaged skid system will sit idle provided the water pressure remains above 80 PSI.

B. Booster Skid Operating Mode:

1. Booster skid will run in the infrequent cases when the House Water main cannot provide the necessary cooling water flow and pressure for the ozone building water supply main. During these times, as indicated by a drop in the pressure read by PE-1 below the set point of 80 PSI, the booster pump system will automatically start and vary the pump speed of one or two pumps to maintain a pressure set point of 80 PSI. The new booster skid PLC will activate and control the speed of operation to meet the pressure set point. If the pressure set point cannot be met by a single pump operation at full speed, a second pump will be started and vary its speed with the lead pump operation at full speed to meet demand. An expansion tank will dampen the pressure swings associated with significant changes in demand. A recirculation loop will be provided to bypass pressurized discharge flow back to the suction side of the booster pumps for low discharge flow conditions.
2. As the water supply available from the House Water system increases, the pressure reading at PE-1 will rise above the skid pressure set point of 90 PSI, thus indicating that the House Water system has capacity to resume its primary supply mode to the Ozone Building Water Supply Main. Once the pressure value at PE-1 remains over the set point for the adjustable time set point and the skid pump has run in full recirculation mode at minimum flow for an adjustable set point period of time (as confirmed by the skid flowmeter, FE-1 not recording a positive flow value), the booster system will shut down and return to standby mode.

PART 3. WORKMANSHIP

3.1 GENERAL

A. Install all piping, equipment, and accessories in strict accordance with the laws, rules and regulations of the state and of the city, whichever represents the higher standard. All work shall be approved by the state and city inspector. Plans do not attempt to show exact details of all piping and ductwork, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract, which require offsets. Where diagrams have been made to show piping connections, the Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in location of equipment, piping, or ductwork, advisable in the opinion of the Contractor, shall be submitted to the Engineer for review before proceeding with the work. All measurements and dimensions shall be verified at the site. All equipment shall be adjusted and left in a condition satisfactory to the Engineer.

B. Any preparation of the structural components of the building required for equipment and material being installed under this Contract shall be done by the particular affected trade to the satisfaction of the Engineer. Work which is deemed unsatisfactory shall be removed and reinstalled until it complies with the Contract Documents. The work carried on under this Contract shall be done in a neat and orderly fashion. All surplus material shall be removed and disposed of upon completion of the work.

C. Pipe sizes shown on Plans are nominal sizes, unless noted otherwise. Provide all piping, which passes through walls, floors, or roofs with standard-weight pipe sleeves. All pipes, which pass through finished walls, shall be provided with chrome-plate canopy flanges. Make joint between pipe and sleeve water tight with oakum and poured and caulked lead. Dry pack sleeves in existing work in place, and provide a finished appearance. Pack holes left in concrete walls and floors by removal of existing piping with grout and finish. Holes left by the removal of pipe in other existing walls shall be finished to match adjacent conditions, for the Engineer's approval.

D. The Mechanical work scope of this section shall include the responsibility for all repair work of existing facilities affected by mechanical work performed in the existing structure. Repair work shall include, but not be limited to, such items as replacement of patching wall for ductwork penetrations, and other repairs arising from extension and remodeling of the existing mechanical systems.

3.2 IDENTIFICATION PLATES AND CODING

A. Attach nametags to equipment with screws, bolts, or mastic to create a permanent bond.

3.3 INDICATING DEVICES

A. All direct-reading control devices, thermometers, and pressure gauges shall be installed so that they can easily be read from floor level and are readily accessible

for maintenance and service. All thermometer-sensing bulbs shall be coated with a silver-base heat transfer grease prior to insertion into the sensing well. Install pressure gauges and thermometers where indicated.

B. Provide field calibration of all control devices at time of installation to insure measuring and reading accuracy.

3.4 FIELD QUALITY CONTROL

A. Functional Tests:

1. Prior to field performance testing and plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test.
2. Pumping unit control system shall be checked for proper installation, adjusted, and calibrated on a loop-by-loop basis to verify that it is ready to function as specified.
3. All system elements shall be checked to verify that they have been installed properly and that all terminations have been made correctly. All discrete elements and system shall have their set points adjusted and shall be checked for proper operation. All continuous elements and system shall have three-point calibrations performed. All controller-tuning constants shall be adjusted to preliminary settings.
4. All system signals being sent from the skid to the plant control system shall be checked to verify proper communication, status and scaling have been established. Similarly, all external plant control system inputs to the pump skid control panel shall also be checked for proper communication and status.
5. Proposed tests procedures shall be submitted for approval prior to the testing and Engineer shall be notified of the test date 2 weeks in advance.

B. Pump Performance Test:

1. The Contractor shall perform field tests on all completed pump skid to demonstrate its conformance to the Specifications to the satisfaction of the Engineer.
2. Tests shall be performed using the pressure gauges that will typically be used by the operating personnel. Gauges shall be calibrated and installed per ANSI/HI 1.6.
3. A test log shall be presented to the Engineer upon the completion of each test that records the following:
4. Flow, as measured by pump station instrumentation and/or storage volumes.
5. Pump suction and discharge pressures as measured by calibrated gauges, converted to feet of the liquid pumped and corrected to pump datum as defined by Hydraulic Institute Standards.

C. Performance Acceptance Tests:

1. The performance tests shall be witnessed by the Engineer and shall demonstrate that the equipment meets all the specification requirements.
2. Proposed test procedures shall be submitted for approval prior to testing and Engineer shall be notified of the test date 2 weeks in advance.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide manufacturer's certificates in accordance with Section 01610.

3.6 MANUFACTURER'S SERVICES

A. The Contractor's and manufacturer's services during construction, start-up, and operation periods of the work shall be made in accordance with Section 01610 – Manufacturer’s Services.

B. A manufacturer's representative for the equipment specified herein including shall be present at the jobsite and/or classroom designated by the Owner for the time necessary it takes to satisfactorily achieve the following services. No minimum or maximum man-days are listed for the services herein under.

1. Installation assistance, inspection, and certification of the installation.
2. Functional testing.
3. Performance testing

C. A manufacturer's representative for the equipment specified herein (excluding travel time) including shall be present at the jobsite and/or classroom designated by the Owner for the minimum time specified herein to perform the following services.

1. One man day for class room training of treatment plant staff.
2. Startup services and training of Owner's personnel shall be at such times as requested by the Owner.

3.7 SAFETY CONSIDERATIONS

A. All mechanical equipment shall be installed with suitable access clearances for maintenance or removal of replaceable parts and components, and with necessary couplings or flanges to perform the maintenance or removal without removing the connecting appurtenances.

B. Where equipment requiring periodic maintenance cannot be reached by normal walkways because of interference with ductwork, piping, or other mechanical obstructions created by conflicts or changes made during construction, or by substitution of equipment, the Contractor shall provide an alternate safe means of access. These may include construction of an overhead platform with stairway or ladder ends and safety railings or handholds, of walk-through duct plenums with

hinged access doors, or as required to meet OSHA standards for safe maintenance procedures.

3.8 CLEANING, STARTUP, AND ADJUSTING

A. The Contractor shall be responsible for proper operation of all systems, minor subsystems, and services provided under this Section. He shall coordinate startup procedures, calibration, and system checkout with all subcontractors involved. Any system operational problems shall be diagnosed; all correctional procedures shall be initiated with the various subcontractors as required to bring the system into compliance with the design, and the problem then shall be rechecked to verify that the system operates normally. Any remaining difficulties shall be brought to the attention of the Engineer.

B. Thoroughly clean all parts of the installation at the completion of the work. The Contractor shall clean up and remove from the premises all refuse material, crates, and rubbish arising from his work. All motors and bearings shall be lubricated in accordance with the manufacturer's service manuals prior to equipment startup. Provide a lubrication schedule for every item of equipment furnished under this Section. The schedule shall include the type of lubricant and the application frequency.

PART 4. PAYMENT

A. Payment for the work in this Section will be included as part of the total lump sum amount stated in the Bid.

END OF SECTION

Section 13001
INSTRUMENTATION AND CONTROL SYSTEM

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. It is the intent of this specification to provide the interface components between a new booster pump control system as supplied in Division 11 and the existing Water Plant control system. All work necessary for detailed engineering, furnishing, installing, adjusting, testing, documenting, start-up and all components specified or required for a complete, operable system shall be included.

B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service. Certain items of equipment may be specified as “no exceptions allowed” to provide standardization with existing devices which will remain in service.

C. Equipment set-up and configuration assistance to the owner during start-up shall be included.

1.3 DEFINITION OF TERMS

A. I & C System: Major components of the I & C System include, but are not limited to, all materials, equipment and work required to implement a complete and operating system of Instrumentation and Control.

B. I & C System Supplier: A single firm, under direction of the Contractor, which shall assume complete responsibility for engineering, furnishing, technically advising on, certifying the correctness of installation, making final connections to, adjusting, documenting, testing, starting-up the primary elements, discrete field mounted control elements, and the PLC system.

1.4 RESPONSIBILITY FOR COMPLETE SYSTEM

A. The Contractor shall be ultimately responsible for and shall provide for the supply, installation, certification, adjustment and startup by the I & C System Supplier, of a complete, coordinated, system which shall reliably perform the specified functions up to and including interface with the PLC Input/Output hardware.

B. The Contractor shall be responsible for performing the work of Division 16, as distinct from the I & C System Supplier, and shall provide all additional materials and work necessary to supplement the materials and work provided by the I & C System Supplier, thereby satisfying all requirements that are within the scope of this Section.

C. The I & C System Supplier shall supervise final power and signal connections to all elements provided under this Section. For all elements provided under this Section and all elements interfaced by the I & C System, the I & C System Supplier shall verify and certify by written notice to the Engineer, correctness of final signal connections and correctness of adjustment.

D. The I & C System Supplier shall obtain from the Contractor the required information on those primary elements, valves, valve actuators, and other control equipment or devices that are required to be interfaced with, but that are not provided under this Section.

E. The I & C System Supplier shall coordinate his work with the Contractor to insure that:

1. All components provided under this Section are properly installed.
2. The proper type, size, and number of control wires with their conduits are provided and installed.
3. Proper electric power circuits are provided for all components and systems.

F. The Contractor shall be responsible for taking reasonable precautions when making tie-ins to existing I & C equipment to prevent damage to said equipment and when making terminations to existing PLC equipment. Furnish reports to the Engineer before and after tie-ins to existing PLC equipment and on the operational condition of equipment. Report all damage caused by work under this Contract. Do not attempt to repair existing equipment determined to be damaged.

G. All existing equipment which will be interfaced by the work of this contract is considered to be in working condition. The Contractor shall notify the Owner and the Engineer if he believes a piece of equipment is not fully functional and would compromise his ability to demonstrate operation following interconnection to the revised control system. The equipment will be investigated and if not functional, will be repaired by the Owner or a revised level of demonstration testing will be established for that particular equipment.

1.5 RELATED SECTIONS

A. Division 16 Section "Basic Electrical Materials and Methods" for general component Identification and support requirements.

B. All conduits are provided and installed under Section 16110. All wiring and cables are provided and installed under Section 16120.

C. Sections to which this Specification Applies: The applicable requirements of this Section are included by reference in the following Sections:

1. Section 16010 – BASIC ELECTRICAL REQUIREMENTS
2. Section 16050 – BASIC ELECTRICAL MATERIALS AND METHODS
3. Section 16100 – ELECTRICAL TESTING
4. Section 16110 – RACEDWAYS
5. Section 16120 – CONDUCTORS

D. Specified and Performed Under Other Sections: The work specified in the following Sections affects or is dependent on the work of this Section. Refer to those Sections for additional information.

1. Specification Section 11000, Ozone Cooling Water Booster System.

1.6 SUBMITTALS

A. General: Submit items in this Article according to the Conditions of the Contract.

B. Before any components are fabricated, and/or integrated into assemblies, or shipped to the site, furnish to the Engineer, in accordance with the approved Submittal/Payment Schedule, and receive his review of five copies of full details, shop drawings, catalog cuts, and such other descriptive matter and documentation as may be required to fully describe the equipment and to demonstrate its conformity to these Specifications. The decision of the Engineer upon the acceptability of any submittal shall be final. Catalog information shall be submitted for all equipment.

C. All submittals shall be complete, neat, orderly, indexed and in accordance with the approved Submittal/Payment Schedule. Partial submittals, not in accordance with the approved Submittal/Payment Schedule, will not be accepted. All components shall be referenced by the instrument name tag designations shown.

D. If, in the opinion of the Engineer, a submittal is not clear, it will be returned to the Contractor and it shall be revised and resubmitted within 30 days.

E. Specifically, the I & C System Supplier shall submit the following material:

1. Catalog information, descriptive literature, wiring diagrams and shop drawings on all transmitters, control stations, and equipment associated with the I&C System.
2. Individual data (or specification) sheets shall be provided for all components provided under this Section. The purpose of these data sheets is to supplement the generalized catalog information provided by citing all specific features for each specific component (e.g., scale range, materials of construction, special options included, etc.). Each component data sheet shall bear the component name and instrument tag number designation shown on the Plans and in the Specifications.
3. Catalog information on all electrical devices furnished under this Section.

4. Interconnecting wiring diagrams, showing all connections between field-mounted components, control stations, inter-connecting termination cabinets (ITCs) and control panel (FP and LCP), and showing all component and panel identification numbers. These diagrams shall be coordinated with the Electrical Contractor and shall bear a mark showing that this has been done. Diagrams, device designations, and symbols shall be in accordance with NEMA ICS 250.

1.7 DOCUMENTATION

A. The I & C System Supplier shall provide documentation for the I&C System as supplied or modified under this contract. This documentation shall include (4) Operating and Maintenance Manuals and Record Drawings.

1.8 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and materials manufactured within the scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.9 TESTS

A. All revised or new elements of the Instrumentation and Control System shall be tested to demonstrate that the total system satisfies all of the requirements of this Specification.

B. All special testing materials and equipment shall be provided by the I & C System Supplier. Where it is not practical to test with real process variables, the I & C System Supplier shall provide suitable means of simulation. These simulation techniques shall be subject to the approval of the Engineer.

C. The I & C System Supplier shall coordinate all of his testing with the Contractor.

D. As a minimum, the testing shall include the following:

1. Operational Acceptance Tests:
   a. The objective of these tests is to demonstrate that the I&C System is READY for loading and testing of process/application specific software.
   b. All system elements shall be checked to verify that they have been installed properly and that all terminations have been made correctly.
   c. The OPERATIONAL ACCEPTANCE TESTS shall be completed prior to starting the FUNCTIONAL ACCEPTANCE TESTS. The actual testing program shall be conducted and documented according to the procedures required hereinafter.
2. Functional Acceptance Tests:
   a. The objective of these tests is to demonstrate that the I&C System is operating and complying with the specified performance requirements.

b. A witnessed, FUNCTIONAL ACCEPTANCE TEST shall be performed on the complete I&C System. Each function shall be demonstrated to the satisfaction of the Engineer on a paragraph-by-paragraph and loop-by-loop basis.

c. The actual testing program shall be conducted and documented according to the procedures required hereinafter.

1.10 TEST PROCEDURE DEVELOPMENT AND TEST DOCUMENTATION

A. After award of the Contract, the I & C System Supplier shall prepare and submit to the Engineer for review, a detailed description of the test procedures that they propose to perform to demonstrate conformance of the complete system of instrumentation and controls to this Specification. The decision of the Engineer upon the acceptability of the test procedures shall be final.

B. It is recommended that the I & C System Supplier develop the test procedures in two steps by first submitting general descriptions and outlines of the tests and then, upon receipt of approval, submit the required detailed procedures and forms.

C. Documentation for testing of the I & C System shall be as follows:

1. Operational Acceptance Tests:

a. The I & C System Supplier shall prepare check-off sheet(s) for each loop and an instrument calibration sheet for each active I & C element (except simple hand switches, lights, etc). These check-off and data sheets shall form the basis for these operational tests and this documentation.

b. Each loop check-off sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the completed loop by the I & C System Supplier:

1) Project name;
2) Wire number;
3) For each element: Description, manufacturer and model number, installation bulletin, and Specification sheet number;
4) Wire description;
5) Installation check;
6) Termination check;
7) Signal to noise ratio check;
8) Communications and packet loss check;
9) Space for comments;
10) Space for wire sign-off by I & C System Supplier and date.

2. Functional Acceptance Tests: Functional Acceptance Testing shall be performed using the process/application specific software apart from this Contract.

1.11 MANUFACTURER'S SERVICES

A. The I&C System Supplier shall furnish service of factory/field engineers as follows:

1. Installation: As required for proper installation.
2. Startup: As required for proper startup.
3. Training: two ½ day training sessions on separate days, travel time excluded.

PART 2. PRODUCTS

2.1 GENERAL

A. The design of the Process Instrumentation and Control System is based on the specific equipment specified hereinafter. For example, for equipment listed in the equipment list, the design is based on the first named manufacturer where there is a difference. Should the I&C System Supplier select other equipment that requires different installation requirements, wiring and conduit, enclosures, intrinsically safe barriers, and accessories, the Contractor and I&C System Supplier shall obtain approval from the Engineer for such changes to the design in accordance with POST-CONTRACT AWARD SUBMITTALS hereinbefore and shall make all approved changes at no additional cost to the Owner.

B. The following are detailed but generalized panel and component/assembly specifications.

1. Whenever any material, article, device, product, or fixture is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired. This procedure is not to be construed as eliminating from competition other products of equal or better quality by other manufacturers where fully suitable in design, and shall be deemed to be followed by the words "or equal." The decision relative to equality shall be solely by the Engineer. Note that certain equipment items are specified as "No Exceptions Allowed' where required to provide standardization with like components of the existing system which shall remain in service.

PART 3. WORKMANSHIP

3.1 GENERAL

A. Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

B. Coordinate I & C work with the Owner, the Engineer, the Contractor, and work of other trades to avoid conflicts, errors, delays, and unnecessary interference with operation of the plant during construction.

3.2 PROTECTION DURING CONSTRUCTION

A. Throughout this Contract, the Contractor shall provide protection for materials and equipment against loss or damage and the effects of weather. Prior to installation, store items in indoor, dry locations. Provide heating in storage areas for items subject to corrosion under damp conditions. Specific storage requirements shall be in accordance with the Engineer-reviewed I & C System Supplier's recommendations.

3.3 MATERIAL AND EQUIMENT INSTALLATION

A. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, and these Contract Documents, follow Engineer's decision, at no additional cost to Owner or the Engineer. Keep copy of manufacturers' installation instructions on the jobsite available for review at all times.

3.4 REMOVAL OR RELOCATION OF MATERIALS AND EQUIPMENT

A. Where existing materials and equipment are removed or relocated, remove and deliver to the Owner all materials no longer used unless otherwise directed by the Engineer. Repair affected surfaces to conform to the type, quality, and finish of the surrounding surface in a neat and workmanlike manner. Follow any specific instructions given by the Engineer.

3.5 CLEANING AND TOUCH-UP PAINTING

A. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touch-up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

3.6 PANELS AND PANEL-MOUNTED EQUIPMENT

A. Panels and panel-mounted equipment shall be assembled as far as possible at the I & C System Supplier's plant. No work, other than correction of minor defects or minor transit damage, shall be done on the panels at the jobsite.

3.7 EQUIPMENT FURNISHED BY I & C SYSTEM SUPPLIER AND INSTALLED BY CONTRACTOR

A. I & C System Supplier shall observe and advise on the installation, to the extent required to certify in writing that the equipment will perform as required.

3.8 ELECTRICAL POWER AND SIGNAL WIRING

A. Control and signal wiring external to the control panels and all power wiring shall conform to the requirements of Division ELECTRICAL.

B. Control and signal wiring in control panels shall be restrained by plastic ties or ducts. Hinge wiring shall be secured at each end so that any bending or twisting will be around the longitudinal axis of the wire and the bend area shall be protected with a sleeve.

C. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for any wire bundles which pass through holes or across edges of sheet metal.

1. Use manufacturer's recommended tool with the proper sized anvil, for all crimp terminations. No more than one wire may be terminated in a single crimp lug and no more than two lugs may be installed on a single screw terminal.
2. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

3.9 INSPECTIONS

A. All materials, equipment, and workmanship shall be subject to inspection at any time by the Engineer or his representatives. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer at no additional cost to the Owner.

END OF SECTION

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Section 15000
PLANT PIPING – GENERAL

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Building piping.

B. General piping requirements. The Detail Piping Specifications provide additional requirements.

1.2 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI Bl.20.1-83 – Pipe Threads, General Purpose (In.).
2. ANSI B16.1-75 – Cast Iron Pipe Flanges and Flanged Fittings.
3. ANSI B16.3-77 – Malleable Iron Threaded Fittings.
4. ANSI B16.4-77 – Cast Iron Threaded Fittings.
5. ANSI B16.5-81 – Pipe Flanges and Flanged Fittings.
6. ANSI B16.9-78 – Factory-Made Wrought Steel Buttwelding Fittings.
7. ANSI B16.12-83 – Cast Iron Threaded Drainage Fittings.
8. ANSI B16.14-77 – Ferrous Pipe Plugs, Bushings, and Lock Nuts with Pipe Threads.
9. ANSI B16.21-78 – Non-Metallic Flat Gaskets for Pipe Flanges.
10. ANSI B16.39-77 – Malleable Iron Threaded Pipe Unions.

B. American Society for Testing and Materials (ASTM):

1. ASTM A47-77 – Specification for Malleable Iron Castings.
2. ASTM A53-82 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated and Seamless.
3. ASTM A106-82 – Specifications for Seamless Carbon Steel Pipe for High Temperature Service.
4. ASTM A120-82 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
5. ASTM A135-79 – Specifications for Electric Resistance Welded Steel Pipe.
6. ASTM A183-80 – Specifications for Carbon Steel Track Bolts and Nuts.
7. ASTM A234-82A – Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
8. ASTM A333-82 – Specification for Seamless and Welded Steel Pipe for Low Temperature Service.

C. American Society of Mechanical Engineers (ASME):

1. ASME Boiler and Pressure Vessel Code, Section II, Part C.
2. ASME Boiler and Pressure Vessel Code, Section IX.

1.3 PIPING SCHEDULE

A. The Piping Schedule in this specification lists each service by name and by legend, and tabulates piping material to be used in a given service and location. In locations where the referenced material for a service is unacceptable, due to unique or localized physical or chemical limitations, the specifications for an acceptable alternative material shall be submitted to the Engineer for approval.

1.4 SUBMITTALS

A. Submit shop drawings under the provisions of Section 01300 – Submittals. Submit pipe material and joint type for each pipeline.

B. Submit shop drawings under the provisions of Section 01300 – Submittals for all couplings, adapters, wall pipes, sleeves, sealants, dielectric fittings, hangers, and supports.

C. Submit shop drawings under the provisions of Section 01300 – Submittals showing double-line drawings of each piping system, locating each support and hanger, identifying the type by catalog number or shop drawing detail number, and showing anchor locations and identifying them by shop drawing detail number. Show also all couplings, adapters, etc.

PART 2. PRODUCTS

2.1 GENERAL

A. The materials to be used for the piping systems shown on the Drawings are listed by service in the Piping Schedule.

B. Like items of material shall be the end products of one manufacturer.

C. Paint and color code all exposed metal piping as specified in Section 09900 – Painting. Label all exposed piping as specified herein.

D. No change in material or joint selection will be permitted after submittal of shop drawings and their final review by the Engineer.

2.2 PIPE JOINTS FOR EXPOSED PIPING

A. Provide flanged pipe joints on exposed piping 3 inches and larger except as shown otherwise. Grooved end pipe joints may be substituted for flange joints for piping 3 inches and larger except as noted otherwise.

B. Provide joints as specified in the Detail Piping Specifications for all pipe smaller than 3 inches.

C. Provide welded pipe joints where shown on the Drawings.

2.3 PIPING SUPPORT SYSTEMS

A. General:

1. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed. Provide special support and hangers where standard catalog supports are inapplicable.
2. No attempt has been made to show pipe supports in most locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing them throughout the plant. Where pipe supports are specifically called out on the Drawings, the Contractor shall provide this type of support.
3. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
4. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus hydraulic thrust, and plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.
5. All buried and submerged piping supports, guides, anchor bolts, and fasteners, and those installed in wetwells, shall be Type 316 stainless steel.
6. Concrete anchors and anchor bolts shall be as specified in Section 05500 – Metal Fabrications.
7. All components of the piping support system shall be hot-dipped galvanized steel inside buildings and galleries, except where stainless steel is specified.

B. Building Piping:

1. Horizontal piping shall be supported with adjustable swivel-ring, split-ring, or Clevis type hangers, Grinnell Figure 104 or 260; B-Line Figure B3171 or B3100; or equal.
2. Stacked horizontal runs of piping along walls shall be supported by a metal framing system attached to concrete insert channels, Unistrut, or equal. No pipe shall be supported from the pipe above it.
3. Pedestal pipe supports shall be adjustable, with stanchion, saddle, and anchoring flange as shown, Grinnell Figure 264; B-Line Figure B3089 with B3092 or B3096; or equal.
4. Horizontal piping hanger support rods:
   a. Attach to steel beams with I-clamps, to concrete with inserts or flanges with flush shells, and to wood not less than 2-1/2-inch thick with lag screws and angle clips.
   b. Provide universal concrete inserts with a load rating greater than the hanger rods they support.
5. Vertical piping hangers and supports shall be channel and pipe straps as manufactured by Unistrut, or equal.

6. Piping supports for vertical piping passing through floor sleeves shall be hot-dipped galvanized steel riser clamps, Grinnell Figure 261; B-Line Figure B3373; or equal.
7. All hangers, rods, clamps, protective shields, metal framing supports, and hanger accessories shall be hot-dipped galvanized unless otherwise noted on the Drawings.

2.4 JOINTS FOR DISSIMILAR PIPE

A. Joints between dissimilar exposed pipe:

1. Make with insulating flanges, couplings and unions of suitable pressure ratings for system working pressures.
2. Construction materials: Galvanically compatible with the piping to which attached.
3. Joints:
   a 2 inch and smaller: Screwed or solder-joint unions.
   b 2-1/2 inch and larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts. Joints between dissimilar buried pipe shall be made with insulating couplings.

2.5 SERVICE SADDLES

A. Service Saddles For Ferrous Metal Piping: Pipe service saddles for all ferrous metal piping except stainless steel shall be Smith Blair Inc., Series 313 or 366; or Dresser Style 91; or equal. Service saddles shall be capable of withstanding 150 psi internal pressure without leakage or overstressing. The run diameter shall be compatible with the outside diameter of the pipe on which the saddle is installed. Taps shall have iron pipe threads. Saddles shall have malleable or ductile iron bodies and galvanized steel straps, steel hex nuts and washers, and Nitrile (Buna N) gasket. Alternate gasket materials (as selected by manufacturer and suitable for fluid service and maximum operating temperature) may be allowed with Engineer's approval. Service saddles shall be of double-strap or triple-strap design. Service saddles shall not be used on glass lined ductile iron pipe or ceramic-epoxy lined ductile iron pipe, factory applied tapping bosses shall be used.

2.6 SLAB, FLOOR, WALL AND ROOF PENETRATIONS AND CLOSURES:

A. All piping penetrations of slabs, floors and walls shall be ductile iron wall pipes with integrally cast seep rings unless shown otherwise on the Drawings. Verify size and location of all penetrations and place wall pipes before pouring concrete.

B. Ductile Iron Wall Pipes:

1. Provide ductile iron wall pipes of the proper diameter and with joints as shown on the Drawings or as required for connection. Wall pipes shall be a thickness equal to or greater than the remainder of the pipe in the line, and shall comply with the requirements for fittings in the applicable Detail

Piping Specification. All wall pipes shall be provided with integrally cast seep rings. Flanges and mechanical joint bells set flush with the face of walls shall be tapped for stud bolts.

2. Rubber-gasketed compression collars are unacceptable. The welding or brazing of seep rings to ductile iron wall pipes is not acceptable. The Contractor shall place early orders for wall pipes so they are available in sufficient time for placement in concrete forms. Coat wall pipes with System No. 2 as specified in Section 09900. Support wall pipes by form work to prevent contact with reinforcing steel.

C. Pipe Sleeves:

1. All piping passing through concrete or masonry shall be installed through hot-dipped galvanized steel pipe or high density polyethylene sleeves as manufactured by Thunderline Corporation; or equal. For fire rated rooms, provide hot-dipped galvanized wall sleeves only. Fabricate sleeves as shown on the detail drawings.
2. All sleeves in exterior or water-bearing walls shall have a center flange for water stoppage. The annular space between pipes and sleeves in exterior walls shall be watertight. The joint shall be sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. The interconnected rubber links shall be assembled of EPDM and composite pressure plates under each bolt head and nut to prevent the nut from turning when the bolt is tightened. Nuts and bolts shall be made of Type 316 stainless steel. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings. Seals shall be Link-Seal as manufactured by Thunderline Corporation; or equal.
3. Coat steel pipe sleeves with System No. 2, as specified in Section 09900 – Paintings. Support sleeves from form work to prevent contact with reinforcing steel.

2.7 INSULATION

A. See Section 15260 – Pipe Insulation.

2.8 FIRESTOPPING

A. For all pipes penetrating a fire rated room, provide hot-dipped galvanized wall sleeves and fill the void with Type II fire resistive caulk. Room fire rating is determined by the door type used which is found in the Architectural Door Schedule.

B. Type II fire resistive caulk shall be 3M brand CP25WB; or equal.

2.9 TAPE WRAP

A. Tape wrap shall be 15-mil butyl rubber adhesive, polyethylene-backed tape as manufactured by Tyco Adhesives, Norwood, MA; Royston Laboratories, Inc., Pittsburgh, PA; or equal.

2.10 METALLIC MARKING TAPE

A. Electrically conductive 2-inch wide bright colored marking tape, designed for direct burial. Tape shall be detectable with standard pipeline detectors.

2.11 PIPING SPECIALTIES

A. Simplex Strainer: Strainers, 3 inches and smaller, for water service shall be iron body, Y-pattern, 125-pound rated, with screwed ductile iron or bolted steel cap. Screen shall be heavy-gauge stainless steel mesh. Strainers shall be Crane F277; or equal.

B. Flashing Sleeves: Flashing sleeves shall be installed wherever piping passes through concrete roof structures. Where piping passes through wood or metal deck roofs, provide a 4-pound lead flashing extending 8 inches from the pipe in all directions, extended up the pipe, and fitted with a double-threaded flashing for pipes 3 inches and smaller. Flashing shall turn down inside the pipe for 4-inch piping. Flashing sleeves shall be J. R. Smith Figure 1720; Josam No. 26400; or equal.

PIPING SCHEDULE

Legend	Service	Installation	Material	Spec. Section	Test Pressure and Type (psig-x)[1]	Insulation	Color Code
CWS	Ozone Cooling Water Supply	Exposed	Galvanized	15000-18	150-H	Yes	Pipe labels with service, Dark Blue Lettering
House Water	House Water	Exposed	Galvanized	15000-18	150-H	Yes	Pipe labels with service, Dark Blue Lettering
Plant Effluent	Ozone Cooling	Exposed	Galvanized	15000-18	150-H	Yes	Pipe labels

PIPING SCHEDULE							
Legend	**Service**	**Installation**	**Material**	**Spec. Section**	**Test Pressure and Type (psig-x)[1]**	**Insulation**	**Color Code**
Channel	Water Supply						with service, Dark Blue Lettering

Notes:

1. Testing Methods (x)

   H – Hydrostatic

   Insulation per Section 15260.

PART 3. EXECUTION

3.1 GENERAL

A. Drawings do not attempt to show exact details of all piping, and no extra payment will be allowed for obstructions by work of other trades or local obstructions to the work under this Contract which require offsets. Where diagrams have been made to show piping connections, the Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in location of equipment or piping, advisable in the opinion of the Contractor, shall be submitted to the Engineer for approval before proceeding with the work. All measurements and dimensions shall be verified at the site. All equipment shall be adjusted and left in a condition satisfactory to the Engineer.

3.2 PIPE PREPARATION AND HANDLING

A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed or the buried pipe or fitting is lowered into the trench. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

B. Use proper implements, tools, and facilities for the safe and proper handling of the pipe. Carefully handle pipe in such a manner as to avoid any damage to the pipe. Do not drop pipe into trenches under any circumstances.

3.3 INSTALLATION OF EXPOSED PIPING

A. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible.

B. Unless noted otherwise on the Drawings, horizontal pipe support or hanger spacing and hanger rod sizing for steel and ductile iron pipe shall be as follows:

Pipe Size	**Maximum Support and Hanger Span**	**Minimum Rod Size Single Rod Hangers**
1-inch and Smaller	6 feet	3/8 inch
1-1/4 inch thru 2-1/2	8 feet	3/8 inch
3 inch and 4-inch	10 feet	1/2 inch
6 inch	12 feet	5/8 inch
8 inch	12 feet	3/4 inch
10 inch and 12 inch	14 feet	7/8 inch
14 inch and 16 inch	16 feet	1 inch
18 inch	16 feet	1-1/8 inch
20 inch thru 24 inch	18 feet	1-1/4 inch
30 inch and larger	As shown on Drawings	

1. When supporting ductile iron pipe, locate hanger rods at all nonrigid joints and at each change of direction.
2. Hanger minimum rod size for copper pipe shall be the same as for steel pipe. Hanger span shall be 2 feet less per size than for steel pipe, with 1-inch and smaller supported every 5 feet or less.
3. Hanger rod sizing for plastic pipe shall be same as for steel pipe. Spacing of hangers shall be as recommended by the manufacturer for the flow temperature in the pipe.
4. Hanger rod sizing and support spacing for stainless steel pipe shall be as shown in the Detail Piping Specification.
5. Vertical sway bracing shall be provided where shown, or on 10-foot maximum centers.
6. All piping shall be supported in a manner which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs.

C. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle the vertical centerline of pipes.

D. Unions shall be installed where required for piping or equipment installation, even though they are not shown on the Drawings.

E. Piping shall be installed without springing or forcing the pipe in a manner that would set up stresses in the pipe, valves, or connected equipment.

3.4 VENTS AND DRAINS

A. Vent the high point and drain the low point of all exposed pipelines, whether shown on the Drawings or not, with 3/4-inch valves on those pipelines 2-1/2-inch and larger and 1/2-inch valves on those pipelines 2-inch and smaller. Valve types shall be as shown on the Drawings or in the Schedule. Where valves do not appear on the Drawings or Schedule for a service listed, Type V300 valves shall be used.

3.5 WALL PIPES AND PIPE SLEEVES

A. Verify the size and location of all building and structure penetrations before concrete is poured. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300 – Cast-in-Place Concrete and as shown. Support all pipes embedded in concrete walls, floors, and slabs with form work to prevent contact with the reinforcing steel and ensure alignment.

3.6 INSTALLATION OF FLEXIBLE COUPLINGS AND FLANGED COUPLING ADAPTERS, GROOVED JOINT COUPLINGS, AND SERVICE SADDLES

A. Before installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

3.7 INSTALLATION OF INSULATING FLANGES, COUPLINGS AND UNIONS

A. Install insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever dissimilar ferrous metal are connected, wherever submerged metallic piping is connected to unsubmerged piping, and where shown on the Drawings. Insulated joints connecting submerged piping to exposed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged metallic piping shall be isolated from the concrete reinforcement.

3.8 TESTING

A. General: Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. Contractor shall provide water (groundwater or final effluent), pumps and piping to bring water to point of use, air supply, and all test pressure equipment (meters, gauges, etc.). Remove temporary devices after test is

complete. The Engineer will monitor the tests. Test pressures and fluid medium shall be as specified in the Piping Schedule.

B. Perform tests before insulation is installed. Pipes shall be clear of dirt, sand, or other foreign material prior to testing.

C. Plug pipe outlets with test plugs: Brace each plug securely to prevent blowouts. Add test fluid slowly. Include regulator set to avoid over pressurizing and damaging pipes. Perform all tests in accordance with local, state, and federal regulations.

D. Testing New Pipe that Connects to Existing Pipe: New pipelines that are to be connected to existing pipelines shall be tested by isolating the new pipe.

E. Correct leaks and defects and retest at no additional cost to Owner.

F. Exposed Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors.

G. Hydrostatic Leak Tests:

1. Equipment – Furnish the following equipment for the hydrostatic tests (as a minimum):

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump Suitable hose and suction pipe as required

2. Exposed Piping – Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four (4) bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. After section of piping to be tested has been filled with water, apply test pressure by means of force pump of such design and capacity that required pressure can be applied and maintained without interruption for duration of test. Measure test pressure by means of tested and properly calibrated pressure gauge acceptable to Engineer. The hydrostatic test pressure shall be continuously maintained for a minimum time of 2 hours and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Correct any visible leakage.

H. Initial Service Leak Tests:

1. Equipment: Equipment used for initial service leak testing may be the same as that specified under HYDROSTATIC and PNEUMATIC LEAK TESTS hereinbefore, or the pump or compressor connected to the piping system.
2. Procedure: The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of ten (10) minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected and retested.
3. Test Records: Records shall be made of each piping system installation during the test. These records shall include:
   a. Date of test
   b. Description and identification of piping tested
   c. Test fluid
   d. Test pressure
   e. Type of test performed
4. Remarks, to include such items as:
   a. Leaks (type, location)
   b. Repairs made on leaks
   c. Results of retesting (if applicable)
5. Certification by Contractor and initialed acknowledgment by Engineer.

3.9 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and filing, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects before assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.10 FINAL CLEANING

A. Following assembly and testing and before final acceptance, all pipelines installed under this section, except air lines and gas lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains 2-inch and larger or by dropping spools and valves. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

B. Air and gas piping shall be blown clean of loose debris with compressed air.

3.11 CORROSION PROTECTION OF ATMOSPHERIC EXPOSED PIPING ACCESSORIES

A. Interior atmospheric exposed surfaces of black steel, brass, copper and bronze piping components shall be painted in accordance with Section 09900 – Paintings, System No. 2. Hot-dip galvanized piping components shall be painted in accordance with Section 09900 – Paintings, System No. 8.

B. Interior pipe support systems, except galvanized or stainless steel components, shall be painted in accordance with Section 09900 – Paintings, System No. 2. Exterior pipe support systems, except galvanized or stainless steel components, shall be painted in accordance with Section 09900 – Paintings, System No. 3.

3.12 PIPE PAINTING AND IDENTIFICATION

A Painting of piping systems shall be as specified in Section 09900, and in accordance with the Piping Schedule.

END OF SECTION

Section 15001-18
GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS

PART 1. GENERAL

1.1 SCOPE

A. This Section covers the work necessary to furnish and install, complete, the galvanized steel plant pipe and fittings specified herein, and as specified further in Section 15000-0, PLANT PIPING – GENERAL.

1.2 GENERAL

A. See Section 15000-0, PLANT PIPING – GENERAL, for additional requirements.

1.3 SPECIFIED UNDER OTHER SECTIONS AND APPLICABLE TO THIS SECTION

A. The applicable materials and workmanship specified in the following Sections are included by reference in this Section.

15000-0, PLANT PIPING – GENERAL

PART 2. PRODUCTS

2.1 PIPE

A. Carbon steel, galvanized, seamless or electric resistance welded, ASTM A 120, Grade A, Schedule 40.

2.2 JOINTS

A. Two-inch and smaller, screwed; 2-1/2 or larger, grooved end or flanged to match adjacent piping.

2.3 FITTINGS

A. Two-inch and smaller, screwed, 150-pound malleable iron, galvanized, ASTM A 197 or ASTM A 47, dimensions conforming to ANSI B16.3; unions, 300-pound malleable iron, galvanized, ASTM A 197 or ASTM A 47, dimensions conforming to ANSI B16.3, brass to iron seat.

B. 2-1/2 inch and larger, grooved end, malleable iron, ASTM A 47, or ductile iron, ASTM A 536 grooves to accept mechanical couplings without field preparation. Victaulic, Bacon, or equal.

C. 2-1/2 inch and larger, ASTM A 47 backing flanges, ASTM A 240, Van Stone type, drilled 150-pound. ANSI B16.1 standard.

2.4 BRANCH CONNECTIONS

A. Two-inch and smaller, screwed tees, as specified under FITTINGS. Two and one half inch and larger, grooved end tees, as specified under fittings.

2.5 THREAD LUBRICANT

A. Teflon tape or non-toxic joint compound that is insoluble in water.

2.6 COUPLINGS

A. Grooved end pipe couplings shall be malleable iron, ASTM A 47, or ductile iron, ASTM A 536, Victaulic Style 75, Gustin-Bacon Style 100, or equal.

B. Screwed pipe couplings shall be malleable iron, ASTM A 197, or ASTM A 47, dimensions according to ANSI B16.3.

2.7 GASKETS FOR GROOVED END JOINTS

A. EPDM or chlorinated butyl with properties conforming to ASTM D 2000, dimensions to AWWA C606.

PART 3. EXECUTION

3.1 GENERAL

A. Ream, clean, and remove burrs from piping before making up joints. Make joints with compound approved for air piping use.

B. Upon completion of installation, piping systems shall be flushed and cleaned as specified in Section 15001, PLANT PIPING – GENERAL. After piping systems have been flushed and blown clean, all strainers shall have their baskets removed in the presence of the Engineer. All strainer baskets shall be thoroughly cleaned before replacement.

3.2 TESTING

A. All lines shall be pneumatically tested at the test pressures listed in the Piping Schedule. Test procedures shall be as specified in Section 15001, PLANT PIPING – GENERAL.

3.3 PAINTING

A. Piping shall be painted as indicated in Section 15000, PIPING SCHEDULES or applicable specification section. Shop prime and finish coats in accordance with Section 09900, PAINTING.

3.4 SUPPORTS AND HANGERS

A. As specified in Section 15000-0, PLANT PIPING – GENERAL.

3.5 CORROSION PROTECTION

A. As specified in Section 15000-0, PLANT PIPING – GENERAL.

END OF SECTION

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Section 15100
VALVES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Valve operators.

B. Floorstand operators.

C. T-handled operating wrenches.

D. Valve boxes and extension stems.

E. Floor boxes and extension stems.

F. Chain wheels and guides.

G. Valve tagging requirements.

H. Pressure and air valves.

I. Check valves.

J. Special valves.

1.2 SUBMITTALS

A. Submit shop drawings under the provisions of Section 01300 – Submittals:

1. Identify all submittal data with specified valve type number.
2. Submit a valve schedule, identifying all valves by type number, pipeline, location, joint type, manufacturer, and model or catalog number.
3. Include all valves in a single submittal package. Partial or incomplete submittals will not be reviewed.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle valves under the provision of Section 01600 – Material and Equipment.

PART 2. PRODUCTS

2.1 GENERAL

A. Like items of equipment shall be the end product of one (1) manufacturer.

B. All valves shall be complete with all necessary operating hand wheels, chain wheels, extension stems, worm and gear operators, operating nuts, chains, wrenches, and other accessories that are required for the proper completion of the work included under this Section.

C. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service.

D. Unless otherwise shown, valves shall be the same size as the adjoining pipe.

E. All units shall have the name of the manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.

F. For the purpose of designating the type and grade of valve desired, a manufacturer's name and list or figure number is given in the following specifications. Valves of equal quality by other manufacturers will be considered in accordance with Section 01600– Material and Equipment.

2.2 VALVE TYPES

A. Valve types are specified by number. The type of valve to be used for each service and application is indicated in the Valve Schedule at the end of this Section by valve number call out. Note: this is a general valve specification so that some of the valve types listed herein may not be a part of the Work.

2.3 DESIGN FEATURES

A. Brass and Bronze Components:

1. Brass and bronze components of valves and appurtenances that have surfaces in contact with the water shall be alloys containing less than 16 percent zinc and 2 percent aluminum. Approved alloys are of the following ASTM designations: B61, B62, B98 (Alloy A, B, or D), B139 (Alloy A), B143 (Alloy 1-B), B164, B194, B292 (Alloy A), B127, and B584 (Alloy 844).
2. Stainless steel Alloy 18-8 may be substituted for bronze at the option of the manufacturer and with the approval of the Engineer.
3. All gland bolts on iron body valves shall be bronze and shall be fitted with brass nuts.

2.4 VALVE OPERATORS

A. Equip all valves with handwheel operators, which open by turning counter-clockwise, unless otherwise shown or specified.

B. Proportion valve operator as to permit operation of the valve under full operating head with a maximum pull of 80 pounds on the handwheel or crank.

C. Worm and Gear Operators for Manually Operated Valves:
1. Provide a totally enclosed design.
2. Provide a self-locking type to prevent the disc or plug from creeping.
3. Self-locking Worm Gears: One (1)-piece design of AWWA gear bronze material, accurately machine cut.
4. Provide a hardened alloy steel worm, with thread ground and polished.
5. Provide proper lubricant for the reduction gearing.
6. Provide with position indicators to show the position of the valve disc or plug.
7. Paint the hand wheels the same color as the valve and associated pipeline.
8. Size for differential pressure for service specified in the Piping Schedule, Section 15000 – Plant Piping – General.

2.5 CHAIN WHEELS AND GUIDES

A. Provide Walworth Company, Figure 804; Clow Valve Company, Figure F-5680; DeZurik Corporation, Series W or LWG; Orbinox; or equal chain wheels and guides.

B. Paint chain wheels and guides.

C. Size chains as recommended by the valve manufacturer and to extend within 4 feet of the operating floor.

D. Provide plated chains of the single loop coil or babbitt type.

E. Where chains hang in normally traveled areas, provide appropriate "L" type tie back anchors and locate as directed by the Engineer.

F. Valves specified or shown to have operating wheels greater than 7 feet above the floor require a chain wheel.

2.6 VALVE TAGGING REQUIREMENT

A. Provide a valve tag for each power or air operated valve.

B. Construction: Fiberglass with embedded lettering.

C. Overall Tag Size: 2-1/2 inch by 4 inch with area to provide two (2) rows of eight (8) 3/4 inch high black characters.

D. Tag Color: White and have no border.

E. Valve Character Designations: Provide during shop drawing review.

F. Provide Type 1-39 valve tags as manufactured by W.H. Brady Co.; Allen Systems Inc.; or equal.

G. Attach tags to the operator with self-locking nylon ties such that tie and tag cannot be removed.

2.7 PRESSURE AND AIR VALVES

A. Pressure Relief Valves: Valves shall have PVC body, FPM seals with no metal parts. The valves shall have NPT connections and relieve pressures from 5 to 75 psi. Valves shall be provided with 1/4 inch NPT gauge port on the valve body for optional installation of pressure gauge. Valve shall be manufactured by Hayward flow control systems, or equal.

B. Air Release Valves: All air release and air valves shall have cast iron body and cover, and stainless steel float. Float guides, bushing, and lever pin shall be stainless steel. Combination air release valves shall be Golden-Anderson, or equal.

C. Air Vacuum Breaker: Air vacuum breakers shall have a stainless steel body, spring ball float, and retainer tube. Vacuum breakers shall be Kadant Johnson VB8-101, or equal.

D. Water Pressure Reducing Valves: Bronze body, diaphragm operated, with an integral thermal expansion bypass valve, inlet union, stainless steel strainer, renewable monel or stainless steel seat and adjustable reduced pressure range, 300 psig at 160°F. Pre-set for the scheduled pressure. A.W. Cash, Conbraco, Watts, Wilkins, or equal.

Service	Size (IN)	Inlet Pressure (PSIG)	Outlet Pressure (PSIG)	Max Flow (GPM)
Ozone Cooling Water	6	120	90	600

2.18 CHECK VALVES

A. Swing Check Valves, 2 inch through 10 inch:

1. The swing check valve with outside lever, weight, and air cushion chamber shall be constructed of heavy cast iron body with a bronze or stainless steel seat ring. The seat ring shall be locked in place with stainless steel lock screws and be field replaceable without the use of special tools. The shaft shall be one (1) piece 316 stainless steel for attachment of outside lever and weight.
2. The lever and weight assembly shall be externally attached to either side of the valve body and the weight easily positioned to adjust the closing speed of the valve disc to suit the application. External air cushion chamber shall dampen valve closure, closing speed adjustable.

3. The swing check valve shall prevent the backflow of the media, without slamming, on pump shut-off or power failure and be tight seating.
4. The valve disc shall be cast iron utilizing a double clevice hinge and be connected to a Ductile Iron disc arm suspended from a stainless steel shaft which shall pass through externally replaceable O-ring seals and be connected to the lever arm of the outside of the valve. The disc seat shall be neoprene material for drip tight shut-off and shall be easily replaced in the field without the use of special tools.
5. All internals shall be field replacement without removing the main valve from the pipeline.
6. Valve shall be full equivalent pipe area when fully open.
7. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

a.	Body, cover, disc	Cast iron	ASTM A126, Class B
b.	Disc arm	Ductile iron	ASTM A536
c.	Seat	Aluminum bronze	ASTM B148
d.	Disc seat	Buna-N	
e.	Pivot shaft	Stainless steel	ASTM A582

8. Valve to be APCO Series 6000LW, Crispin SWC Series, or equal.

2.19 SPECIAL VALVES

A. Reduced Pressure Backflow Preventers: Reduced pressure principle backflow assembly shall be modular check assembly type with center stem guiding. Each check module shall have a captured spring and be accessible through a bolted cover plate. Seats shall be replaceable without special tools. It shall be a complete assembly consisting of tight-closing resilient seated shutoff valves, test cocks, and a strainer. Assembly shall meet the requirements of ASSE No. 1015. Assembly shall be Watts Regulator Company Series 709, or equal.

B. Balancing Plug Valve: Combination balancing and shutoff valves shall be non-lubricated plug valves with semi-steel body with wrench lever manual operator and EPDM resilient plug facing. Valves shall have adjustable memory stop. Valves shall be rated 150-pound minimum and shall be furnished with 125-pound ANSI flanged ends. Valves shall be DeZurik PEC, or equal.

PART 3. EXECUTION

3.1 GENERAL

A. Bolt holes of flanged valves shall straddle the vertical centerline of the pipe run. Before installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert gasket and bolts, and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen or remove the nuts and bolts, reseat or replace the gasket, retighten and/or reinstall the nuts and bolts, and retest the joints. Joints shall be watertight at test pressures before acceptance. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads before making joints. Joints shall be watertight at test pressures before acceptance.

3.2 PLACING

A. Where centerline of manually operated valves are over 5 feet 6 inches above the floor line, chain wheel and guide assemblies or chain lever assemblies shall be furnished and installed for operation of the valves, unless otherwise directed by the Engineer.

B. Generally, unless otherwise indicated on the Drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 5 feet 6 inches above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems orientated to facilitate the most practicable operation.

3.3 TESTING

A. Valves shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Repair joints that show signs of leakage before final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test, they shall be properly protected. Correct any damage caused by the testing.

B. If requested by the Engineer, the valve manufacturer shall furnish an affidavit stating the materials options furnished and/or that he has complied with these and other referenced specifications.

END OF SECTION

Section 15260
PIPING INSULATION

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.2 RELATED SECTIONS

A. Section 15000 – Plant Piping – General.

1.3 REFERENCES

A. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. ASTM C195 – Standard Specification for Mineral Fiber Thermal Insulating Cement.

C. ASTM C518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

D. ASTM C533 – Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

E. ASTM C547 – Standard Specification for Mineral Fiber Preformed Pipe Insulation.

F. ASTM D2842 – Standard Test Method for Water Absorption of Rigid Cellular Plastics.

G. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E96 – Standard Test Methods for Water Vapor Transmission of Materials.

I. NAIMA National Insulation Standards.

J. NFPA 255 – Standard Method of Test of Surface Burning Characteristics of Building Materials.

K. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS FOR REVIEW

A. Section 01300 – Submittals: Procedures for submittals.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section 3 years documented experience approved by manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Section 01600 – Material and Equipment: Transport, handle, store, and protect products.

B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2. PRODUCTS

2.1 INTERIOR PIPE

A. If piping is to be insulated, it is noted on the Plans or in the Specifications. Insulation shall be heavy-density, sectional, preformed glass-fiber insulation with factory-applied vinyl-coated and embossed vapor jacket, self-sealing lap, and UL rating. Laps and butt joints shall be sealed with pressure-sensitive joint sealing tape of the same finish as the insulation jacket, to provide a continuous vapor seal. Furnish 1-inch thick material for piping smaller than 4 inches in diameter

and 1-1/2-inch thick material for piping 4 inches and larger in diameter. Material shall be Owens-Corning Type 25 ASJ, or equal.

B. Insulate at each pipe hanger for piping 1 inch and larger. Insulation shall be preformed rigid cell, half-round insulation, with factory-applied vinyl-coated and embossed vapor jacket, self-sealing lap, and UL rating. Minimum length shall be 8 inches, centered at each pipe hanger, and equal in thickness to the adjacent insulation. Material shall be Owens-Corning Type 25 heavy-density, or equal.

C. House water piping insulation shall be white with white labels with dark blue lettering.

PART 3. EXECUTION

3.1 EXAMINATION

A. Section 01039 – Coordination and Meetings: Verification of existing conditions before starting work.

B. Verify that piping has been tested before applying insulation materials.

C. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Section 01400 – Quality Control: Manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

E. Inserts and Shields:

1. Application: Piping 1½ inches (40 mm) diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between support shield and piping and under the finish jacket.
4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

END OF SECTION

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Section 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Requirements specified within this section apply to all sections in Division 16, ELECTRICAL. Work specified herein shall be performed as if specified in the individual sections.

1.2 DESIGN REQUIREMENTS

A. All equipment anchoring and mounting shall be in accordance with manufacturer's requirements.

1.3 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA 70).
2. The National Electrical Safety Code (ANSI C-2).
3. The Life Safety Code (NFPA 101).
4. The Uniform Building Code.
5. The BOCA Basic Building Code.
6. Occupation Safety and Health Administration (OSHA).
7. Municipal ordinance governing electric work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM).
2. Underwriters' Laboratories, Inc. (UL).
3. National Electrical Manufacturer Association (NEMA).
4. Insulated Cable Engineers Association (ICEA).
5. Institute of Electrical and Electronic Engineers (IEEE).
6. National Fire Protection Association (NFPA).
7. American National Standards Institute (ANSI.
8. Edison Electric Institute (EEI).

1.4 MATERIAL AND EQUIPMENT SPECIFIED UNDER DIVISION 16 WITH RACEWAY AND ELECTRICAL CONDUCTORS FURNISHED, AND INSTALLED, AND CONNECTED UNDER DIVISION 16, ELECTRICAL

A. Equipment indicated on the Drawings by a circled solid triangle, including but not limited to:

1. Package Process Equipment.
2. Motor thermal protectors and any required special protector monitoring relay.
3. Speed Control systems.
4. Instrumentation and Control Systems specified in Section 16950.

1.5 MECHANICAL SYSTEM INTERFACE

A. All booster pump system instruments shall be furnished and installed under Division 11.

B. Motor controllers (VFDs) shall be furnished and installed under Division 11 as part of the booster pump skid.

C. Power wiring to all motors and motor controllers and between motors and controllers shall be provided under Division 11.

D. Pump skid control panel shall be furnished and installed under Division 11. All power and control wiring to and from the pump skid control panel shall be provided under Division 16.

1.6 INSPECTION OF THE SITE AND EXISTING CONDITIONS:

A Before submitting a bid, visit the site and determine conditions at the site in order to become familiar with all existing conditions which will, in any way or manner, affect the work required under this Contract. No subsequent increase in Contract cost will be allowed for additional work required because of the Contractor's failure to fulfill this requirement.

B. After award of Contract, confer with Engineer to verify, at each area of construction activity the location of existing underground utilities. Protect all existing underground utilities during construction. Pay for all required repairs without increase in Contract cost should damage to underground utilities occur during construction.

1.7 RESPONSIBILITY

A. The Contractor shall be responsible for:

1. Complete systems in accordance with the intent of these Contract Documents.
2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, ELECTRICAL.
3. Furnishing and installing all incidental items not actually shown or specified, but which are required by good practice to provide complete and functional systems.

1.8 SUBSTITUTION OF MATERIAL AND EQUIPMENT:

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing a minimum standard of quality and general configuration except as modified within this Specification and/or the Drawings. Products of other manufacturers will be considered in accordance with the GENERAL CONDITIONS.

B. Make requests for approval of alternatives in writing to the Engineer in accordance with the GENERAL CONDITIONS. Provide sufficient material or data to allow evaluation of the proposed alternative and determination of compliance with these Contract Documents. List any proposed deviations from these Contract Documents.

1.9 SUBMITTALS

A. Quality Control Submittals:

1. Voltage Balance Report.
2. Equipment Line Current Report.
3. Factory test certification and reports for all major electrical equipment.
4. Site test certification and reports as specified in other Division 16, ELECTRICAL, sections.

PART 2. PRODUCTS

2.1 GENERAL

A. Provide materials and equipment listed by UL wherever standards have been established by that agency.

B. Equipment Finish:

1. Provide manufacturers' standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with ANSI No.61, light gray color.

C. Enclosures: In general and unless otherwise noted, enclosures shall be:

1. NEMA 4 for wet indoor areas.
2. NEMA 4X, fiberglass reinforce plastic (FRP), if available (otherwise 316 stainless steel), for outdoor, normally damp or wet nonhazardous areas, or where designated "WP."
3. Booster pump control panel as specified in Division 11.
4. For enclosures requiring constant access (i.e., safety switches, junction or pull boxes, control panels) provide quick-release door latch or knurled thumbscrews with padlock hasps.
5. Equip enclosures with breathers/drains.
6. All gasketing shall be permanently adhered, close-cell neoprene.

7. Underground structures shall be treated as normally damp or wet areas, unless specifically identified otherwise.

D. Hazardous Areas: Materials, equipment and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

PART 3. EXECUTION

3.1 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

3.2 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical loads between phases as nearly as possible on panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loads and unloaded conditions.
3. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal voltage.
   b. Obtain a written certification from a responsible power company official that the voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If any phase current for any piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

END OF SECTION

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Section 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and Supplementary Conditions, apply to this Section.

1.2 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NPFA 70 – National electrical Code.

B. State of Illinois local electrical codes

C. ANSI C84.1 – Voltages Tolerances for North America.

D. CSA C22.2 No. 14-M91 – Industrial Control Equipment.

E. IEC 721 – Classification of Environmental Conditions.

F. NEMA 250 – Enclosures for Electrical Equipment.

G. UL 508 – UL Standard for Safety Industrial Control Equipment.

H. UL 50 – UL Standard for Safety Enclosures for Electrical Equipment.

I. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.3 SUBMITTALS

A. Shop Drawings:

1. Outlet and Junction boxes.
2. Wiring devices.
3. Terminal junction boxes.
4. Circuit Breaker data.

1.4 QUALITY ASSURANCE

A. UL Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

PART 2. PRODUCTS

2.1 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron
2. Cover: Gasketed, weatherproof, malleable iron with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or EAJ.
   b. Appleton; Type GR.

2.2 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article OUTLET AND DEVICE BOXES.

B. Conduit Bodies Used as Junction Boxes: As specified under Article FITTINGS in Section 16110, RACEWAYS.

C. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast malleable iron with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps or screws.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O.Z./Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O.Z./Gedney; Series YW.

D. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel with white enamel painted interior mounting panel.
3. Cover: Hinged with clamps or screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.

5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

2.3 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless located in hazardous area.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks (0 to 600V):

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 50 percent.

2.4 TERMINAL BLOCK (0 TO 600 VOLTS)

A. UL 486F/GEN and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.5 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA AB 1, UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: Match existing MCC interrupt rating.

C. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75°C wire at full NFPA 70, 75°C ampacity.

E. Locking: Provisions for padlocking handle.

F. Multi-pole breakers to automatically open all poles when an overload occurs on one pole.

G. Enclosure: NEMA 250, Type as indicated in Part 3 of this Specification, unless otherwise shown.

H. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

I. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

J. Where installing new circuit breakers in existing Electrical Distribution Equipment new circuit breaker(s) shall be compatible with existing equipment.

2.6 MAGNETIC CONTROL RELAY

A. NEMA ICS 2, Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic type, timer adjustable from 0.2 to 60 seconds (minimum).
2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

D. Manufacturers and Products:

1. Cutler-Hammer; Type M-600.
2. General Electric Co.; Type CR120B.

2.7 VARIABLE FREQUENCY DRIVES

A. As specified in Section 11000, OZONE COOLING WATER BOOSTER PUMP SKID SYSTEM.

2.8 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge, ASTM A570, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge.

E. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

F. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

G. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.9 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: Black, engraved to a white core.

D. Engraving:

1. Pushbuttons/Selector Switches: Name of drive controlled on one, two, or three lines, as required.
2. Panelboards: Panelboard designation, service voltage, and phases.

E. Letter Height:

1. Pushbuttons/Selector Switches: 1/4 inch.
2. Panelboards: 3/8 inch.

PART 3. EXECUTION

3.1 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

B. Use appropriate conduit and conductor entry fittings with enclosures to maintain the specified enclosure environmental capability after installation.

3.2 OUTLET AND DIVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Symbiont/Owner.
3. As required by the National Electrical Code and Illinois local code.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by Symbiont/Owner.

E. Install plumb and level.

F. Support boxes independently of conduit by attachment to building structure or structural member.

G. Install bar hangers in frame construction or fasten boxes directly as follows:

1. Wood: Wood screws.

2. Concrete or Brick: Bolts and expansion shields.
3. Hollow Masonry Units: Toggle bolts.
4. Steelwork: Machine screws.

H. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

I. Provide plaster rings where necessary.

J. Boxes embedded in concrete or masonry need not be additionally supported.

K. Install galvanized mounting hardware in industrial areas.

L. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.

M. Box Type:

1. Exterior Locations:
   a. Exposed Raceways: Cast metal.
   b. Concealed Raceways: Cast metal.
   c. Concrete Encased Raceways: Cast metal.
   d. Class I, II, or III Hazardous Areas: Cast metal.
2. Interior Wet/Damp Locations:
   a. Exposed Raceways: Cast metal.
   b. Concealed Raceways: Cast metal.
   c. Lighting Circuits, Ceiling: Sheet steel.
   e. Class I, II, or III Hazardous Areas: Cast metal.

3.2 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible and shall be installed plumb and level.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Install bar hangers in frame construction or fasten boxes directly as follows:

1. Concrete or Brick: Bolts and expansion shields.
2. Hollow Masonry Units: Toggle bolts.
3. Steelwork: Machine screws.

I. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

J. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Owner's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

K. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

L. Location/Type:

1. Unfinished, Indoor and Outdoor, Wet: NEMA 250, Type 4.
   a. Steel Raceway System: Cast metal.
2. Unfinished, Indoor and Outdoor, Hazardous: NEMA 250, Type 7.
   a. Steel Raceway System: Cast metal.
3. Underground Conduit: Concrete.
4. Corrosive Locations: NEMA 250, Type 4X, stainless steel.

M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

N. Provide empty outlet boxes and cover plates meeting requirements of EIA/TIA 569.

3.7 TERMINAL JUNCTION BOX

A. Install in accordance with Article JUNCTION AND PULL BOXES.

B. Label each block and terminal with permanently attached, nondestructible tag.

C. Do not install on finished outdoor surfaces.

D. Boxes installed in Hazardous rated environments shall be specifically approved for the Class, Division, and Group shown.

3.3 CIRCUIT BREAKER

A. Install Circuit Breakers where indicated on the drawings.

B. Coordinate motor controller and circuit breaker installation work with electrical raceway and cable work, as necessary for proper interface.

C. Location/Type:

1. Damp: NEMA 250, Type 4.
2. Damp/Corrosive: NEMA 250, Type 4X.
3. Industrial Use: NEMA 250, Type 12.

3.4 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:
   a. PVC-Coated Conduit: PVC coated.
   b. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
2. Interior, Corrosive (Wet or Dry) Locations:
   a. PVC Conduit: Type 316 stainless steel or nonmetallic.
   b. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
3. Outdoor, Noncorrosive Locations:
   a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.
4. Outdoor Corrosive Locations:
   a. PVC Conduit: Type 316 stainless steel or nonmetallic.
   b. PVC-Coated Steel Conduit, and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC coated steel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
3. Nonmetallic Channel: Epoxy resin sealer.
4. PVC-Coated Channel: PVC patch.

END OF SECTION

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Section 16100
ELECTRICAL TESTING

PART 1. GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI):
   a. C2, National Electrical Safety Code.
   b. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   c. 95, Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.
   d. 118, Standard Test Code for Resistance Measurement.
3. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guideline for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. WC 7, Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
   c. WC 8, Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety Requirements for Employee Workplaces.

1.2 SUBMITTALS

A. Administrative Submittals: Submit 30 days prior to performing inspections or tests:

1. Schedule for performing inspection and tests.
2. List of references to be used for each test.
3. Sample copy of equipment and materials inspection form(s).
4. Sample copy of individual device test form.
5. Sample copy of individual system test form.

B. Quality Control Submittals: Submit within 30 days after completion of test:

1. Test or inspection reports and certificates for each electrical item tested.

1.3 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Corporately and financially independent organization functioning as an unbiased testing authority.
2. Professionally independent of manufacturers, suppliers, and installers, of electrical equipment and systems being tested.
3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
4. Supervising engineer accredited as Certified Electrical Test Technologist by National Institute for Certification of Engineering Technologists (NICET), or International Electrical Testing Association and having a minimum of 5 years testing experience on similar projects.
5. Technicians certified by NICET or NETA.
6. Assistants and apprentices assigned to project at ratio not to exceed two certified to one noncertified assistant or apprentice.
7. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
8. In compliance with OSHA Title 29, Part 1907 criteria for accreditation of testing laboratories.

B. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.

C. Test instrument calibration shall be in accordance with NETA ATS.

1.4 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Owner at least 24 hours prior to performing tests on energized electrical equipment.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

3.1 GENERAL

A. Tests specified in this section are to be performed in accordance with the requirements of Section 01810, EQUIPMENT TESTING & FACILITY STARTUP.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, and ANSI C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Adjust mechanisms and moving parts for free mechanical movement.

E. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

F. Verify nameplate data for conformance to Contract Documents.

G. Realign equipment not properly aligned and correct unlevelness.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Inform Owner of working clearances not in accordance with NFPA 70.

M. Investigate and repair or replace:

1. Electrical items that fail tests.

2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by ENGINEER, door and panel sections having dented surfaces.
5. Repair or replace, as determined by ENGINEER, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required due to extensive damage, as determined by ENGINEER, refinish the entire assembly.

O. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

P. Replace transformer insulating oil not in compliance with ASTM D923.

3.2 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect Each Individual Exposed Power Cable No. 6 and Larger For:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.
   d. Color coding conformance with specifications.
   e. Proper circuit identification.
2. Mechanical Connections For:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 10.1, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables For:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables For:
   a. Proper termination.
   b. Proper circuit identification.

5. Cables Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 6 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.3 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers 100 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 10.1.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75°C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480- and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 10.2.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.

b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4.

3.4 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually Check Current, Potential, and Control Transformers For:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically That:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.
2. Potential Transformer Tests:
   a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 7.1.1 for 1 minute on:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.5 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in panelboard, switchboard, and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-Of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b. Main ground electrode system resistance to ground to be no greater than 5 ohms.
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.

3.6 GROUND FAULT SYSTEMS

A. Inspection and Testing Limited To:

1. Zero sequence grounding systems.
2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral Main Bonding Connection to Assure:
   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.
   b. Ground strap sensing system is grounded through sensing device.
   c. Neutral ground conductor is solidly grounded.
2. Verify that control power has adequate capacity for system.
3. Manually Operate Monitor Panels For:
   a. Trip test.
   b. No trip test.
   c. Nonautomatic rest.

4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.
5. Relay check for pickup and time under simulated ground fault conditions.
6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.
2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.
3. Test relay timing by injecting 300 percent of pickup current, or as specified by manufacturer. Relay operating time in accordance with manufacturer's time-current characteristic curves.
4. Test system operation at 55 percent rated control voltage, if applicable.
5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.7 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 1/2 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate Motor and Check For:
   a. Excessive mechanical and electrical noise.
   b. Overheating.
   c. Correct rotation.
   d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
   e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
      1) Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.

2) Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.

b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.

2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.

3. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.

4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

END OF SECTION

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Section 16110
RACEWAYS

PART 1. GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Manufacturer's Literature:
   a. Rigid galvanized steel conduit.
   b. Flexible metal, liquid-tight conduit.
   c. Conduit fittings.
2. Conduit Layout:
   a. Plan and section type, showing arrangement and location of conduit and duct bank required for:
      1) Low and medium voltage feeder and branch circuits.
      2) Instrumentation and control systems.
      3) Communications systems.
      4) Empty conduit for future use.
   b. Reproducible mylar; scale not greater than 1-inch equals 20 feet.
3. Equipment and machinery proposed for bending metal conduit.
4. Method for bending PVC conduit less than 30 degrees.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2. PRODUCTS

2.1 CONDUIT AND TUBING

A. Rigid Aluminum Conduit:

1. Meet requirements of ANSI C80.5, Federal Specification WW-C-540c, and UL 6.
2. Material: Cooper-free aluminum alloy conduit, including couplings, bushings, elbows, nipples, and other fittings.

B. PVC Schedule 40 or 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90°C insulated conductors.

C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105°C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

2.2 FITTINGS

A. Rigid Aluminum Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, copper-free. Set screw fittings not permitted.
2. Insulated Bushing:
   a. Material: Cast aluminum, with integral insulated throat, rated for 150°C.
   b. Manufacturer and Product: O.Z. Gedney; Type AB.
3. Grounding Bushing:
   a. Material: Cast aluminum with integral insulated throat, rated for 150 degrees, with solderless lugs.
   b. Manufacturer and Product: O.Z. Gedney; Type ABLG.
4. Conduit Hub:
   a. Material: Cast aluminum, with insulated throat.
   b. UL listed for use in wet locations.
   c. Manufacturers and Products:
      1) O.Z. Gedney; Type CHA.
      2) Thomas & Betts; Series 370AL.
      3) Meyers; Series SA.
5. Conduit Bodies:
   a. Manufacturers and Products (For Normal Conditions):
      1) Appleton; Form 85 threaded unilets.
      2) Crouse-Hinds; Mark 9 or Form 7-SA threaded condulets.
      3) Killark; Series O electrolets.
   b. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Conduit Sealing Fitting Manufacturers and Products:
   a. Appleton; Type EYF-AL or EYM-AL.
   b. Crouse-Hinds; Type EYS-SA or EZS-SA.
   c. Killark; Type EY or EYS.
8. Drain Seal Manufacturers and Products:
   a. Appleton; Type EYDM-A.
   b. Crouse-Hinds; Type EYD-SA or EZD-SA.
9. Drain/Breather Fitting Manufacturers and Products:
   a. Appleton; Type ECDB.
   b. Crouse-Hinds; ECD.
10. Expansion Fitting Manufacturers and Products:
   a. Deflection/Expansion Movement: Steel City; Type DF-A.
   b. Expansion Movement Only: Steel City; Type AF-A.

11. Cable Sealing Fittings: To form watertight nonslip cord or cable connection to conduit.
    a. Bushing: Neoprene at connector entry.
    b. Manufacturer: Appleton; CG-S.

B. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC-3.
2. Type: PVC, slip-on.

C. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105° C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
    a. Thomas & Betts; Series 5331.
    b. O.Z. Gedney; Series 4Q.

D. Watertight Entrance Seal Device:

1. New Construction:
    a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
    b. Manufacturer and Product: O.Z. Gedney; Type FSK or WSK, as required.
2. Cored-Hole Application:
    a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
    b. Manufacturer and Product: O.Z. Gedney; Series CSM.

2.3 ACCESSORIES

A. Identification Devices:

1. Raceway Tags:
    a. Material: Permanent, nonferrous metal.
    b. Shape: Round.
    c. Raceway Designation: Pressure stamped, embossed, or engraved.
    d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
    a. Material: Polyethylene, 4-mil gauge with detectable strip.
    b. Color: Red.
    c. Width: Minimum 6 inch.
    d. Designation: Warning on tape that electric circuit is located below tape.
    e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.

f. Manufacturers and Products:
   1) Panduit; Type HTDU.
   2) Reef Industries; Terra Tape.

B. Raceway Coating: Clean and paint in accordance with Section 09900, PAINTING AND PROTECTIVE COATINGS.

C. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. 50 mm width (minimum).
3. Manufacturer and Product: Raychem; Type TWDB.

PART 3. EXECUTION

3.1 GENERAL

A. Conduit and Tubing sizes shown are based on the use of copper conductors.

B. All installed Work shall comply with NECA 5055.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads and cut ends, before assembly of fittings, aluminum conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundation footings, or beams.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Do not combine analog signal cables in a conduit with any power or discrete wiring. Analog signal cables shall be installed in Rigid Galvanized conduit.

U. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 596-A.

3.2 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed: Rigid Aluminum.

C. Interior, Exposed: Rigid Aluminum.

D. Under Slabs-On-Grade or Underground: Schedule 40 PVC.

3.3 CONNECTIONS

A. For motors, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible metal liquid-tight.
4. Hazardous Areas: Flexible coupling suitable for Class 1, Division 1 and 2 areas.
5. Length: 18-inch minimum, 36-inch maximum unless noted otherwise, sufficient to allow movement or adjustment of equipment.

B. Outdoor Areas, Process Areas Exposed to Moisture: Liquid-tight metallic flexible conduit.

C. Indoor Areas, Oil-tight and Dust Tight: Flexible metal.

D. Motor Connections Exposed to Moisture: Gird-tight metallic flexible conduit.

3.4 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating.

D. Apply single layer of wraparound duct band to all metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal device on each side.
   c. With Concrete Encasement: Install watertight entrance seal device on the accessible side.
   d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Corrosive-Sensitive Areas:
   a. Seal all conduit passing through chemical area walls.
   b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
   c. Seal penetration with approved sealant, as specified in Section JOINT SEALANTS.
4. Existing or Precast Wall (Underground): Core drill wall and install a watertight entrance seal device.
5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.

3.5 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 56 percent extra space for future conduit.

C. Application/Type of Conduit Strap:

1. Rigid Aluminum Conduit: Aluminum or 316 Stainless Steel.
2. Nonmetallic Conduit: Nonmetallic or PVC coated metal.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
   a. Dry, Noncorrosive Areas: Galvanized.
   b. Wet, Noncorrosive Areas: Stainless steel.
   c. Corrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.6 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches, minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30-Degree and Larger: Provide factory-made elbows.
2. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.7 EXPANSION/DEFLECTION FITTINGS

A. Provide on all raceways at all structural expansion joints, and in long tangential runs.

B. Provide expansion/deflection joints for 50°F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.8 PVC CONDUIT

A. Solvent Welding:

1. Provide manufacturer recommended solvent; apply to all joints.
2. Install such that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit: PVC female adapter.

C. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

3.9 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. Rigid Galvanized**:**
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.

d. Install insulated bushing on ends of conduit where grounding is not required.
e. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
f. Utilize sealing locknuts or threaded hubs on outside of NEMA 3R and NEMA 12 enclosures.
g. Terminate conduits at threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.

2. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
3. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
4. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut.

D. Motor Control Center, Switchboard, Switchgear, and Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

3.10 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify Raceway Schedule designation.
2. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed Raceway, whether in ceiling space or surface mounted.
3. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

C. Buried Raceway Markers:

1. Install at grade to indicate direction of underground raceways.
2. Install at all bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.11 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over all conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION

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Section 16120
CONDUCTORS

PART 1. GENERAL

1.1 SUBMITTALS

A. Shop Drawings:

1. Wire and cable descriptive product information.
2. Wire and cable accessories descriptive product information.
3. Cable fault detection system descriptive product information.

B. Quality Control Submittals:

1. Certified Factory Test Report for conductors 600 volts and below.
2. Certified Factory Test Report per AEIC CS6, including AEIC qualification report for conductors above 600 volts.

1.2 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

1.3 PROJECT CONDITIONS

A. Conductor sizes are based on copper. Use 75°C ratings for all conductors. All conductors shall be sized as shown on the plans or as required by the actual load to be served, whichever is larger. Article 310 of the NEC shall be the guide in determining conductor sizes. Long circuits shall be sized to prevent voltage drop in excess of 3 percent.

B. Circuit and raceway routing shown on the Drawings is approximate unless dimensioned. Route circuit and raceways as required to meet Project Conditions. Reroute conduits to avoid existing obstructions from other disciplines. Include circuit and raceway lengths within 10 feet of length shown.

C. Where circuit and raceway routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2. PRODUCTS

2.1 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 3, WC 5, and WC 7.

B. Conductor Type:

1. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
2. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation. Where conductors are routed underground or wet and damp locations or classified locations (Class I, Division 1 or Class I, Division 2) provide XHHW only.

D. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.3 600-VOLT RATED CABLE

A. No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. No. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with NEMA WC 5, Method 1, Sequence K-2.
2. Cable: Passes the ICEA T-29-520 210,000 Btu/hr Vertical Tray Flame Test.

3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Rome Cable.

C. Type 2, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors black and red.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.

2.4 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90°C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) Scotch: Brand 77, with Scotch Brand 69 glass cloth tapebinder.

2) Plymount: Plyarc 30, with Plymount Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.
   a. Manufacturer and Product: Raychem; Type D-SCE or ZH-SCE.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer: 3M Co.; Type SCS-HB.
3. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturer: 3M Co.

2.5 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, wax-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Suitable for zinc-coated steel, PVC, bituminized fiber, and fiberglass raceways.

D. Manufacturers and Products:

1. Ideal Co.; Yellow 77.
2. Polywater, Inc.

2.6 SOURCE QUALITY CONTROL

A. Conductors 600-Volts and below: Test in accordance with UL 44 and 854 Standards.

PART 3. EXECUTION

3.1 GENERAL

A. Conductor storage, handling, and installation to be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate all conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

3.2 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
   a. 208Y/120 Volt, Three-Phase, Four-Wire Systems: Grounded Neutral – White, Phase A – Black, Phase B – Red, Phase C – Blue
   b. 480Y/277 Volt, Three-Phase, Four-Wire Systems: Grounded Neutral – White, Phase A – Brown, Phase B – Orange, Phase C – Yellow
   c. All Systems: Equipment Grounding – Green

4. Tracer: Outer covering of white with an identifiable colored strip, other than green, in accordance with NFPA 70.

3.3 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination and in accessible locations such as panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Assign circuit name based on device or equipment at load end of circuit.

C. Conductors No. 3 AWG and Smaller: Identify with sleeves or heat bond markers.

D. Cables and Conductors No. 2 AWG and Larger:

1. Identifying with marker plates; or
2. Tie-on cable marker tags.
3. Attach with nylon tie cord.

E. Taped-on markers or tags relying on adhesive not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors No. 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors No. 4 AWG through No. 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors No. 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors No. 10 AWG and larger.
7. Tape insulate all uninsulated connections.
8. Place no more than one conductor in any single-barrel pressure connection.
9. Install crimp connectors with tools approved by connector manufacturer.
10. Install terminals and connectors acceptable for type of material used.
11. Compression Lugs:
    a. Attach with a tool specifically designed for purpose.
    b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    c. Do not use plier type crimpers.

B. Do not use soldered mechanical joints.

C. Splices and Terminations:

1. Indoors: Use general purpose, flame retardant tape.
2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

D. Cap spare conductors and conductors with UL listed end caps.

E. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

F. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.
4. Where connections of cables installed under this section are to be made under Section 13400, PROCESS INSTRUMENTATION AND CONTROL SYSTEMS (PICS), leave pigtails of adequate length for bundled connections.
5. Cable Protection:
   a. Under Infinite Access Floors: May be installed without bundling.
   b. All Other Areas: Install individual wires, pairs, or triads in flex conduit under the floor or grouped into bundles at least 1/2 inch in diameter.
   c. Maintain integrity of shielding of instrumentation cables.
   d. Ensure grounds do not occur because of damage to jacket over the shield.

G. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.5 WIRING IN HAZARDOUS AREAS

A. Wiring in hazardous areas as indicated by class, division and group on the drawings shall comply with the Electrical code requirements.

B. All wiring shall be in threaded rigid galvanized steel conduit as required elsewhere in the specifications or as shown on the drawings with termination fittings approved for the class location.

C. All boxes, fittings and joints shall be threaded for connection to conduit and shall be explosion proof and approved for the class location.

D. Threaded joints shall be at least 5 threads fully engaged. Running threads will not be accepted.

E. All connections to equipment which is subject to movement or vibration shall be with flexible fittings of the explosion proof type, where required.

F. Seals shall be provided in the conduit system to prevent the passage of vapors or flames from one portion of the installation to another through conduit in accordance with the code requirements.

1. All conduits entering or exiting the Pump Control Panel shall have an explosion proof conduit seal suitable for the class, division, and group shown.

3.6 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Section 01400.

B. Inspect wire and cable for physical damage and proper connection.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

END OF SECTION

Section 16450
GROUNDING

PART 1. GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.2 SUBMITTALS

A. Shop Drawings:

1. Product Data:
   a. Exothermic weld connectors.
   b. Mechanical connectors.
   c. Compression connectors.

1.3 UL COMPLIANCE

A. Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

PART 2. PRODUCTS

2.1 GROUND CONDUCTORS

A. As specified in Section 16120, CONDUCTORS.

2.2 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.

4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.
   c. Ilso Corp.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

PART 3. EXECUTION

3.1 GENERAL

A. Grounding shall be in compliance with NFPA 70 and ANSI C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Instrumentation Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

F. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.2

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.4 CONTROL PANEL GROUNDING

A. Panel enclosure shall be properly grounded in accordance with the National Electrical Code and local grounding requirements.

B. Each analog signal loop shall only be grounded at a single point for the loop. This single point shall be at the location of the DC power supply for the loop.

C. Each analog signal loop shall only have its shield wire connected to ground at a single point for the loop. Shields shall be grounded at control panels where signals are input to the receiving device and not at the source of the transmitting device.

3.5 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.

2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Owner prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.6 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.7 FIELD QUALITY CONTROL

A. As specified in Section 16100, ELECTRICAL TESTING.

END OF SECTION