1

Letting July 12, 2019

Notice to Bidders, Specifications and Proposal

Illinois Department of Transportation

Contract No. 62B78
COOK County
Section 3434-232I-R
Route FAI 290
Project NHPP-TRTJ(747)
District 1 Construction Funds

Prepared by

Checked by

F

(Printed by authority of the State of Illinois)

Illinois Department of Transportation

NOTICE TO BIDDERS

1. **TIME AND PLACE OF OPENING BIDS.** Electronic bids are to be submitted to the electronic bidding system (iCX-Integrated Contractors Exchange). All bids must be submitted to the iCX system prior to 10:00 a.m. July 12, 2019 at which time the bids will be publicly opened from the iCX SecureVault.

2. **DESCRIPTION OF WORK**. The proposed improvement is identified and advertised for bids in the Invitation for Bids as:

   Contract No. 62B78
   COOK County
   Section 3434-232I-R
   Project NHPP-TRTJ(747)
   Route FAI 290
   District 1 Construction Funds

   Pump station 4 reconstruction. I-290 just west of the Des Plaines River in Forest Park.

3. **INSTRUCTIONS TO BIDDERS**. (a) This Notice, the invitation for bids, proposal and letter of award shall, together with all other documents in accordance with Article 101.09 of the Standard Specifications for Road and Bridge Construction, become part of the contract. Bidders are cautioned to read and examine carefully all documents, to make all required inspections, and to inquire or seek explanation of the same prior to submission of a bid.

   (b) State law, and, if the work is to be paid wholly or in part with Federal-aid funds, Federal law requires the bidder to make various certifications as a part of the proposal and contract. By execution and submission of the proposal, the bidder makes the certification contained therein. A false or fraudulent certification shall, in addition to all other remedies provided by law, be a breach of contract and may result in termination of the contract.

4. **AWARD CRITERIA AND REJECTION OF BIDS**. This contract will be awarded to the lowest responsive and responsible bidder considering conformity with the terms and conditions established by the Department in the rules, Invitation for Bids and contract documents. The issuance of plans and proposal forms for bidding based upon a prequalification rating shall not be the sole determinant of responsibility. The Department reserves the right to determine responsibility at the time of award, to reject any or all proposals, to readvertise the proposed improvement, and to waive technicalities.

By Order of the
Illinois Department of Transportation

Omer Osman,
Acting Secretary

FAI Route 290 (I-290)
Project NHPP-TRTJ(747)
Section 3434-232I-R
Cook County
Contract No. 62B78

SPECIAL PROVISIONS

F.A.I. ROUTE 290 (INTERSTATE 290)

IDOT PUMP STATION NO. 4 RECONSTRUCTION

CONTRACT: 62B78

VOLUME I

(1 OF 2)

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FAI Route 290 (I-290)
Project NHPP-TRTJ(747)
Section 3434-232I-R
Cook County
Contract No. 62B78

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FOR
SUPPLEMENTAL SPECIFICATIONS
AND RECURRING SPECIAL PROVISIONS

Adopted January 1, 2019

This index contains a listing of SUPPLEMENTAL SPECIFICATIONS and frequently used RECURRING SPECIAL PROVISIONS.

ERRATA Standard Specifications for Road and Bridge Construction (Adopted 4-1-16) (Revised 1-1-19)

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Project NHPP-TRTJ(747)
Section 3434-232I-R
Cook County
Contract No. 62B78

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STATE OF ILLINOIS

I-290 PUMP STATION NO. 4 RECONSTRUCTION

SPECIAL PROVISIONS

The following Special Provisions supplement the "Standard Specifications for Road and Bridge Construction," adopted April 1, 2016, the latest edition of the “Manual on Uniform Traffic Control Devices” and the “Manual of Test Procedures for Material” in effect on the date of invitation for bids, and the "Supplemental Specifications and Recurring Special Provisions" adopted January 1, 2019 and indicated on the "Check Sheet" included herein which apply to and govern the reconstruction of FAI Route 290 (I-290), Project NHPP-TRTJ(747), Section 3434-232I-R, Cook County, Contract No. 62B78, and in case of conflict with any part or parts of said specifications, the said Special Provisions shall take precedence and shall govern.

LOCATION OF IMPROVEMENT

The project is located at the existing IDOT Pump Station No. 4 located on the south side of Interstate 290 and immediately west of the Des Plaines River in the Village of Forest Park, Illinois, Cook County.

DESCRIPTION OF IMPROVEMENT

a. Improvements shall consist of water main relocation, site civil work, removal of the existing IDOT Pump Station No. 4 superstructure, and the construction of a new pump station wet well and building south of the existing Pump Station No. 4. Work includes, but is not limited to, materials, transportation, labor, supervision, installation, testing, commissioning, demolition, hauling, material removal and disposal associated with the following:

    1) Installation of ductile iron pipe water main. Removal and abandonment of existing water main.
    2) Design, construction, monitoring, dewatering, excavation, backfilling, and partial demolition/removal of a Temporary Excavation Retention System (TERS).
    3) Design, construction, and installation of the influent piping tie-in connections to the Existing Pump Station wet well.
    4) Construction of a new wet pit stormwater pumping station including architectural, structural, mechanical, electrical, instrumentation and process control components as identified in the Contract Documents. New Pump Station 4 includes sluice gates, mechanical screens, submersible pumps, bridge crane, heating ventilation and air conditioning (HVAC) equipment, and power distribution equipment.
    5) Demolition and repurposing of the Existing Pumping Station into a grit collection chamber with new buried structural cap, electrical, lighting, and personnel access.
    6) Site grading, erosion control, outfall box culverts, retaining walls, site drainage collection system, paving, fencing, and concrete barrier wall with impact attenuator

and other miscellaneous site work components as identified in the Contract Documents.

7) Supply of new material, equipment, transportation, labor, installation, testing and commissioning, demolition and material removal as indicated in the Contract Documents.
8) Removal and disposal or salvage of equipment and electrical devices in the existing Pump Station 4 as indicated in the Contract Documents.
9) Abandonment of the existing 54-inch outfall sewer by filling with controlled low strength material (CLSM).

b. The new pump station will consist of, but is not limited to, dual electric services with metering and connection to the station, fiber optic connection to the station, motor control centers, electrical distribution equipment, control panels, equipment, level monitoring system, lighting, instrumentation, interfacing, a new Supervisory Control and Data Acquisition (SCADA) System, and verification of SCADA signals at remote end, District 1, IDOT Traffic Systems Center (TSC), and Maintenance Contractor's facility, Aperture Employee Guardian and Intrusion System (AEGIS), gas detection, fire alarm, conduit, and wiring.

c. The Contractor shall operate and maintain the existing pump station until the new pump station is commissioned and online. The existing pump station output capacity shall be maintained at all times. The existing pump station shall be modified and repurposed as shown on the Drawings. Contractor shall coordinate with Department Electrical Maintenance staff and Utilities to determine which equipment is to be salvaged and hauled to the respective owner's storage facility.

PRE-BID SITE INSPECTION OF PUMP STATION

The existing Pump Station No. 4 site will be open for Contractor's inspection 10 calendar days prior to bid opening. A representative of the State will be on hand on this date.

CONTRACTOR COOPERATION

The attention of the Contractor is directed to the fact that other contracts are or may be in force that adjoins the limits of this project. The Contractor shall cooperate with the other contractors in the phasing and performance of his work so as not to delay, interrupt or hinder the progress or completion of work being performed by the other contractors.

No additional compensation will be allowed this Contractor for compliance with the above requirements, nor for any delays or inconvenience resulting from the activities of the other contractors.

PROGRESS SCHEDULE

Time is of the essence in this Contract. It may be necessary for the Contractor to work longer hours, use additional crews, and work during weekends in order to complete the work within the required time limit. The Contractor shall submit a Critical Path Method (CPM) Progress Schedule for the Engineer's approval before the work can be started.

In the event the Contractor falls more than three (3) days behind the approved progress schedule, the Contractor shall work seven (7) days a week at extended hours in order to meet the specified Completion Date.

The Contractor will not be allowed any extra compensation for working longer hours or using extra shifts; and working on weekends or during holidays; working during winter months, etc., to meet the specified Completion Date.

EXISTING UTILITIES

The Contractor shall familiarize themselves with the locations of all utilities and structures that may be found in the vicinity of the construction. The Contractor shall conduct his operations to avoid damage to the above-mentioned utilities and structures. Should any damage occur due to the Contractor’s negligence, repairs shall be made by the Contractor at their expense in a manner acceptable to the Engineer.

The Contractor shall notify all utility owners of the construction schedule and shall coordinate construction operations with utility owners so that relocation of utility lines and structures may proceed in an orderly manner. Notification shall be in writing, with copies transmitted to the Engineer.

GEOTECHNICAL REPORT

Refer to “Geotechnical Investigation Report – Phase II, Proposed IDOT Pump Station #4” as prepared by Geo Services, Inc. dated November 23, 2016. Document available at the IDOT District 1 Office, Schaumburg, IL.

STATUS OF UTILITIES (D-1)

Effective: June 1, 2016

Utility companies and/or municipal owners located within the construction limits of this project have provided the following information in regard to their facilities and the proposed improvements. The tables below contain a description of specific conflicts to be resolved and/or facilities which will require some action on the part of the Department's contractor to proceed with work. Each table entry includes an identification of the action necessary and, if applicable, the estimated duration required for the resolution.

UTILITIES TO BE ADJUSTED

Conflicts noted below have been identified by following the suggested staging plan included in the contract. The company has been notified of all conflicts and will be required to obtain the necessary permits to complete their work; in some instances resolution will be a function of the construction staging. The responsible agency must relocate or complete new installations as noted in the action column; this work has been deemed necessary to be complete for the Department's contractor to then work in the stage under which the item has been listed.

STAGE / LOCATION	TYPE	DESCRIPTION	RESPONSIBLE AGENCY	ACTION
Stage 2 / Pump Station No. 4 Site	Underground Electric	Existing dual underground electric utilities connecting to the north side of the existing pump station	ComEd	ComEd to relocate
Stage 1 / Pump Station No. 4 Site	Broadview Westchester Joint Water Agency (BWJWA)	Existing 24-IN water main along the south side of the existing pump station	BWJWA	Water main to be relocated by Contractor as part of the Contract

No conflicts to be resolved (or if there are conflicts they are to be listed as noted above)

The following contact information is what was used during the preparation of the plans as provided by the Agency/Company responsible for resolution of the conflict.

Agency/Company Responsible to Resolve Conflict	Name of Contact	Address	Phone	E-mail address
ComEd	Pete Kratzer	7601 S. Lawndale Ave. Chicago, IL 60652	708-518-6209	Peter.Kratzer@comed.com
ComEd (Alt Contact)	Angela Harrell	One Lincoln Centre Oakbrook Terrace, IL 60181	224-422-7142	Angela.Harrell@comed.com
Broadview Westchester Joint Water Agency (BWJWA)	Sam Pulia	2222 S. 10th Ave. Broadview, IL 60155	708-865-0300	SPulia@westchester-il.org

UTILITIES TO BE WATCHED AND PROTECTED

The areas of concern noted below have been identified by following the suggested staging plan included for the contract. The information provided is not a comprehensive list of all remaining utilities, but those which during coordination were identified as ones which might require the Department's contractor to take into consideration when making the determination of the means and methods that would be required to construct the proposed improvement. In some instances the contractor will be responsible to notify the owner in advance of the work to take place so necessary staffing on the owners part can be secured.

STAGE / LOCATION	**TYPE**	**DESCRIPTION**	**OWNER**	**ACTION**
Stage 1 & 2 / Pump Station No. 4 Site	Underground Electric	Existing dual underground electric utilities connecting to the north side of the existing pump station	ComEd	Coordinate with utility owner prior to work within the vicinity of the utility
Stage 1 & 2 / Pump Station No. 4 Site	Broadview Westchester Joint Water Agency (BWJWA)	Existing 24 in. water main along the south side of the existing pump station	BWJWA	Coordinate with utility owner prior to work within the vicinity of the utility

The following contact information is what was used during the preparation of the plans as provided by the owner of the facility.

Agency/Company Responsible to Resolve Conflict	Name of Contact	Address	Phone	E-mail address
ComEd	Pete Kratzer	7601 S. Lawndale Ave. Chicago, IL 60652	708-518-6209	Peter.Kratzer@comed.com
ComEd (Alt Contact)	Angela Harrell	One Lincoln Centre Oakbrook Terrace, IL 60181	224-422-7142	Angela.Harrell@comed.com
Broadview Westchester Joint Water Agency (BWJWA)	Sam Pulia	2222 S. 10th Ave. Broadview, IL 60155	708-865-0300	SPulia@westchester-il.org

The above represents the best information available to the Department and is included for the convenience of the bidder. The days required for conflict resolution should be taken into account in the bid as this information has also been factored into the timeline identified for the project when setting the completion date. The applicable portions of the Standard Specifications for Road and Bridge Construction shall apply.

Estimated duration of time provided in the action column for the first conflicts identified will begin on the date of the executed contract regardless of the status of the utility relocations. The responsible agencies will be working toward resolving subsequent conflicts in conjunction with contractor activities in the number of days noted.

The estimated relocation dates must be part of the progress schedule submitted by the contractor. A utility kickoff meeting will be scheduled between the Department, the Department's contractor and the utility companies. The Department's contractor is responsible for contacting J.U.L.I.E. prior to any and all excavation work

COMPLETION DATE PLUS WORKING DAYS (D-1)

Effective: September 30, 1985
Revised: January 1, 2007

Revise Article 108.05 (b) of the Standard Specifications as follows:

"When a completion date plus working days is specified, the Contractor shall complete all contract items and safely open all roadways to traffic by 11:59 PM on **September 1, 2021** except as specified herein.

The Contractor will be allowed to complete all clean-up work and punch list items within **10** working days after the completion date for opening the roadway to traffic. Under extenuating circumstances the Engineer may direct that certain items of work, not affecting the safe opening of the roadway to traffic, may be completed within the working days allowed for clean up work and punch list items. Temporary lane closures for this work may be allowed at the discretion of the Engineer.

Article 108.09 or the Special Provision for “Failure to Complete the Work on Time”, if included in this contract, shall apply to both the completion date and the number of working days.

FAILURE TO COMPLETE THE WORK ON TIME (D-1)

Effective: September 30, 1985
Revised: January 1, 2007

Should the Contractor fail to complete the work on or before the completion date as specified in the Special Provision for "Completion Date Plus Working Days", or within such extended time as may have been allowed by the Department, the Contractor shall be liable to the Department in the amount of $9,525, not as a penalty but as liquidated damages, for each calendar day or a portion thereof of overrun in the contract time or such extended time as may have been allowed.

In fixing the damages as set out herein, the desire is to establish a certain mode of calculation for the work since the Department's actual loss, in the event of delay, cannot be predetermined, would be difficult of ascertainment, and a matter of argument and unprofitable litigation. This said mode is an equitable rule for measurement of the Department's actual loss and fairly takes into account the loss of use of the roadway if the project is delayed in completion. The Department shall not be required to provide any actual loss in order to recover these liquidated damages provided herein, as said damages are very difficult to ascertain. Furthermore, no provision of this clause shall be construed as a penalty, as such is not the intention of the parties.

A calendar day is every day shown on the calendar and starts at 12:00 midnight and ends at the following 12:00 midnight, twenty-four hours later.

DIVISION 01
GENERAL REQUIREMENTS

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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. General:
   1. The Contractor shall maintain operation of the existing Pump Station 4 at full design capacity during construction of the new pump station structure and building.
   2. The Contract Documents describe a functionally complete project. The Contractor shall furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and functional installation. The Contractor's scope of work shall include transportation, testing, and commissioning. No portion of the work required to provide a complete installation shall be omitted although not expressly specified or indicated.

B. Work associated with lump sum unit price pay items includes, but is not necessarily limited to, the following:
   1. General Work:
      a. The Pump Station General Work shall include, but not be limited to, the following and shall be paid under pay item PUMP STATION GENERAL WORK:
         1) All site work not already covered by a pay item or as indicated on the Drawings and as specified herein.
         2) All grout and unit masonry work consisting of glass unit masonry work as indicated on the Drawings and as specified in Division 04, Masonry.
         3) All miscellaneous metal work as indicated on the Drawings and as specified in Division 05, Metals.
         4) All carpentry, fiberglass, and fiber reinforced plastic work as indicated on the Drawings and as specified in Division 06, Rough Carpentry.
         5) All roofing membrane, flashing, waterproofing, firestopping, and joint sealing work as indicated on the Drawings and as specified in Division 07, Thermal and Moisture Protection.
         6) All doors, skylights, louvers, and hardware as indicated on the Drawings and as specified in Division 08, Openings.
         7) All painting and wall/ceiling panels as indicated on the Drawings and as specified in Division 09, Finishes.
         8) All station identification plate, shop desk, bulletin board, staff gauges, emergency access cabinets, fire extinguishers, electric clock, metal shelf and trash can as indicated on the Drawings and as specified in Division 10, Specialties.
         9) All shop emergency and safety equipment shall be as indicated on the Drawings and as specified in Division 11, Equipment.
         10) All modifications to the existing pump station not already covered by a pay item.
   2. Mechanical-Process and Plumbing:
      a. The Pump Station Mechanical-Process and Plumbing Work shall include, but not be limited to, the following and shall be paid under pay item PUMP STATION MECHANICAL WORK:

1) All piping and plumbing work not already covered by a pay item or as indicated on the Drawings and specified herein.
2) All process sleeves, wall pipes, penetration seals, fasteners, supports, brackets, associated appurtenances and work as indicated on the Drawings and as specified in Division 40.
3) Pressure grouting of the annular space between the influent piping and surrounding tunnel surface per Division 31.
4) All sluice gates, electric actuators, appurtenances, and work as indicated on the Drawings and specified in Division 40.

3. Mechanical-Heating and Ventilation:
   a. The Pump Station Mechanical-Heating and Ventilation Work shall include, but not be limited to, the following and shall be paid under pay item HEATING AND VENTILATION:
      1) All ventilation and heating work not already covered by a pay item or as indicated on the Drawings and specified herein.
      2) All fans, ventilators, unit heaters, dampers, ducts, duct supports, instrumentation, penetration seals, diffusers, associated appurtenances and work as indicated on the Drawings and as specified in Division 23, Heating, Ventilating, and Air-Conditioning (HVAC).
4. Electrical:
   a. The Pump Station Electrical Work shall include, but not be limited to, the following and shall be paid under pay item PUMP STATION ELECTRICAL WORK:
      1) All electrical work not already covered by a pay item or as indicated on the Drawings and specified herein.
      2) All conduit, conductors, cable/conduit supports, lighting, penetration sleeves and sleeves, panel boards, disconnects, breakers, low voltage transformers, surge protectors, associated appurtenances and work as indicated on the Drawings and as specified in Division 26.
      3) All new electrical work to be performed in the existing pump station to convert it to a grit chamber as shown on the Drawings and as specified herein.
   b. The Pump Station Electrical Service Connection shall include, but not be limited to, the following and shall be paid under pay item ELECTRICAL SERVICE CONNECTION:
      1) All electrical utility fees for disconnecting the existing electrical service and providing a new service to the new pump station.
      2) An allowance of $500,000 shall be included for this work. The Contractor shall be paid only for the actual fees paid by him to the utility plus an administrative cost in accordance with the Standard Specifications.
5. Maintenance of the existing pump station during construction shall be paid for at the contract unit price per calendar month under the MAINTENANCE OF EXISTING PUMP STATION DURING CONSTRUCTION pay item and shall be as specified herein:
   a. The Contractor shall be fully responsible for maintenance of the existing Pump Station No. 4 from the first day the Contractor begins work at the site until the day of final acceptance of the entire project by the Engineer. Maintenance shall be in full compliance with the most recent District 1 Electrical Maintenance

Contract from the date of the Bid.

b. The Contractor shall maintain and operate both the new Pump Station No. 4 and the existing Pump Station No. 4 until date of Final Acceptance of the Entire Project. Apart from the influent piping tie-in work, work on the existing pump station shall not begin until the new pump station has been started up, commissioned, and the Contractor receives approval to begin work on the existing pump station from the Engineer.
c. The Contractor shall transfer the maintenance of the new Pump Station No. 4 and modified existing Pump Station 4 structure back to the Department on the day of Final Acceptance of the entire Project by the Engineer.
d. The Contractor shall be responsible for maintaining the existing Pump Station including, but not limited to, removal of captured screenings, debris, and sediment from the wet well until maintenance responsibility has been transferred back to the Department. Contractor shall clean the wet well at intervals not to exceed three (3) months or as required during construction to prevent damage to existing pumping equipment. The wet well shall be cleaned and free of debris on the day of Final Acceptance of the entire Project by the Engineer.
e. The Contractor shall be responsible for operating and maintaining the new Pump Station after startup and commissioning is approved by the Engineer including, but not limited to, removal of captured screenings, debris, and sediment from the wet well until maintenance responsibility has been transferred back to the Department. Contractor shall clean the wet well at intervals not to exceed three (3) months or as required during construction to prevent damage to mechanical equipment. The wet well shall be cleaned and free of debris on the day of Final Acceptance of the entire Project by the Engineer.
f. Existing and new drainage elements shall remain in use during construction and shall be kept free of debris resulting from construction activities. All work and equipment required to prevent accumulation of sediment and debris in the drainage structures and piping will be considered as included in the Contract. During construction, contractor shall remove and dispose of any accumulated debris at no additional cost.
g. Prior to the start of work, the Contractor shall notify the Engineer and arrange for a pre-construction inspection. At the pre-construction inspection, the existing facility and its equipment shall be examined, photographed by the Contractor, and defective or missing items shall be repaired by the State's Electrical Maintenance Contractor or shall otherwise be recorded. A record of inspection shall be submitted to the Engineer within 15 working days after the pre-construction inspection.
h. Emergency Service Requirements:
    1) The Contractor shall be responsible for providing emergency response to existing pumping station alarms 24 HR, 7 days a week.
    2) Upon notification of a pump station alarm, the Contractor shall dispatch emergency service personnel to the station immediately and shall arrive at the station within one (1) hour of the receipt of the alarm.
    3) All emergency repairs required to restore the existing pump station to its normal operating condition shall be performed by the Contractor

immediately. Emergency service personnel shall remain at the station to monitor the station operations until the alarm(s) are cleared or otherwise notified by the Engineer.

4) The IDOT COMCENTER shall be immediately notified by the Contractor whenever an "Entry Alarm", “High Water Level Alarm”, or "Water on Pavement Alarm" are received, the IDOT COMCENTER shall be notified with the following information: number of pumps running, water depth in wet well, depth of water on pavement and if the drainage inlets are clogged.
5) Failure to respond or meet the emergency service requirements of a pumping station alarm, the Contractor shall be liable to the Department in the amount paid to other subcontractors hired by the State to perform the necessary alarm response.

i. Routine Maintenance Requirements:
   1) Ongoing maintenance activities are required to maintain the rated existing pump station flow capacity. Routine maintenance inspections of all equipment shall be conducted by the Contractor. Routine maintenance items shall be done at intervals and as outlined in the District 1 Electrical Maintenance Contract, Article 15.0 "Routine Patrol Requirements".
   2) Failure to meet the routine maintenance requirements of the pumping station, the Contractor shall be liable to the Department in the amount paid to other subcontractors hired by the State to perform the necessary routine maintenance.

j. Operational Requirements:
   1) The existing pumping station shall function under normal operating conditions and full firm capacity throughout the duration of construction, until the new Pump Station No. 4 is commissioned and online. At that point, the existing pumps can be removed during demolition activities.
   2) The existing pumping station may be temporarily shut down to facilitate work within the existing wet well. The Contractor shall submit requests for shutdown to the Engineer and shall not begin work until written approval is provided by the Engineer. Requests for shutdown shall include date, duration, reason for shutdown, and any other pertinent details.

k. The Contractor shall ensure that two sets of construction lock and entry keys for all construction facilities are provided to the Engineer and IDOT Bureau of Electrical Operations (two sets each).

l. The Contractor shall provide snow plowing services to clear snow from the facility no more than one (1) working day after a snow fall of two (2) inches or more.

6. Demolition of the existing pump station shall be paid for under the contract lump sum pay item DEMOLITION OF EXISTING PUMP STATION and shall be as specified herein:
   a. Demolition of the existing pump station shall be initiated after the new pump station has been started up, commissioned, online and approved by the Engineer. The Contractor shall request and receive approval from the Engineer prior to beginning work on demolition of the existing pump station.
   b. All work associated with removal of equipment, conduit, piping, concrete, cutting openings for the tie-in to the new influent piping, shall be paid for under this pay item.

c. Contractor's work associated with bulkheading and filling of the existing outfall sewer shall be paid for under this pay item.
d. The Contractor shall be responsible for protecting the existing pumps while demolition activities take place to make the tie-in connection to the new pump station.
e. Damage to equipment caused by demolition activities shall be the responsibility of the Contractor to repair and/or replace at no additional cost to the Contract.

1.2 SUGGESTED WORK SEQUENCE

A. The following sequence of construction is presented for the Contractor's consideration in developing the sequence of work to be presented to the Engineer for review:
   1. Locate utilities on site.
   2. Conduct any additional geotechnical investigation deemed relevant by the Contractor, at no additional cost.
   3. Relocate existing 24 IN water main to the north side of the existing pump station structure. Remove existing water main as indicated on the Drawings.
   4. Locate and secure existing telephone line prior to clearing and grubbing.
   5. Clear and temporarily grade the existing site to facilitate construction activities.
   6. Relocate telephone line as shown on the Drawings.
   7. Design and propose to the Engineer a Temporary Excavation Retention System (TERS) per Division 31.
   8. Upon Engineer's completion of review and acceptance, construct the primary support perimeter walls of the TERS and perform water drawdown test. If the pump test does not meet the specifications, seal the bedrock with pumped grout curtain as required to create a watertight system.
   9. Dewater and excavate the TERS while monitoring the existing pump station and the excavation as specified in Division 31.
   10. Install secondary support system between the TERS and existing wet well wall exterior.
   11. Design and install temporary bulkheads in the existing wet well to seal new influent pipe penetrations.
   12. Set rock anchors and construct base slab. Continue pouring influent channel base slab and pump station perimeter walls.
   13. Install process piping between existing wet well and the north wall of the new pump station. Contact grout the annular space between process piping and secondary support system.
   14. Continue pouring interior concrete members and perimeter walls per the Contract Documents. After in-situ concrete strength has been established, the area between the pump station perimeter wall and TERS system can begin to be backfilled.
   15. Once the buried pump station structure is complete and the TERS is no longer required for soil retention, the top of the TERS wall and any compression rings are to be removed as shown on the Drawings and to avoid any utility, retaining wall, or sewer piping interference.
   16. Install pump station outfall sewer box culverts in coordination with the riverside

retaining wall construction. The TERS wall will have to be demolished down to an elevation below the footing of the riverside retaining wall to facilitate construction of the wall and setting of the box culverts as indicated on the Drawings.

17. Complete east and west retaining wall installation while coordinating storm sewer penetrations and grade the compensatory storage basin south of the pump station. Install erosion control measures.
18. Install new electrical service, duct banks, switch gear, and transformers.
19. Install site storm sewer drainage system.
20. Install electrical duct banks from exterior transformers to the Electrical Room. Extend conduit from the Electrical Room into the buried pump station structure.
21. Finish grade the site and seed areas as indicated on the Contract Documents.
22. Install interior architectural, mechanical, structural, electrical, controls, process piping and equipment, and finishes per the Contract Documents.
23. Install fencing, guard rail and remaining site civil features.
24. Plant trees, shrubs, and grasses per the landscape plan.
25. Conduct startup procedures on the new pump station. After the new pump station has been commissioned and is accepted by the Engineer, the Contractor shall request and receive approval from the Engineer prior to beginning decommissioning and demolition work on the existing pump station.
26. Remove traffic surveillance cabinet and related communications conduit and duct banks. Relocate the traffic surveillance hand hole and associated fiber optic and telephone communications lines.
27. Existing equipment shall be salvaged or disposed of as indicated in the Drawings. Existing pump station superstructure can be removed and the perimeter wall can be cut and removed down to the elevation indicated on the Drawings.
28. Care shall be taken by the Contractor to maintain the new pump station in service while demolition work is on-going. Any damage to the new pump station gates or equipment due to demolition work in the existing pump station shall be repaired and/or replaced by the Contractor to the satisfaction of the Engineer at no additional cost to the Contract.
29. Pour concrete cap slab on the existing pump station, install new manholes atop the cap slab and backfill the structure. Power, gas monitoring, and lighting shall be installed.
30. Lay subgrade materials down and pave the access drive and parking areas.
31. Demobilize all equipment and construction trailers. Complete site clean-up.

1.3 UTILITY OUTAGES

A. The Contractor shall organize and plan the construction activities so that the number and length of any required utility outages shall be minimized.

B. An outage to any utility customer shall require specific approval of the Engineer. The Engineer reserves the right to reject any request for an outage.

C. The existing pump station shall retain full pumping capacity at all times. Outages of the pump station and instances of reduced pumping capacity will not be allowed.

D. In some cases it may be necessary, at Contractor's expense, to either install temporary facilities for service or schedule the Work during a period when the utility outage would have minimal impact on the utility customers.

E. The Contractor shall provide the Engineer at least 48 HRS notice in advance of any requested shut down so that the Engineer may advise and coordinate the utility outage.

F. Water main shut downs shall be conducted as specified in the WATER MAIN RELOCATION GENERAL REQUIREMENTS special provision.

1.4 UNDERGROUND UTILITIES

A. Utilities known to the Engineer who may have underground facilities in the vicinity of the Work, may be contacted at the information listed in the special provision for STATUS OF UTILITIES (D-1).

1.5 WARRANTIES AND GUARANTEES

A. Unless otherwise specified, all equipment shall be furnished complete with the manufacturer's warranty or trade guarantee beginning from the date of Final Acceptance of the entire Project by the Engineer and extending a minimum of twelve (12) months from the date of final acceptance.

B. Warranties and trade guarantees shall be applicable to the Illinois Department of Transportation and shall include all parts and labor.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01 33 00 - SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administration of the submittal process for:
      a. Shop Drawings.
      b. Samples.
      c. Informational Submittals.
      d. Submittals Requiring Engineer Review and Approval
   2. General content requirements for Shop Drawings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Operations and Maintenance Manual submittal requirements are specified in Specification Section 01 33 04.
   3. Technical Specification Sections identifying required submittal materials.

C. The cost of submittals, certifications, any required samples, and similar costs shall not be separately paid for but shall be included in the pay item bid price for the respective material or work.

1.2 DEFINITIONS

A. Shop Drawings:
   1. Shop Drawings include technical data and drawings specially prepared for this Project, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information not in standard printed form.
   2. Standard or generic information prepared without specific reference to elements included in the Project will not be considered a Shop Drawing.

B. Samples:
   1. Physical product samples submitted by the Contractor for review and selection by the Engineer.
   2. Samples include both fabricated and manufactured physical examples of materials, products, and units of work, partial cuts of manufactured or fabricated work, swatches showing color, texture, and pattern, and units of work to be used for independent inspection and testing.
   3. Mock-ups are special forms of samples, which are too large or otherwise inconvenient for handling in a manner specified for transmittal of sample submittals. Mock-ups shall be erected on site for Engineer review.

C. Informational Submittals:
   1. Submittals other than Shop Drawings, Samples, and Submittals Requiring Engineer Review and Approval required by the Contract Documents that do not require review and/or approval by the Engineer.
   2. Informational Submittal items include but are not limited to:
      a. Welding certificates.

b. Manufacturer's installation and startup reports.
c. Service agreements.

D. Submittals Requiring Engineer Review and Approval:
1. Submittals Requiring Engineer Review and Approval items include but are not limited to:
a. Record Drawings
b. Manufacturer's field test procedures
c. Manufacturer's certified factory performance test reports.
d. Delegated designs per performance specification requirements.
e. HVAC test and balance reports.
f. Installed equipment and systems field performance test reports.
g. SCADA field test report.
h. Pump factory tests and field inspection reports.
i. Instrumentation and control commissioning reports.
j. Warranties and Guarantees.

1.3 SUBMITTAL SCHEDULE

A. Schedule of Shop Drawings and Samples:
1. Per Section 105.04 of the Standard Specifications.

B. Informational Submittals:
1. Submittals showing compliance with required qualifications submitted twenty (20) calendar days prior to any work beginning using the subject qualifications.

C. Submittals Requiring Engineer Review and Approval:
1. Reports and installation certifications
a. Submit to Engineer within seven (7) calendar days of conducting testing, installation, or examination.
2. Record Drawings
a. Deliver to the Engineer at the completion of the Contract and before final payment is made.

D. The submittal schedule shall include the following columns as a minimum:

Submittal Section	Submittal Description	Planned Submittal Date	Submittal Need Date	Actual Submittal Date	Actual Return Date	Disposition

1.4 PREPARATION OF SUBMITTALS

A. General:
1. All equipment, products, and materials not included in the Project Procedures Guide incorporated in the Work shall be submitted to Engineer for approval.
2. Submittals required for individual elements of work are specified in their respective Sections. Except as otherwise indicated, requirements specified herein shall be complied with for each indicated type of submittal.
3. Materials and equipment shall be the products of established and reputable

manufacturers and shall be suitable for the service required.

4. Materials or equipment items which are similar or identical shall be the product of the same manufacturer.
5. Contractor shall not combine submittal items covered by more than one pay item into a single submittal.
6. The cost of submittals, certifications, any required samples, and similar costs shall not be separately paid for but shall be incidental to the Contract.
7. Minimize extraneous information for equipment and products not relevant to the submittal.

B. Shop Drawings:
   1. Scope of any submittal and letter of transmittal:
      a. Limited to one (1) Specification Section. Submittals with more than one (1) specification section included will be rejected.
      b. Do not submit under any Specification Section entitled (in part) "Basic Requirements" unless the product or material submitted is specified, in total, in a "Basic Requirements" Specification Section.
   2. Recommended numbering letter of transmittal:
      a. Include the Specification Section number as prefix followed by a series number, beginning with "-01" and increasing sequentially with each additional transmittal for that Specification Section.
      b. If more than one (1) submittal under any Specification Section, assign consecutive series numbers to subsequent transmittal letters, "-02, -03", etc.
   3. Describing transmittal contents:
      a. Provide listing of each component or item in submittal capable of receiving an independent review action.
      b. Any unidentified deviation in the submittals shall not be acceptable. Deviations if any shall be highlighted and contractor shall provide cost analysis justifying equal or better product. The Engineer shall be the sole authority for the acceptance or rejection without any justification.
      c. Identify for each item:
         1) Project Route/Name
         2) Contract Identification
         3) Contractor's name
         4) Supplier's name
         5) Manufacturer's name
         6) Submittal date and date of previous submittals on the same material.
         7) Submittal title and number.
         8) Specification section number associated with submittal.
         9) Manufacturer's Drawing or data number.
         10) Contract Document identification tag number(s).
         11) Unique page numbers for each page of each separate item.
         12) Each major equipment submittal shall have a detailed bill of material list.
         13) Equipment dimensions
         14) The catalog cuts shall be highlighted identifying all selected options and project specific details. Generic catalog cuts shall be unacceptable.
   4. Contractor certification of review and approval:
      a. Contractor's review and approval certification stamp shall be applied either to the letter of transmittal or a separate sheet preceding each independent item

in the submittal.
1) Provide clear space of 3 SQIN for Contractor stamping.
2) Stamp may be either a wet ink stamp or electronically embedded.
3) Clearly identify the person who reviewed the submittal and the date it was reviewed.
4) Shop Drawing submittal stamp shall read "(Contractor's Name) has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval as stipulated in the Contract."

b. Submittals containing multiple independent items shall be prepared with each item listed on the letter of transmittal or on an index sheet for all items listing the discrete page numbers for each page of each item, which shall be stamped with the Contractor's review and approval stamp.
1) Each independent item shall have a cover sheet with the transmittal number and item number recorded.
a) Provide clear space of 3 IN SQ for Engineer stamping.
2) Individual pages or sheets of independent items shall be numbered in a manner that permits the entire contents of a particular item to be readily recognized and associated with Contractor's certification.

c. Materials, products or systems shall not be installed until copy of applicable product data showing only approved information is in possession of installer.

5. Contractor shall not use red color for marks on transmittals.
a. Contractors or vendors written comments on the submittal drawings shall be in green.
b. Duplicate all marks on all copies transmitted, and ensure marks are photocopy reproducible.
c. Engineer will use red marks or enclose marks in a cloud.

6. Shop Drawing Contents:
a. Coordinate and identify Shop Drawing contents so that all items can be easily verified by the Engineer.
b. Provide submittal information or marks defining specific equipment or materials utilized on the Project.
1) Generalized product information, not clearly defining specific equipment or materials to be provided, will be rejected.
c. Identify equipment or material project use, tag number, Drawing detail reference, weight, and other Project specific information.
d. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
e. Do not modify the manufacturer's documentation or data except as specified herein.
f. Submit items such as equipment brochures, cuts of fixtures, product data sheets or catalog sheets not exceeding 11 x 17 IN pages.
1) Indicate exact item or model and all options proposed by arrow and leader.
g. When a Shop Drawing submittal is called for in any Specification Section, include as appropriate, scaled details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout Drawings, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data in addition to information specifically stipulated in the Specification Section.

1) Arrange data and performance information in format similar to that provided in Contract Documents.
2) Provide, at minimum, the detail specified in the Contract Documents.

h. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.

7. Recommended Engineer's Review Action:
   a. Items within transmittals will be reviewed for overall design intent and will receive one (1) of the following actions:
      1) APPROVED
      2) APPROVED AS NOTED
      3) DISAPPROVED
      4) INFORMATION ONLY
   b. Rejection of Submittals
      1) Submittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp. Submittals not stamped by the Contractor or stamped with a stamp containing language other than that specified herein will be rejected without review.
      2) Engineer reserves the right to reject poorly organized and poorly described submittals without review.
      3) Engineer reserves the right to reject submittals transmitted with a description identifying a single item and found to contain multiple independent items without review.
   c. Submittals returned with Action "APPROVED" are considered ready for fabrication and installation and may proceed provided it complies with the Contract Documents. Acceptance of Work will depend upon that compliance.
   d. Submittals returned with Action "APPROVED AS NOTED" shall be resubmitted for review and approval unless expressly noted by the Engineer that resubmittal is not required. If resubmittal is required, the Contractor shall submit a disposition of comments describing action taken to address each of the Engineer's comments.
   e. Modifications requested along with the "APPROVED AS NOTED" action response shall be made by the Contractor and resubmittal is not required. Fabrication and installation may proceed provided it complies with the Contract Documents. Acceptance of Work will depend upon that compliance.
   f. If for any reason a submittal receiving an "APPROVED" or "APPROVED AS NOTED" action with no resubmittal requirement is resubmitted by the Contractor, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal.
   g. Contractor shall destroy or conspicuously mark "SUPERSEDED" all documents having previously received "APPROVED" or "APPROVED AS NOTED" action that are superseded by a resubmittal.
   h. Submittals receiving a "DISAPPROVED" action are the result of a major portion of the individual Drawings or documents failing to meet the basic intent of the specifications or design.

1) The entire submittal may be given "DISAPPROVED" Action, at the sole discretion of the Engineer.
   a) The Engineer may provide general comments as to why the submittal does not meet the specifications but is not obligated to review the entire submittal and provide detailed comments.
   b) Major changes shall be made to the submittal by the Contractor and it shall be resubmitted as a complete package.
   c) Distribution to the field shall not be made until an "APPROVED" or "APPROVED AS NOTED" action is received.

i. Failure to include any specific information specified under the submittal paragraphs of the Specifications will result in the submittal being returned to the Contractor with a "DISAPPROVED" action.

j. Calculations required in individual Specification Sections will be received for information purposes only, as evidence calculations have been stamped by the professional as defined in the specifications and for limited purpose of checking conformance with given performance and design criteria.
   1) The Engineer is not responsible for checking the accuracy of the calculations and the calculations will be returned stamped "INFORMATION ONLY".

k. Contractor shall provide submittals with sufficient information and accuracy to obtain required approval with no more than two (2) re-submittals. Engineer will record Review Engineer's time for reviewing any subsequent re-submittals of Shop Drawings, samples, or other items requiring approval, and the Contractor shall be responsible for Engineer's review expenses for such time. Engineer may impose a set-off against Contractor progress payments to secure reimbursement for such charges.

l. Transmittals of submittals that the Engineer considers as "Not Required", which is supplemental to, but not essential to, prior submitted information or items of information in a transmittal which have been reviewed and received "APPROVED" or "APPROVED AS NOTED" action in a prior submittal, will be returned with action "INFORMATION ONLY".

m. Samples may be retained for comparison purposes.
   1) Remove samples when directed.
   2) Include in bid all costs of furnishing and removing samples.

n. Approved samples submitted or constructed, constitute criteria for judging completed work.
   1) Finished work or items not equal to samples will be rejected.

8. Resubmittal of Shop Drawings:
   a. Re-submittal preparation shall comply with Shop Drawings submittal requirements, of this Section. In addition, it shall be identified on the transmittal form that the submittal is a resubmission. Re-submittal shall have previous comments and detailed point by point response to each previous comments.
   b. Number with original Specification Section and series number with a suffix letter starting with "-A" on a (new) duplicate transmittal form.
   c. Do not increase the scope of any prior transmittal.
   d. Resubmittals shall be complete in superseding prior submittals in entirety and should not require referring back to earlier submittals.
   e. Account for all components of prior transmittal.
      1) If prior transmittal received "DISAPPROVED" action, list prior review

comments and provide response to each and where the correction is found in the resubmittal.

f. Provide the same number of copies of re-submittal as is required by the original submittal to the Engineer.
g. Any need for more than one resubmittal, or any other delay in the Engineer's review of submittals, shall not entitle the Contractor to extension of the Contract time.
h. Samples:
    1) Identification:
        a) Identify sample as to transmittal number, manufacturer, item, use, type, project designation, tag number, Specification Section or Drawing detail reference, color, range, texture, finish and other pertinent data.
        b) If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
    2) Include application specific brochures, and installation instructions.
    3) Provide Contractor's review and approval certification stamp or Contractor's Submittal Certification form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
    4) Where possible, samples shall be physically identical with proposed materials or products to be incorporated into the Work. Where variations in color, pattern or texture are inherent in material or product represented by sample, multiple units (not less than 3 units) shall be submitted showing approximate limits of variations.
    5) A full set of optional samples shall be provided where Engineer's selection required. Samples shall be prepared to match Engineer's selection where so indicated.
    6) Each sample shall include generic description, source or product name and manufacturer, limitations, and compliance with standards.
    7) Samples for Engineer's visual review and final check of coordination of these characteristics with other related elements of work shall be of general generic kind, color, pattern, texture.
    8) At Contractor's option, and depending upon nature of anticipated response from Engineer, initial submittal of samples may be either preliminary or final submittal.
    9) A preliminary submittal, consisting of a single set of samples, is required where specifications indicate Engineer's selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary. Preliminary submittals will be reviewed and returned with Engineer's "Action" marking.
    10) Three (3) sets of samples shall be submitted in final submittal, One (1) set will be returned.
    11) The returned final set of samples shall be maintained at Project site, in suitable condition and available for quality control comparisons throughout course of performing work.
    12) Returned samples intended or permitted to be incorporated in the Work are indicated in Specification sections, and shall be in undamaged condition at time of use.

13) Mock-ups and similar samples specified in Specification sections are recognized as special type of samples. Requirements for samples submittal shall be complied with to greatest extent possible. Transmittal forms shall be processed to provide record of activity.
14) Resubmit revised samples of rejected items.

C. Samples:
1. Contractor shall submit sample information where required in the technical specifications. Refer to Shop Drawing Submittal Requirements above.
2. Each sample shall include generic description, source or product name and manufacturer, limitations, and compliance with standards.
3. Samples for Engineer's visual review and final check of coordination of these characteristics with other related elements of work shall be of general generic kind, color, pattern, texture.
4. A preliminary submittal, consisting of a single set of samples, is required where Specification sections indicate Engineer's selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary. Preliminary submittals will be reviewed and returned with Engineer's action response.
5. Three (3) sets of samples shall be submitted in final submittal, one (1) set will be returned.
6. The returned final set of samples shall be maintained at Project site, in suitable condition and available for quality control comparisons throughout course of performing work.
7. Returned samples intended or permitted to be incorporated in the Work are indicated in Specification sections, and shall be in undamaged condition at time of use.
8. Mock-ups and similar samples specified in Specification sections are recognized as special type of samples. Requirements for samples submittal shall be complied with to greatest extent possible. Transmittal forms shall be processed to provide record of activity.

D. Informational Submittals:
1. Prepare informational submittals in the format described for Shop Drawings above. Provide information and detail specified in Specification sections requiring informational submittals.
2. Engineer will acknowledge receipt of informational submittals but will return with an "INFORMATION ONLY" action response.
3. It is the Contractor's responsibility that informational submittals meet the requirements described in their respective Specification sections.

E. Submittals Requiring Engineer Review and Approval
1. Inspection and Test Reports:
   a. Inspection and factory test reports shall be submitted for pumps, SCADA panel and MCC.
2. Submittals for detailed factory and field test procedures for pumps.
3. Submittals for detailed field test procedures for pumps, SCADA panel and MCC.
4. Guarantees, Warranties, Maintenance Agreements, and Workmanship Bonds.
   a. Refer to Specification Sections and section Guarantees and Warranties of this Division for specific requirements. Submittal is final when returned by Engineer marked "APPROVED".

b. In addition to copies desired for Contractor's use, two (2) executed copies shall be furnished. Two additional copies shall be provided where required for maintenance data.

5. Certifications:
   a. Refer to Specification sections for specific requirements on submittal of certifications. Six (6) copies shall be submitted. Certifications are submitted for review of conformance with specified requirements and information. Submittal shall be final when returned by Engineer marked "APPROVED".
   b. Where certifications are specified, the information submitted for approval shall incorporate certification information. When a certification can be made prior to manufacture, the certification shall be included with initial submittal information. When certification is possible only after manufacture, the initial submittal information shall include a statement of intent to furnish the certification after equipment approval and manufacture.
   c. Certifications involving inspections and/or tests shall be complete with all test data presented in a neat, descriptive format, with all test data, applicable dates, times, and persons responsible.
   d. There should be a section in the report analyzing results and test data that meets the requirements of the contract and also list the items that fall short of contract requirements with conclusive remarks for acceptance/rejection of the equipment.
6. Record Drawings
   a. Record Drawings shall consist of three (3) copies of 11"x17" bond media Contract Drawings reflecting all changes made during construction.
   b. Drawings shall be stamped "Record Drawings" and shall be marked with the Contractor's stamp, the date, and signature of the Contractor's representative.
   c. Record Drawings shall reflect the actual field installed equipment, locations, nameplates, electrical control logic, conduit locations with corresponding labeling, and wiring changes etc. Any deletions of the design drawings shall cross reference to the replaced drawings.
   d. The Record Drawings must be submitted and must be acceptable to the Engineer prior to final acceptance.
   e. The Record Drawings shall be submitted in PDF format on CDROM as well as hardcopy for review and approval. In addition to the Record Drawings, copies of the final catalog cuts which have been Approved or Approved as Noted shall be submitted in PDF format along with the Record Drawings. The PDF files shall clearly indicate either by filename or PDF table of contents the respective pay item number. Specific part or model numbers of items which have been selected shall be clearly visible.
   f. In addition to the specified Record Drawings, the Contactor shall record GPS coordinates of the following electrical components:
      1) Hand holes
      2) Conduit crossings
      3) Buildings
      4) Electric service locations

1.5 TRANSMITTAL OF SUBMITTALS

A. Shop Drawings, Samples, Informational Submittals, and Submittals Requiring

Engineer Review and Approval:

1. Contractor shall deliver submittals for review, pick up reviewed submittals, and distribute as directed by the Engineer.
2. Reduced-size drawings shall be legible and reproducible.
3. Contractor shall utilize the IDOT submittal cover form for all submittals.
4. Shipping address for samples and submittals shall be determined at the pre-construction meeting.
5. Utilize Bureau of Traffic Operations shop drawing transmittal form for all shop drawing submittals as provided by the Engineer.
6. All submittals must be from Contractor.
   a. Submittals will not be received from or returned to subcontractors.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01 33 04 - OPERATION AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administration of the submittal process for Operation and Maintenance Manuals.
   2. Content requirements for Operation and Maintenance Manuals.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. General submittal requirements are specified in Specification Section 01 33 00 - Submittals.
   3. Technical Specification Sections identifying required Operation and Maintenance Manual submittals.

1.2 DEFINITIONS

A. Equipment Operation and Maintenance Manuals:
   1. Contain the technical information required for proper installation, operation and maintenance of process, electrical and mechanical equipment and systems.

B. Building Materials and Finishes Operation and Maintenance Manuals:
   1. Contain the information required for proper installation and maintenance of building materials and finishes.

1.3 SUBMITTALS

A. List of all the Operation and Maintenance Manuals required by the Contract as identified in the Technical Specification Sections. These may be referred to as "Operation and Maintenance Data" submittals.

B. Operation and Maintenance Manuals:
   1. Draft paper copies: Three (3).
   2. Draft electronic version in PDF format.
   3. Final paper copies: Three (3).
   4. Final electronic version in PDF format on CD: Four (4) CD's, each in a jewel case.

1.4 SUBMITTAL SCHEDULE

A. List of Required Operation and Maintenance Manuals:
   1. Submit list with Specification Section number and title within ninety (90) days after Notice to Proceed.

B. Draft Operation and Maintenance Manuals:
   1. Submit approvable draft manuals as scheduled in paragraph 1.3 within ninety (90) days following approval of the respective Shop Drawing.
      a. Include placeholders or fly sheet pages where information is not final or is missing from the draft manual.
   2. All Draft Operation and Maintenance Manuals shall be received by no later than

75 PCT project completion.

C. Final Operation and Maintenance Manuals:
   1. Final approval of Operation and Maintenance Manuals as scheduled in Paragraph 1.3 shall be received from Contractor no later than 45 days prior to equipment start- up.
   2. Provide paper copies and CD-ROMs of approved final Operation and Maintenance Manuals in electronic format (PDF).
   3. Issue addenda to Final Approved Operation and Maintenance Manual to include:
      a. Equipment data that requires collection after start-up, for example but not limited to HVAC balancing reports, electrical switchgear, circuit breaker settings, short circuit study, protective device and coordination study, breaker and protection relay settings, and arc flash study.
      b. Equipment field testing data.
      c. Equipment start-up reports.

1.5 PREPARATION OF SUBMITTALS

A. General:
   1. All pages of the Operation and Maintenance Manual submittal shall be legible.
      a. Submittals which, in the Engineer's sole opinion, are illegible will be rejected without review.
   2. Identify each equipment item in a manner consistent with names and identification numbers used in the Contract Documents, not the manufacturer's catalog numbers.
   3. Neatly type any data not furnished in printed form.
   4. Operation and Maintenance Manuals are provided for the Department's use, to be reproduced and distributed as training and reference materials within the Department's organization.
      a. This requirement is:
         1) Applicable to both paper copy and electronic files.
         2) Applicable to materials containing copyright notice as well as those with no copyright notice.
   5. Notify supplier and/or manufacturer of the intended use of Operations and Maintenance Manuals provided under the Contract.

B. Operation and Maintenance Manual Format and Delivery:
   1. Draft electronic submittals:
      a. Provide manual in Portable Document Format (PDF), latest version.
      b. Create one (1) PDF file for each equipment Operation and Maintenance Manual.
      c. Do not password protect or lock the PDF document.
      d. Scanned images of paper documents are not acceptable. Create the Operation and Maintenance Manual PDF file from the original source document.
      e. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
      f. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 dpi or greater.
      g. Rotate sheets that are normally viewed in landscape mode so that when the

PDF file is opened the sheet is in the appropriate position for viewing.

h. Create bookmarks in the bookmarks panel for the Operation and Maintenance Manual cover, the Table of Contents and each major section of the Table of Contents.

2. Final electronic submittals:
   a. Submit final electronic copies as scheduled in paragraph 1.3.
   b. CD-ROM Labeling:
      1) Provide the following printed labeling on all CD-ROM discs:
         a) Project name.
         b) Specification Section.
         c) Equipment names and summary of tag(s) covered.
         d) Manufacturer name.
         e) Date (month, year).
   c. CD-ROM Jewel Case Holder:
      1) Insert jewel cases containing labeled CD-ROM discs in three-ring binder holder (C-Line Products, www.c-lineproducts.com stock number CLI-61968 or equivalent) at the front of each final paper copy.
3. Final paper copy submittals:
   a. Quantity: As scheduled in paragraph 1.3.
   b. Paper: 8.5 x 11 IN or 11 x 17 IN bright white, 20 LBS paper with standard three-hole punching.
   c. All documents must be legible.
   d. Binder:
      1) Provide heavy-weight, hard cover, 3-ring binder with clear vinyl sleeves (i.e. view binder) on front and spine.
      2) Binder shall have piano-style metal hinges or an alternate format approved by the Engineer.
      3) Organize binder by subject and engineering discipline.
      4) Insert binder title sheet with the following information under the front and spine sleeves:
         a) Project name.
         b) Specification Section.
         c) Equipment names and summary of tag(s) covered.
         d) Manufacturer name.
         e) Date (month, year).
      5) Provide plastic sheet lifters prior to first page and following last page.
      6) Binders shall not be overfilled and shall have adequate space for turning pages and replacing pages in the manuals.
   e. Drawings:
      1) Provide all Drawings at 11 x 17 IN size, triple folded and three-hole punched for insertion into manual.
      2) Where reduction is not practical to ensure readability, fold larger Drawings separately and place in three-hole punched vinyl envelopes inserted into the binder.
      3) Identify vinyl envelopes with Drawing numbers.
   f. Use plastic coated and reinforced dividers to tab each section of each manual in accordance with the Table of Contents.

C. Equipment Operation and Maintenance Manual Content. The manual shall consist of

the following and shall be prepared and arranged subject wise and chronological order as follows

1. Provide a cover page as the first page of each manual with the following information:
   a. Manufacturer(s) Name and Contact Information.
   b. Vendor's Name and Contact Information.
   c. Date (month, year).
   d. Project Name.
   e. Specification Section.
   f. Project Equipment Tag Numbers.
   g. Model Numbers.
   h. Engineer's Name.
   i. Contractor's Name.
2. Provide a Table of Contents for each manual.
3. Provide a section of the pump station vital information. The section shall include:
   a. Location
   b. Telephone number
   c. Number of Main Pumps
   d. Number of Low Flow Pumps
   e. Pump Station Capacity
   f. Type of Pump Station
   g. Pump Station Discharge/Outlet Structure
   h. Electrical Services
   i. Generator Connection Equipment
   j. Medium Voltage Switchgear
   k. Medium Voltage MCC
   l. Low Voltage MCC
   m. Mechanical Screens
   n. Sluice Gates
   o. SCADA
   p. Pump Station Control Elevations with rising water and falling water
   q. Maps, Photos and Driving Directions
4. A Section Consisting of Equipment Data Summary for each Equipment Item.
5. A Section Consisting of Preventive Maintenance Data Summary for each Equipment Item.
6. A Section Consisting of Equipment Manufacturer's Operating and Maintenance Instructions. Operating Instructions shall include equipment start-up, normal operation, shut down, emergency operation and troubleshooting. Maintenance Instructions shall include equipment installation, calibration and adjustment, preventive and repair maintenance, lubrication, troubleshooting, parts list and recommended spare parts.
7. A Section consisting Power System Short Circuit Study, Protective Device and Coordination Study, Arch Flash Study and Breaker and Protective Relay Settings.
8. A Section consisting of interconnection wiring diagram for equipment furnished including all control and lighting systems.
9. The manual shall include comprehensive equipment technical data sheets for pumps, mechanical screens, sluice gates, motors, equipment within switchgear,

MCC, transformers, circuit breakers, SCADA and other control panels.

10. Detailed summary of quantities and bill of material with technical descriptions for major equipment such as Medium voltage switchgear, motor starters, MCC, SCADA and all control panels.
11. The manual shall include approved shop drawings and catalog cuts. Each shop drawing shall have “Record” stamp, signature and date. The catalog cuts of each device and equipment shall have Engineer’s “Approved” stamp.
12. The manual shall include shop drawings of SCADA, all control panels, medium voltage switchgear, MCC with front and internal views, internal wiring and field termination details/terminal schedules.
13. The manual shall include control schematic shop drawings for pumps, mechanical screens, influent, discharge and recirculation sluice gates and HVAC equipment.
14. The manual shall contain a section for detailed description of sequence of pump operations during rising and falling wet well water level through SCADA, float control, manual and auto operation of various level systems, remote monitoring of pump station and communication method.
15. The manual shall include mechanical and HVAC schedules.
16. Provide a printed copy of the Manufacturer’s Field Services report as required by Specification Section 01 75 00.
17. Provide the following detailed information, as applicable:
    a. Use equipment tag numbers from the Contract Documents to identify equipment and system components.
    b. Equipment Nameplate details and technical ratings.
    c. Equipment function, normal and limiting operating characteristics.
    d. Instructions for assembly, disassembly, installation, alignment, adjustment, and inspection.
    e. Operating instructions for start-up, normal operation, control, shutdown, and emergency conditions.
    f. Lubrication and maintenance instructions.
    g. Troubleshooting guide.
    h. Mark each sheet to clearly identify specific products and component parts and data applicable to the installation for the Project; delete or cross out information that does not specifically apply to the Project.
    i. Parts lists:
        1) A parts list and identification number of each component part of the equipment.
        2) Exploded view or plan and section views of the equipment with a detailed parts callout matching the parts list.
        3) A list of recommended spare parts.
        4) List of spare parts provided as specified in the associated Specification Section.
        5) A list of any special storage precautions which may be required for all spare parts.
    j. General arrangement, cross-section, and assembly drawings.
    k. Electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, and interconnection diagrams.
    l. Test data and performance curves.
    m. As-constructed fabrication or Layout Drawings and wiring diagrams.

n. Copy of the equipment manufacturer's warranty meeting the requirements of the Contract.
o. Copy of any service contracts provided for the specific piece of equipment as part of the Contract.

18. Additional information as required in the associated equipment or system Specification Section.

D. Equipment O&M manuals shall include approved record shop drawings and schematics. The manufacturer's approved catalog and O&M manuals shall be project specific. The details, model numbers and applicable features/options shall be highlighted and inapplicable material shall be crossed out.

E. Each O&M manual submittal shall be dedicated for each subject. The different subjects and/or systems associated with different engineering disciplines shall not be combined with others in one package of submittal.

F. All operating and maintenance material that is bound by the equipment manufacturer shall be kept intact in its original bound state. The appropriate sections of the Contractor's O&M manual shall cross reference the manufacturer's bound manuals or vice versa.

G. Building Materials and Finishes Operation and Maintenance Manual Content:
1. Provide a cover page as the first page of each manual with the following information:
   a. Manufacturer(s) Name and Contact Information.
   b. Vendor's Name and Contact Information.
   c. Date (month, year).
   d. Project Name.
   e. Specification Section.
   f. Model Numbers.
   g. Engineer's Name.
   h. Contractor's Name.
2. Provide a Table of Contents for each manual.
3. Building products, applied materials and finishes:
   a. Include product data, with catalog number, size, composition and color and texture designations.
   b. Provide information for ordering custom manufactured products.
4. Necessary precautions:
   a. Include product material safety data sheet (MSDS) for each approved product.
   b. Include any precautionary application and storage guidelines.
5. Instructions for care and maintenance:
   a. Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods and recommended schedule for cleaning and maintenance.
6. Moisture protection and weather exposed products:
   a. Include product data listing, applicable reference standards, chemical composition, and details of installation.
   b. Provide recommendations for inspections, maintenance and repair.
7. Additional requirements as specified in individual product specifications.

H. Operation and Maintenance Manual Organization
   1. Equipment O&M manuals shall be organized by major discipline such that the mechanical HVAC manuals are bound together, the mechanical pumping manuals are bound together, and electrical equipment are bound together. If any manual is too large to combine with other manuals, it shall be a standalone binder.
   2. Separate O&M manual binders shall be provided for each of the MV Switchgear, MCC's, and SCADA.

1.6 TRANSMITTAL OF SUBMITTALS

A. Operation and Maintenance Manuals.
   1. Transmit all submittals to the Engineer at the shipping address determined during the pre-construction meeting.
   2. Transmittal form: Use Operation and Maintenance Manual Transmittal, Exhibit A.
   3. Transmittal numbering:
      a. Number each submittal with the Specification Section number followed by a series number beginning with "-01 IN and increasing sequentially with each additional transmittal, followed by "-OM" (for example: 43 23 14-01-OM).
   4. Submit draft and final Operation and Maintenance Manual in electronic format (PDF) to Engineer, until manual is approved.

1.7 ENGINEER'S REVIEW ACTION

1. Refer to Section 01 33 00.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

STORMWATER PUMP STATION NO. 4

Operation and Maintenance

Manual Equipment Data

Summary

Equipment Name: | Specification Reference:

Manufacturer Name:

Address:

Telephone:

Number Supplied: | Location / Service

Model No.: | Serial No.:

Type:

Size/ Speed / Capacity / Range (as applicable)

Power Requirement (Phase / Volts / Hertz):

Local Representative
Name:

Address:

Telephone:

NOTES:

STORMWATER PUMP STATION NO. 4

Operation and Maintenance Manual

Preventive Maintenance Summary

Equipment Name: _____ Location: _____

Manufacturer

Name: _____

Address: _____

Telephone: _____

Model No.: _____ Serial No.: _____

Maintenance Task	Lubricant/Part	D W M Q S A A

NOTES:

SECTION 01 65 50 - PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 SUMMARY

A. This work shall be according to Section 106.06 - STORED MATERIALS and Section
107.30 – CONTRACTOR'S RESPONSIBILITY FOR WORK of the Standard Specifications with the addition of the following.

1.2 PROTECTION, STORAGE AND HANDLING

A. Manufacturer's Instruction:
   1. Protect all products or equipment in accordance with manufacturer's written directions.
      a. Store products or equipment in location to avoid physical damage to items while in storage.
      b. Handle and store products or equipment in accordance with manufacturer's recommendations and instructions.
   2. Protect equipment from exposure to elements and keep thoroughly dry.
   3. Store pumps, motors, electrical equipment, and other equipment having antifriction or sleeve bearings in weathertight warehouses which are maintained at a temperature to prohibit the accumulation of condensation on the equipment. Storage locations must be approved by the Department prior to delivery of equipment.
   4. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.
   5. All materials for interior use on the project shall be stored indoors and away from exposure to weather. Such materials would include ductwork, doors and frames, louvers, grating, building hardware, windows and glass block, wire and cable, conduit, and piping.

B. Protection of the Work:
   1. All work shall be protected from damage by vandals, the weather, or other sources until final acceptance by the Engineer. Such protection shall include temporary fencing or other barriers, if necessary, to restrict access to the work.
   2. Open pits, doors, hatches, etc. shall be covered, closed and locked.
   3. Contractor shall make the worksite safe at the end of each work day, leaving no attractive nuisance hazards and no open electrical boxes and the like.
   4. No additional compensation will be granted and no additional time will be allowed due to delays caused by failure to adequately protect the work from damage.

1.3 FIELD QUALITY CONTROL

A. Monitor Storage Area(s): Monitor storage area(s) to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

1.4 DELIVERY

A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.

C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.

D. Protection and Handling: Follow manufacturer's instructions for storage and handling for all equipment.

1.5 BASIS OF PAYMENT

A. This work will not be paid separately but will be considered as included in the contract lump sum price for PUMP STATION GENERAL WORK, which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION- (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 01 73 20 - OPENINGS AND PENETRATIONS IN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Methods of installing and sealing openings and penetrations in construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 – Metal Fabrications.
   3. Section 07 62 00 - Flashing and Sheet Metal.
   4. Section 07 84 00 - Firestopping.
   5. Section 07 92 00 - Joint Sealants.
   6. Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      d. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
      f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
      g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      i. A995, Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 501, Class 1 Locations.
      b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
      c. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.4 DEFINITIONS

A. Corrosive Areas: For the purpose of this specification section, the following areas are defined as corrosive:
   1. Existing Pump Station Wet Well.
   2. Pump Room (all levels).
   3. Screen Area (all levels).
   4. Pump Area (all levels).
   5. All below-grade areas, including stairwells.

B. Hazardous Areas: Areas listed in the Contract Documents as having Class I or Class II area classifications.
   1. Existing Pump Station Wet Well.
   2. Pump Room (all levels).
   3. Screen Area (all levels).
   4. Pump Area (all levels).
   5. All below-grade areas, including stairwells.

C. Washdown Areas:
   1. All below-grade areas, including stairwells.

1.5 PROJECT CONDITIONS

A. Refer to the Project Soils Report entitled Geotechnical Investigation Report – Phase II, Proposed Pump Station #4 included in the Specifications for water table levels used for this Project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Sleeves:
   1. Areas listed as Corrosive Areas in PART 1:
      a. Stainless steel, Type 316L.
      b. Penetrations 24 IN DIA or less: ASTM A269, ASTM A312 or ASTM A554, Schedule 40.
      c. Penetrations larger than 24 IN DIA: ASTM A666, Minimum 1/4 IN thickness.
   2. All other Areas:
      a. Steel, Hot-dipped galvanized after fabrication.
      b. Penetrations 24 IN DIA or less: ASTM A53, Schedule 40.
      c. Penetrations larger than 24 IN DIA: ASTM A36, Minimum 1/4 IN thickness.

B. Backing Rod and Sealant: See Specification Section 07 92 00.

C. Modular Mechanical Seals:
   1. Acceptable manufacturers:
      a. Link-Seal.
   2. 316 stainless steel bolts, nuts and washers.

D. Firestopping Material: See Specification Section 07 84 00.

E. Sheet Metal Sleeves:

1. Areas listed as Corrosive Areas in PART 1:
   a. Stainless steel, Type 316L.
   b. ASTM A240.

F. Commercial Wall Castings:
   1. Ductile iron, ASTM A536.
   2. For wet/corrosive areas either side of penetration: Stainless Steel, ASTM A352 or ASTM A995.
   3. Slope equal to connecting piping system.

PART 3 - EXECUTION

3.1 FABRICATION

A. Fabricate pipe sleeves in accordance with Specification Section 05 50 00.

B. Fabricate sheet metal sleeves in accordance with Specification Section 07 62 00.

C. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in- place in concrete.
   1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
   2. For commercial castings, cast water stop/anchor with wall pipe.
   3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.
   4. For fabricated units, diameter of plate or flange to be 4 IN larger than outside diameter of sleeve, pipe or ductwork.
   5. For commercial castings, waterstop/anchor size to be manufacturer standard.
   6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

D. Factory or shop-coat painted components in accordance with Specification Section 09 96 00.

3.2 INSTALLATION AND APPLICATION

A. Firestopping materials used in fire-resistance rated construction shall be in full compliance with Specification Section 07 84 00.

B. Seal openings and penetrations in non-fire-resistance-rated construction in accordance with Specification Section 07 92 00.

C. Obtain prior approval from Engineer when any opening larger than 100 SQIN must be made in existing or newly completed construction.

D. Perform HVAC penetrations in accordance with NFPA 90A.

E. Perform electrical penetrations in accordance with NFPA 70, Article 501.

F. Install sleeves and castings in accordance with ACI 318, Chapter #6.

G. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.
   1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.

H. Where pipes, conduits or ducts pass through floors in washdown areas, install

sleeves with top 3 IN above finish floors.
1. In non-washdown areas, install sleeves with ends flush with finished surfaces.

I. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.

J. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.

K. Where pipes, conduits or ducts pass through grating, provide banding at the entire perimeter of the opening.
1. Metal grating: See Specification Section 05 50 00.

L. Where pipes, conduits or ducts are removed where passing through grating:
1. Metal grating:
a. Provide banding at perimeter and cover opening with 1/4 IN plate of the same material of the grating.
b. See Specification Section 05 50 00.
2. FRP grating:
a. Provide full depth cover meeting same loading requirement as existing material or replace grating section.

M. Do not cut into or core drill any beams, joists, or columns.

N. Do not install sleeves in beams, joists, or columns.

O. Do not install recesses in beams, joists, columns, or slabs.

P. Field Cutting and Coring:
1. Saw or core drill with non-impact type equipment.
2. Mark opening and drill small 3/4 IN or less holes through structure following opening outline.
3. Sawcut opening outline on both surfaces.
a. Knock out within sawcuts using impact type equipment.
b. Do not chip or spall face of surface to remain intact.
c. Do not allow any overcut with saw kerf.

Q. Precast-Prestressed Concrete Construction:
1. Do not cut openings or core drill vertically or horizontally through stems of members.
2. Do not locate or install sleeves or recess sleeves vertically or horizontally through or in stems of members.
3. Cast openings and sleeves into flanges of units.
4. Cast openings larger than 6 IN in diameter or 6 IN maximum dimension in units at time of manufacture.
5. Cast openings smaller than 6 IN in diameter or 6 IN maximum dimensions in flanges of units at time of manufacture or field cut.

R. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.

S. Where area is blocked out to receive sheet metal sleeve at later date:
1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
a. Size blockout based on sleeve size required plus 4 to 6 IN each side of

sleeve for concrete encasement.
   b. Provide #4 dowels at 12 IN spacing along each side of blockout with minimum of two (2) dowels required per side.
2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
   a. Size blockout based on sleeve size required plus 2 to 4 IN each side of sleeve for concrete encasement.

T. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.

U. Refer to Drawings for location of fire-rated walls, floors, and ceilings.
1. Utilize firestopping materials and procedures specified in Specification Section 07 84 00 IN conjunction with scheduled opening type to produce the required fire rating.

V. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.

W. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.

X. Modular Mechanical Seals:
1. Utilize one (1) seal for concrete thickness less than 8 IN and two (2) seals for concrete, 8 IN thick or greater.
2. Utilize two (2) seals for piping 16 IN diameter and larger if concrete thickness permits.
3. Install seals such that bolt heads are located on the most accessible side of the penetration.

Y. Backer Rod and Sealant:
1. Install in accordance with Specification Section 07 92 00.
2. Provide backer rod and sealant for modular mechanical seal applications.
   a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

3.3 SCHEDULES

A. General Schedule of Penetrations through Floors, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:
1. Provide the following opening and penetration types:
   a. Type A - Block out 2 IN larger than outside dimensions of duct, pipe, or conduits.
   b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
   c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring.
   d. Type D - Commercial type casting or fabrication.
   e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.

f. Type F - Integrally cast pipe, duct or conduit.
g. Type G - Saw cut or line-drill and remove area 1 IN larger than outside dimensions of duct, pipe or conduit.
h. Type H - Core drill.
i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
j. Type J- Grating Banding for any field cut openings.

2. Provide seals of material and method described as follows.
   a. Category 1 - Modular Mechanical Seal.
   b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings. Refer to Specification Section 07 62 00 and roofing Specification Sections for additional requirements.
   c. Category 3 - 12 GA stainless steel sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
   d. Category 4 - Backer rod and sealant.
   e. Category 5 - Full depth compressible sealant with stainless steel escutcheons on both sides of opening.
   f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 IN larger than opening.
   g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.
   h. Category 8 - Banding for all grating openings and banding and cover plate of similar materials for abandoned openings.
3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.
4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE FOR NEW CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors in washdown areas	C I	4 4	C	1	F H (2) I (1)	Not Req 3 7
Through floors with bottom side a hazardous location	C F I	7 Not Req 7	C	1	C F	7 Not Req
Through slab on grade above water table	C F I	4 Not Req 4	C D F	1 Not Req Not Req	C F I (1)	4 Not Req 7
Through slab on grade below water table	F	Not Req	D	Not Req	F	Not Req
Through walls where one side is a hazardous area	C F I	7 Not Req 7	D	Not Req	C F	7 Not Req
Through wall from tankage, channel, or wet well (above high water level) to dry well or dry area	C F I	7 Not Req 7	D	Not Req	C F H (2) I (1)	7 Not Req 7 7
Through wall from tankage, channel, or wet well (below high water level) to dry well or dry area	N/A	N/A	D	Not Req	F	Not Req
Through exterior wall below grade above water table	N/A	N/A	C D F	1 Not Req Not Req	F I (1)	Not Req 7
Through exterior wall below grade below water table	N/A	N/A	F	Not Req	F I (1)	Not Req 7
Through exterior wall above grade	A B C	6 6 6	A	3	C H (2)	5 4
Roof penetrations	A	2	A	2	A	2
Through interior walls and slabs not covered by the above applications	A C	4 4	A C	4 4	A C F	4 4 Not Req

(1) Multiple piping 3 IN and smaller or multiple conduits.
(2) Single pipe 3 IN and smaller or single conduit.
(3) Single pipe or conduit larger than 3 IN.

SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE FOR EXISTING CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	B E	7 Not Req	N/A	N/A	B (1) E (3) H (2)	7 Not Req 7
Through walls where one side is a hazardous area	B E	7 Not Req	N/A	N/A	B (1) (3) E H (2)	7 Not Req 7
Through interior walls and slabs not covered by the above applications	G	4	N/A	N/A	G (1) (3) H (2)	4 4
Grating openings and penetrations	J	8	N/A	N/A	J	8

(1) Multiple piping 3 IN and smaller or multiple conduits.
(2) Single pipe 3 IN and smaller or single conduit.
(3) Single pipe or conduit larger than 3 IN.

END OF SECTION

SECTION 01 73 29 - DEMOLITION, CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Demolition, cutting and patching of existing construction where shown on Drawings, or as required to accommodate new work shown or specified.
   2. See Drawings for items identified to be salvaged.
   3. See Section 02 41 00 for removal and protection of items identified to be salvaged.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 02 41 00 - Demolition
   3. Section 03 31 30 - Concrete, Materials and Proportioning.
   4. Section 09 96 00 - High Performance Industrial Coatings.
   5. Section 31 23 00 - Earthwork.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, DEMOLITION OF EXISTING PUMP STATION.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Store materials per manufacturer recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   1. Nonshrink grout:
      a. Illinois Department of Transportation Bureau of Materials QUALIFIED PRODUCT LIST OF NONSHRINK GROUTS
   2. Epoxy bonding adhesive:
      a. Euco No.452 MV by Euclid Chemical Co.
      b. Sikadur 32, Hi-Mod by Sika Corporation.
   3. Epoxy patch:
      a. Depth of patch:
         1) Greater than 3/4 IN: Five Star MP Epoxy Patch.
         2) Between 1/8 IN and 3/4 IN: Five Star Fluid Epoxy.
   4. Polymer Modified Portland Cement Mortar:
      a. Illinois Department of Transportation Bureau of Materials QUALIFIED PRODUCT LIST OF POLYMER MODIFIED PORTLAND CEMENT MORTAR.

B. No like, equivalent or "or-equal" item or substitution is permitted without written

approval by the Engineer and the substitution meets the requirements of the Specifications.

C. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Temporary Partitions:
   1. Plywood: 1/2 IN minimum for interior or exterior use.
   2. Paneling: 1/4 IN minimum for interior use.

B. Nonshrink Grout: See Section 03 31 30.

C. Epoxy Bonding Adhesive:
   1. See Specification Section 03 31 30.
   2. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide and maintain temporary partitions as required in public areas.
   1. Construct partitions of braced plywood in exterior areas.
   2. Adequately braced paneling may be used in interior areas.

B. Provide and maintain covered passageways where necessary to ensure safe passage of persons in or near areas of work.

C. Provide and maintain substantial barricades and safety lights as required.

D. Provide and maintain temporary dustproof partitions where indicated or necessary.
   1. Prevent infiltration of dust into occupied areas.

E. Provide and maintain temporary weather protection as necessary.

F. Provide adequate temporary bracing to maintain safety, stability and to resist all loads to which the structure may be subjected.

3.2 DEMOLITION

A. Cutting and Removal:
   1. Remove existing work indicated to be removed, or as necessary for installation of new work.
   2. Neatly cut and remove materials, and prepare all openings to receive new work.
   3. Remove masonry or concrete in small sections.

B. Modification of Existing Concrete:
   1. Where indicated, remove existing concrete and finish remaining surfaces:
      a. Make openings by sawing through the existing concrete.
         1) Core drill with 6 IN DIA core at the corners of rectangular openings to avoid overcutting at corners.
      b. Break out concrete after initial saw cuts in the event concrete thickness prevents cutting through.
      c. Where saw cutting is not possible, make openings by drilling holes around perimeter of opening and then chipping out the concrete.
         1) Holes shall be sufficient in number to prevent damage to remaining concrete.
   2. Oversize required openings in existing concrete 1 IN on all sides and build back to required opening size by means of nonshrink grout epoxy bonded to the existing concrete.
   3. Where oversized openings cannot be made, remove the concrete to the required opening size and cut back exposed reinforcing 1 IN from face of concrete and fill resulting holes with nonshrink grout.
   4. Protect remaining concrete from damage.
      a. If existing concrete to remain becomes damaged, cease demolition and make corrections as required to avoid further damage.
      b. Notify Engineer immediately of any damage to remaining concrete.

C. Removal of Existing Anchor Bolts or Other Protruding Elements:
   1. Remove all protruding elements.
   2. Remove to a depth of 1/4 IN from finished surface.
   3. Fill void with epoxy patch.

D. Matching and Patching:
   1. Walls, ceilings, floors or partitions:
      a. Repair abutting walls, ceilings, floors or partitions disturbed by removal.
      b. Match and patch existing construction disturbed during installation of new work.
   2. Methods and materials:
      a. Similar in appearance, and equal in quality to adjacent areas for areas or surfaces being repaired.
      b. Subject to review of Engineer.
   3. Reinforcing steel that is cut and exposed:
      a. Remove to a depth of 1 IN.
      b. Fill void with epoxy patch.

3.3 SALVAGE

A. Salvaged Items:
   1. Prime all bare metal in accordance with Specification Section 09 96 00.
   2. Dispose of items or materials not designated for Engineer's or Utility's salvage or reuse.
      a. Promptly remove from site.
   3. Do not store or sell Contractor salvaged items or materials on-site.
   4. Carefully remove items to be salvaged and reused or to be delivered to Engineer or Utility's storage.
      a. Store and protect items indicated on Drawings or those which have been marked by Engineer to be salvaged or to be reused in Work.
      b. Replace any item damaged through carelessness in removal, storage, or handling with new items of same type.
      c. Do not reuse materials or equipment not specifically indicated or specified to be reused.
   5. Preparation of equipment for storage:
      a. Identify each component with markings or tags to show its position in the assembly and the assembly of which it belongs.
      b. Place small parts of wooden boxes and clearly mark contents on the outside.
      c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
      d. Grease grease-lubricated bearings.
      e. Replace any breather plug with solid plug.
      f. Megger test motor windings: Attach report of the test results to the unit and furnish one (1) copy to the Engineer.
      g. Attach unit to suitable crate bottom.
      h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.
      i. Construct crate of wooden slats around top and sides of unit.
      j. Attach permanent instruction tag to outside of crate stating "This unit has been prepared for storage--replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up."

B. See Drawings for items to be salvaged.

END OF SECTION

SECTION 01 74 13 - FINAL CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Description. This work shall be according to Section 104.06 of the Standard Specifications with the addition of the following.

1.2 MATERIALS

A. Cleaning Agents:
   1. Compatible with surface being cleaned.
   2. New and uncontaminated.
   3. For Manufactured Surfaces: Material recommended by manufacturer.

B. Section Includes:
   1. Intermediate and final cleaning of Work not including special cleaning of closed systems specified elsewhere.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.4 STORAGE AND HANDLING

A. Store cleaning products and cleaning wastes in containers specifically designed for those materials.

1.5 SCHEDULING

A. Schedule cleaning operations so that dust and other contaminants disturbed by cleaning process will not fall on newly painted surfaces.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 CLEANING - GENERAL

A. Final Cleaning:
   1. Complete immediately prior to Final Acceptance of the entire project.
   2. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed surfaces.
   3. Wipe all lighting fixture reflectors, lenses, lamps and trims clean.
   4. Wash and shine glazing.
   5. Polish glossy surfaces to a clear shine.

6. Ventilating systems:
   a. Clean permanent filters and replace disposable filters if units were operated during construction.
   b. Clean ducts, blowers and coils if units were operated without filters during construction.
7. Replace all burned out lamps.
8. Broom clean process area floors.
9. Mop electrical room floors.

END OF SECTION

SECTION 01 75 00 - FACILITY START-UP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Procedures and actions, required of the Contractor, which are necessary to achieve and demonstrate Substantial Completion.
   2. Requirements for Substantial Completion Submittals.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 DEFINITIONS

A. Project Classified System (PCS): A defined part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, wiring, materials, or incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system.

B. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:
   1. Finishing type construction work to ensure the Project has reached a state of Substantial Completion.
   2. Equipment start-up.
   3. Personnel training.

C. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the facility and starts up and operates the facility, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the facility as evidence of Substantial Completion.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Submit in the chronological order listed below prior to the completion of the Pre-Demonstration Period.
   1. Master operation and maintenance training schedule:
      a. Submit 30 days (minimum) prior to first training session for Engineer.

b. Schedule to include:
   1) Target date and time for Engineer witnessing of each system initial start-up.
   2) Target date and time for Operation and Maintenance training for each system, both field and classroom.
   3) Target date for initiation of Demonstration Period.
c. Submit for review and approval by Engineer.
d. Include holidays observed by Engineer.
e. Attend a schedule planning and coordination meeting 90 calendar days prior to first anticipated training session.
   1) Provide a status report and schedule-to-complete for requirements prerequisite to manufacturer's training.
   2) Identify initial target dates for individual manufacturer's training sessions.
f. Engineer reserves the right to insist on a minimum seven (7) days' notice of rescheduled training session not conducted on master schedule target date for any reason.
g. Schedule to be resubmitted until approved.

1.5 COST OF START-UP

A. Contractor to pay all costs associated with Facility Start-Up.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL

A. Facility Start-up Divided into Two Periods:
   1. Pre-Demonstration Period including:
      a. Completion of construction work to bring Project to a state of Substantial Completion.
      b. Start-up of Equipment.
      c. Training of Personnel.
      d. Completion of the filing of all required submittals.
      e. Filing of Contractor's Notice of Substantial Completion and Request for Inspection.
   2. Demonstration Period including:
      a. Demonstration of functional integrity of Facility.

3.2 PRE-DEMONSTRATION PERIOD

A. Completion of Construction Work:
   1. Complete the work to bring the Project to a state of substantial completion.

B. Equipment Start-up:
   1. Requirements for individual items of equipment are included in the Technical Specification Sections.

2. Prepare the equipment so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
3. Perform Equipment Start-up without introducing process flow.
4. Introduce product flow to complete Equipment Start-up for the following equipment:
    a. Mechanical Screens.
    b. Low Flow Pumps.
    c. Main Pumps.
    d. Bridge Crane.
5. Procedures include but are not necessarily limited to the following:
    a. Test or check and correct deficiencies of:
        1) Power, control, and monitoring circuits for continuity prior to connection to power source.
        2) Voltage of all circuits.
        3) Phase sequence.
        4) Cleanliness of connecting piping systems.
        5) Alignment of connected machinery.
        6) Vacuum and pressure of all closed systems.
        7) Lubrication.
        8) Valve orientation and position status for manual operating mode.
        9) Pumping equipment using screened storm water.
        10) Instrumentation and control signal generation, transmission, reception, and response.
            a) See Specification Section 40 90 00.
        11) Tagging and identification systems.
        12) All equipment: Proper connections, alignment, calibration and adjustment.
    b. Calibrate all safety equipment.
    c. Manually rotate or move moving parts to assure freedom of movement.
    d. "Bump" start electric motors to verify proper rotation.
    e. Perform other tests, checks, and activities required to make the equipment ready for Demonstration Period.
    f. Documentation:
        1) Prepare a log showing each equipment item subject to this paragraph and listing what is to be accomplished during Equipment Start-up.
        2) Provide a place for the Contractor to record date and person accomplishing required work.
        3) Submit completed document before requesting inspection for Substantial Completion certification.
6. Obtain certifications, without restrictions or qualifications, and deliver to Engineer:
    a. Manufacturer's equipment installation check letters (sometimes referred to as Manufacturer’s Field Services report).
    b. Instrumentation Supplier's Instrumentation Installation Certificate.

C. Personnel Training:
1. See individual equipment specification sections.
2. Conduct all personnel training after completion of Equipment Start-up for the equipment for which training is being conducted.
    a. Personnel training on individual equipment or systems will not be considered completed unless:

1) All pretraining deliverables are received and approved before commencement of training on the individual equipment or system.
2) No system malfunctions occur during training.
3) All provisions of field and classroom training specifications are met.

b. Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to Engineer.

3. Field and classroom training requirements:
   a. Hold classroom training on-site.
   b. Notify each manufacturer specified for on-site training that the Engineer reserves the right to video record any or all training sessions.
      1) Organize each training session in a format compatible with video recording.
   c. Training instructor qualification: Factory trained and familiar with giving both classroom and "hands-on" instructions.
   d. Training instructors:
      1) Be at classes on time.
      2) Session beginning and ending times to be coordinated with the Engineer and indicated on the master schedule.
      3) Normal time lengths for class periods can vary, but brief rest breaks should be scheduled and taken.
   e. Organize training sessions into maintenance verses operation topics and identify on schedule.
   f. Plan for minimum class attendance of 15 people at each session and provide sufficient classroom materials, samples, and handouts for those in attendance.
   g. Instructors to have a typed agenda and well prepared instructional material.
      1) The use of visual aids, e.g., films, pictures, and slides is recommended for use during the classroom training programs.
      2) Deliver agendas to the Engineer a minimum of seven (7) days prior to the classroom training.
      3) Provide equipment required for presentation of films, slides, and other visual aids.
   h. In the on-site training sessions, cover the information required in the Operation and Maintenance Manuals submitted according to Specification Section 01 33 04 and the following areas as applicable to PCS's.
      1) Operation of equipment.
      2) Lubrication of equipment.
      3) Maintenance and repair of equipment.
      4) Troubleshooting of equipment.
      5) Preventive maintenance procedures.
      6) Adjustments to equipment.
      7) Inventory of spare parts.
      8) Optimizing equipment performance.
      9) Capabilities.
      10) Operational safety.
      11) Emergency situation response.
      12) Takedown procedures (disassembly and assembly).
   i. Address above Paragraphs 1), 2), 8), 9), 10), and 11) in the operation sessions. Address above Paragraphs 3), 4), 5), 6), 7), and 12) in the

maintenance sessions.

j. Maintain a log of classroom training provided including: Instructors, topics, dates, time, and attendance.

D. Complete the filing of all required submittals:
   1. Shop Drawings.
   2. Operation and Maintenance Manuals.
   3. Training material.

END OF SECTION

DIVISION 02
EXISTING CONDITIONS

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SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Demolition, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, DEMOLITION OF EXISTING PUMP STATION.

1.3 QUALITY ASSURANCE

A. Design, engineering, and construction of shoring, bracing and supports are responsibility of the Contractor.
   1. Contractor shall employ a Registered Engineer, licensed to practice structural engineering in the State of Illinois.
   2. Design to support dead, live, and lateral, wind or seismic loads required by code or otherwise indicated, along with construction loads during demolition until permanent construction is in place.

1.4 DESCRIPTION

A. Work Includes:
   1. Demolition of designated structures.
   2. Demolition of portions of structures indicated.
   3. Removal of demolition debris.
   4. Protection of construction to remain, including:
      a. Utilities.
      b. Existing pump station wet well structure.
      c. Other items indicated.
   5. Refer to Section 01 73 29 and the Drawings for equipment to be salvaged.

B. Condition of Existing Structures to be Demolished:
   1. The Department assumes no responsibility for the actual condition of structures to be demolished.
   2. The Department will maintain existing building conditions at time of the pre-construction inspection for bidding purposes.
   3. The Engineer will perform a pre-construction inspection of the existing pump station to record the condition prior to the start of construction. Any damage to the existing pump station by the Contractor outside of the demolition limits shall be repaired or replaced at no additional cost to the Contract.

1.5 JOB CONDITIONS

A. Perform preliminary investigations to ascertain extent of work.
   1. Conditions apparent by investigation shall not be allowed as claim for extra cost.
B. Obtain approval of authorities having jurisdiction for work affecting existing means of egress.
   1. Review with and obtain approval of authorities for means of egress to be used during temporary construction which affects such areas.
   2. Obtain approval of fire authorities.
C. Separate, store and dispose of hazardous materials and toxic wastes in accordance with local and EPA regulations and criteria listed below:
   1. Disposal of fluorescent light tubes in open containers is not permitted.
   2. Disposal of ballasts and other building elements containing PCBs in open containers is not permitted.
   3. Disposal of building elements containing mercury in open containers is not permitted.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL DEMOLITION PROCEDURES

A. Demolition of Structures:
   1. Demolish completely and remove from site.
   2. Coordinate with Engineer and utility suppliers for shut-off of utilities serving each building.
   3. Disconnect and seal utilities before commencement of demolition.
B. Structural Demolition:
   1. Demolish concrete and masonry in small sections.
   2. Perform removal to avoid excessive loads on supporting walls, floors or framing.
C. Existing Utilities to Remain.
   1. Keep in service and protect against damage during demolition.
   2. Do not interrupt existing utilities serving occupied or facilities in use, except as authorized by Engineer.
   3. Provide temporary services during interruptions to existing utilities, as acceptable to Engineer.
D. Provide barricades and safety lights as required.

3.2 PROTECTION OF FACILITIES TO REMAIN

A. Protect Property to Remain:
   1. Conduct operations to prevent damage by falling debris or other cause to structures and other facilities as well as persons.
   2. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures.

3.3 ITEMS SALVAGED FOR THE DEPARTMENT AND UTILITIES

A. Refer to Section 01 73 29 and the Drawings for items to be salvaged.

3.4 ITEMS SALVAGED FOR CONTRACTOR

A. Items of salvage value to Contractor may be removed from structure as work progresses.

B. Salvage of equipment shall be performed at no additional cost to the Contract.

C. Transport salvaged items from site as they are removed.

D. Storage or sale of removed items is not permitted on site.

3.5 CLEAN-UP AND DISPOSAL OF DEMOLITION MATERIALS

A. Remove debris, rubbish, and materials resulting from demolition operations.
   1. Remove and legally dispose of off-site.
   2. Do not burn materials on site.

B. Dispose of items and materials not designated for Engineer salvage or reuse.
   1. Promptly remove from site.
   2. Do not store or sell Contractor salvaged items or materials on site.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations.

END OF SECTION

DIVISION 03
CONCRETE

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SECTION 03 15 19 - ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for all cast-in-place anchor bolts, anchor rods, reinforcing adhesive anchorage, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
   2. Design of all concrete anchors not indicated on the Drawings including, but not limited to, installation of anchors into concrete for the following structural and nonstructural components:
      a. Structural members and accessories.
      b. Metal, wood, and plastic fabrications.
      c. Architectural components.
      d. Mechanical and electrical equipment and components.
      e. Plumbing, piping, and HVAC work.
      f. All other components requiring attachment to concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 09 96 00 - High Performance Industrial Coatings.
   3. Section 40 05 07 - Pipe Support Systems.

1.2 BASIS OF PAYMENT

A. The work specified herein will not be paid separately, but shall be considered as included in the unit price for the item(s) being anchored to concrete, and no additional compensation will be allowed.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
      a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
   3. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
   4. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
i. F436, Standard Specification for Hardened Steel Washers.
j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
k. F594, Standard Specification for Stainless Steel Nuts.
l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. ICC Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   c. ESR-1917, Hilti Kwik Bolt TZ Carbon and Stainless Steel Anshors in Cracked and Uncracked Concrete.
   d. ESR-2322, Hilti HIT-RE 500-SD Adhesive Anchors in Concrete.
   e. ESR-3027, Hilti Kwik HUS-EZ (KH-EZ) and Kwik HUS-EZ 1 (KH-EZ 1) Carbon Steel Screw Anchors for Use in Cracked and Uncracked Concrete.
   f. ESR-3814, Hilti HIT-RE500 V3 Adhesive Anchors and Post-Installed Reinforcing Bar Connections in Cracked and Uncracked Concrete.
6. Building Code:
   a. International Code Council (ICC):
      1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Anchor designer for Contractor-designed post-installed anchors shall be a Professional Structural Engineer licensed in the State of Illinois.
   2. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
   3. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Post-installed anchors and related materials shall be listed by the following agencies:
   1. ICC-ES.
   2. Engineer approved equivalent.

1.4 DEFINITIONS

A. Adhesive Anchors:
   1. Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
   2. Includes anchors using acrylics, epoxy and other similar adhesives.

B. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.

C. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.

D. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.

E. Galvanizing: Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

F. Hardware: As defined in ASTM A153.

G. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

H. MPII: Manufacturer's printed installation instructions.

I. Mechanical Anchors:
   1. Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
   2. Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
   3. Drop-in anchors and other similar anchors are not allowed.

J. Post-Installed Anchor: Any adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cast-in-place Concrete Anchors:
   1. Building, nonbuilding structures, and equipment:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. All other cast-in-place concrete anchors:
      a. Stainless steel with matching nut and washer.
      b. Submerged application: ASTM F593, Type 316.
      c. Non-submerged application: ASTM F593, Type 304 or Type 316.

B. Post-Installed Mechanical and Adhesive Concrete Anchors:
   1. Stainless steel with matching nut and washer.
   2. Submerged application: ASTM F593, Type 316.
   3. Non-submerged application: ASTM F593, Type 304 or Type 316.

C. Reinforcement: In accordance with Standard Specifications for Road and Bridge Construction, Section 508.

D. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.
   1. Provide stainless steel headed studs where indicated on Drawings.

E. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 psi and a

minimum tensile strength of 80,000 psi.

F. Washers:
   1. ASTM F436 unless noted otherwise.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, furnish washers of the same material and alloy as in the accompanying anchorage.
   3. Plate washers: Minimum 1/2 IN thick fabricated ASTM A36 square plates as required.
   4. Follow manufacturer's requirements for all post-installed anchorage.

G. Nuts:
   1. ASTM A563 for all cast-in-place anchorage.
   2. If stainless steel anchorage is being used for cast-in-place anchorage, nuts shall meet ASTM F594 and be the matching material and alloy as in the accompanying anchorage.
   3. Follow manufacturer's requirements if using post-installed anchorage.

H. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 percent in dry film.
   4. ZRC "ZRC Cold Galvanizing" or Clearco "High Performance Zinc Spray."

I. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.2 CONTRACTOR DESIGNED ANCHORAGE

A. Acceptable Manufacturers:
   1. Post-installed anchor systems for the listed manufacturers will be considered only if a current ICC-ES evaluation report is submitted and if the anchor system is approved by the Engineer.
      a. Hilti.
      b. Powers Fasteners.
      c. Simpson Strong-Tie.
   2. Submit the following:
      a. Current ICC-ES report for each post-installed anchor system indicating the following:
         1) Certification that anchors meet all requirements indicated in this Specification.
         2) Performance data showing that anchor is approved for use in cracked concrete.
         3) Seismic design categories for which anchor system has been approved.
         4) Required installation procedures.
         5) Inspection requirements for installation.
      b. Anchorage layout drawings and details:
         1) Indicate anchor diameter, embedment, length, anchor type, material and finish.
         2) Drawings showing location, configuration, spacing and edge distance.
      c. Contractor Designed Post-Installed Anchors:
         1) Show diameter and embedment depth of each anchor.

2) Indicate compliance with ACI 318.
3) Design tension and shear loads used for anchor design.
4) Engineering design calculations:
   a) Indicate design load to each anchor.
   b) When the design load is not indicated on Drawings, include calculations to develop anchor forces based on Design Criteria listed herein.
   c) Sealed and signed by Contractor's Professional Structural Engineer
   d) Calculations will be submitted for information purposes only.
5) Type of post-installed anchor system used.
   a) Provide manufacturer's ICC-ES report for the following:
      (1) Mechanical anchorage per ICC-ES AC193.
      (2) Adhesive anchorage per ICC-ES AC308.

B. Contractor shall design the anchorage when any of the following occur:
   1. Design load for concrete anchorage is shown on the Drawings.
   2. When specifically required by the Contract Documents.
   3. When an anchorage is required but not specified in the Drawings.
   4. When anchorage is shown on Drawings other than Structural Drawings.

C. Anchorage Design Loads:
   1. Determine all of the design loads, including wind and seismic loads, per the Building Code.
      a. Anchorage of equipment and non-structural components: Use the actual dead and operating loads provided by the manufacturer.

D. When Contract Drawings, other than the Structural Drawings, indicate an anchor diameter or length, the Contractor design shall incorporate these as "minimums."

E. Cast-in-Place Concrete Anchors:
   1. Provide the material, nominal diameter, embedment length, spacing, edge distance and design capacity to resist the calculated load based on the requirements given in the Building Code including ACI 318, Appendix D.
   2. Design assuming cracked concrete.

F. Post-installed Concrete Anchors:
   1. Provide the manufacturer's system name/type, nominal diameter, embedment depth, spacing, minimum edge distance, cover, and design capacity to resist the specified or calculated load based on requirements given in the Building Code, ACI 318, Appendix D and current ICC-ES report, for the anchor to be used.

2.3 ENGINEER DESIGNED ANCHORAGE

A. When the size, length and details of anchorages are shown on Contract Structural Drawings, Contractor design of anchorage is not required unless otherwise indicated.

B. Acceptable Manufacturers:
   1. Additional newer post-installed anchor systems for the listed manufacturers will be considered only if a current evaluation agency report is submitted in accordance with the SUBMITTALS Article in PART 1 of this Specification Section, the anchor system is certified by ICC-ES for cracked concrete conditions, and if approved by

the Engineer.

2. Mechanical Anchors:
   a. Hilti:
      1) Kwik Bolt TZ (ICC-ES ESR-1917).
3. Adhesive Concrete Anchors:
   a. Hilti:
      1) HIT RE 500-SD (ICC-ES ESR-2322).
      2) HIT RE 500 V3 (ICC ESR-3814).
4. Screw Concrete Anchors:
   a. Hilti: Kwik HUS-EZ Screw (ICC-ES ESR-3027).
5. Submit request for substitution to Engineer for approval.
   a. Substitution request to indicate the proposed anchor has the at least the same tension and shear strength as the specified anchor installed as indicated in the Contract Drawings.
   b. Calculations to be stamped by a Professional Engineer registered in the state that the Project is located in.

PART 3 - EXECUTION

3.1 GENERAL

A. Cast-in-Place Anchorage:
   1. Use where anchor rods or bolts are indicated on the Drawings, unless another anchor type is approved by the Engineer.
   2. Provide concrete anchorage as shown on the Drawings or as required to secure components to concrete.

B. Adhesive Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. May be used where subjected to vibration or where buried or submerged.
   3. Do not use in overhead applications or sustained tension loading conditions such as utility hangers.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturers printed installation requirements.

C. Mechanical Anchorage:
   1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
   2. Do not use where subjected to vibration.
   3. May be used in overhead applications.
   4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturers printed installation requirements.

D. Do not use powder actuated fasteners and other types of bolts and fasteners not specified herein for structural applications unless approved by the Engineer or specified in Contract Documents.

3.2 PREPARATION

A. Provide adequate time to allow for proper installation and inspection prior to placing concrete for cast-in-place concrete anchorage.
B. Prior to installation, inspect and verify areas and conditions under which concrete anchorage is to be installed.
   1. Notify Engineer of conditions detrimental to proper and timely completion of work.
   2. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.
C. Special Inspection is required in accordance with the Building Code for all concrete anchorage.
   1. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
   2. See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section for additional requirements.
D. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors at no additional cost.
   1. Follow such procedures to assure acceptable installation.

3.3 INSTALLATION

A. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
   1. Tack welding of anchorage is prohibited.
   2. Coat the projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
   3. Anchorage location tolerance shall be in accordance with AISC 303.
   4. Provide steel or durable wood templates for all column and equipment anchorage.
      a. Templates to be placed above top of concrete and not impede proper concrete placement and consolidation.
B. Unless noted or specified otherwise:
   1. Connect aluminum and steel members to concrete and masonry using stainless steel cast-in-place anchorage unless shown otherwise.
      a. Provide dissimilar materials protection per Specification Section 09 96 00.
   2. Provide washers for all anchorage.
   3. Where exposed, extend threaded anchorage a maximum of 3/4 IN and a minimum of 1/2 IN above the top of the fully engaged nut.
      a. If anchorage is cut off to the required maximum height, threads must be dressed to allow nuts to be removed without damage to the nuts.
C. Do the following after nuts are snug-tightened down:
   1. If using post-installed anchorage, follow MPII.
   2. Upset threads of anchorage to prevent nuts from backing off.
      a. Provide double nut or lock nut in lieu of upset threads for items that may require removal in the future.
   3. For all other cast-in-place anchorage material, tighten nuts down an additional 1/8 turn to prevent nuts from backing off.
   4. If two (2) nuts are used per concrete anchor above the base plate, tighten the top

nut an additional 1/8 turn to "lock" the two (2) nuts together.

5. If using post-installed anchorage, follow manufacturer's installation procedures.

D. Assure that embedded items are protected from damage and are not filled in with concrete.

E. Secure architectural components such that it will not be aesthetically distorted nor fasteners overstressed from expansion, contraction or installation.

F. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

G. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions and ASTM A780.

H. For post-installed anchors, comply with the MPII on the hole diameter and depth required to fully develop the tensile strength of the anchor or reinforcing bar.
   1. Use hammer drills to create holes.
   2. Properly clean out the hole per the ICC-ES reports utilizing a non-metallic fiber bristle brush and compressed air or as otherwise required to remove all loose material from the hole prior to installing the anchor in the presence of the Special Inspector.

3.4 FIELD QUALITY CONTROL

A. Anchor to Concrete Inspections to be performed by the Engineer:
   1. Post installed anchors as required by the Building Code, ICC-ES Evaluation Reports, and as specified by the Engineer.
      a. Frequency: Per ICC-ES Report.
   2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
      a. Frequency: Prior to each concrete pour.

3.5 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

END OF SECTION

SECTION 03 31 30 - CONCRETE, MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete materials, strengths and proportioning for concrete work at the following structures:
      a. Proposed pump station work below the precast roof.
      b. Grit chamber (formally existing pump station) work.
   2. Grouting:
      a. Base plates for columns and equipment.
      b. As specified and indicated in the Contract Document.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 15 19 - Anchorage to Concrete.
   3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 METHOD OF MEASUREMENT

A. The work specified herein will be measured for payment in Cubic Yards (CU YD) in place. The volume measured for payment will be limited to the dimensions agreed upon with the Engineer before construction.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract unit price per CU YD for CONCRETE STRUCTURES (SPECIAL), which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. Supplementary Cementitious Materials (SCM): Fly ash, silica fume and ground granulated blast furnace slag.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers are acceptable:
   1. Non-shrink grout:
      a. BASF Corporation.
      b. Euclid Chemical Company.
      c. Five Star Products, Inc.
   2. Epoxy grout:
      a. BASF Corporation.

b. Five Star Products, Inc.
c. Euclid Chemical Company.
d. Sika Corporation.

B. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Cement:
1. ASTM C150, Type II.
2. Cement type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

B. SCM:
1. Fly Ash: In accordance with Standard Specifications for Road and Bridge Construction, Section 1010.
2. Cement and SCM type used shall correspond to that upon which selection of concrete proportions was based in the mix design.

C. Admixtures:
1. Air entraining: ASTM C260.
2. Water reducing, retarding, and accelerating: Conform to ASTM C494, Types A through E, and provisions of ACI 212.3R.
3. High range water reducers (superplasticizers): Conform to ASTM C494, Types F or G.
4. All concrete mixes require the use of water reducers to maintain the specified water-to-cement ratios without additional cement.
5. SCM: Per above.
6. Admixtures to be chloride free.
   a. Do not use calcium chloride.
7. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in the mix design.
8. Provide admixtures certified by manufacturer to be compatible with other admixtures.

D. Water:

1. Potable.
2. Clean and free from deleterious substances.
3. Free of oils, acids and organic matter.

E. Aggregates for Normal Weight Concrete:
   1. Fine and coarse aggregates to be regarded as separate ingredients.
   2. Provide aggregates approved for bridge construction by the Illinois Department of Transportation.
   3. Coarse aggregate:
      a. In accordance with Standard Specifications for Road and Bridge Construction, Section 1004.
      b. Coarse aggregate sieve analysis:
         1) Per Table 1 in the PART 2 MIXES Article.
   4. Fine aggregate: In accordance with Standard Specifications for Road and Bridge Construction, Section 1003.

F. Maximum total chloride ion content for concrete mix including all ingredients measured as a weight percent of cement in accordance with ASTM C1218: 0.10.

G. Sand Cement Grout (referred to as "Grout" on the Drawings):
   1. Approximately three (3) parts sand, one (1) part Portland cement, 6 $\pm$1 percent entrained air and water to produce a slump which allows grout to completely fill required areas and surround adjacent reinforcing.
      a. Provide sand in accordance with requirements for fine aggregate for concrete.
   2. Minimum 28 day compressive strength:
      a. 3000 psi.
      b. Shall be at least strength of parent concrete when used at construction joints.

H. Nonshrink Grout:
   1. Nonshrink, nonmetallic, noncorrosive, and nonstaining.
      a. Conform to ASTM C1107.
   2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
   3. Grout to produce a positive but controlled expansion.
      a. Mass expansion shall not be created by gas liberation or by other means.
   4. Minimum 28 day compressive strength: 7,000 psi.
   5. Acceptable manufacturers:
      a. BASF Admixtures, Inc. "Masterflow, 713".
      b. Euclid Chemical "NS Grout".
      c. Sika Corporation "Sika Grout 212".
      d. Sauereisen, Inc. "F-100 Level Fill Grout".

I. Epoxy Grout:
   1. Three-component epoxy resin system:
      a. Two (2) liquid epoxy components.
      b. One (1) inert aggregate filler component.
   2. Adhesive acceptable manufacturers:
      a. BASF “Masterflow 648”.
      b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
      c. Euclid Chemical "E3-G."
      d. Sika "Sikadur Hi-Mod."

3. Aggregate acceptable manufacturers:
   a. BASF “Masterflow 648”.
   b. Five Start Products, Inc. "DP Five Start Epoxy Grout."
   c. Euclid Chemical "Euclid aggregate."
   d. Sika aggregate.
4. Aggregate manufacturer shall be the same as the adhesive manufacturer.
5. The aggregate shall be compatible with the adhesive.
6. Each component furnished in separate package for mixing at jobsite.

J. See Specification Section 03 31 31 for Grout Schedule of use.

2.3 MIXES

A. General:
   1. Provide concrete capable of being placed without aggregate segregation and, when cured, of developing all properties specified.
   2. Ready-mixed concrete shall conform to ASTM C94/C94M.
   3. All concrete to be normal weight concrete, weighing approximately 145 to 150 LBS per cubic foot at 28 days after placement.

B. Concrete Mixes: Refer to Table 1 below.

C. Air Entrainment:
   1. Provide air entrainment in concrete resulting in a total air content percent by volume per Table 1 below.
      a. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures.

D. Slump:
   1. Measure slump at point of discharge into concrete members.
   2. Walls and columns:
      a. 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
      b. Slump shall be obtained by use of mid-range or high-range water reducer conforming to ASTM C494.
   3. All other members:
      a. Concrete using a water reducer per ASTM C494: 8 IN maximum, 4 IN minimum measured at the point of discharge into the concrete member.
      b. Concrete without a water reducer per ASTM C494: 5 IN maximum, 1 IN minimum measured at point of discharge into the concrete member.
   4. Concrete of lower than minimum slump may be used provided it can be properly placed and consolidated.
   5. Provide additional water or water reducing admixture at ready mix plant for concrete that is to be pumped to allow for slump loss due to pumping.
      a. Provide only enough additional water so that slump of concrete at discharge end of pump hose does not exceed maximum slump specified and the maximum specified water-cement ration is not exceeded.
   6. Slump may be adjusted in the field through the use of water reducers.
      a. Coordinate dosage and mixing requirements with concrete supplier.
   7. Slump tolerances shall comply with the requirements of ACI 117.

E. Proportioning:
   1. General:
      a. Proportion ingredients to produce a mixture which will work readily into corners and angles of forms and around reinforcement by methods of placement and consolidation employed without permitting materials to segregate or excessive free water to collect on surface.
      b. Proportion ingredients to produce proper placability, durability, strength and other required properties.
   2. Normal weight concrete target cementitious materials contents and maximum water cementitious ratios per Table 1 below.
      a. Cement is intended to provide a crack free, durable finished product, not one with excessive strength.
   3. SCM:
      a. Fly ash:
         1) For cast-in-place concrete only, a maximum of 25 percent by weight of Portland cement content per cubic yard may be replaced with fly ash at a rate of 1 LB fly ash for 1 LB cement.
         2) If fly ash is used, the water to fly ash plus cement ratio not to exceed the maximum water cement ratio specified in this Specification Section.
   4. Water reducing, retarding, and accelerating admixtures:
      a. Use in accordance with manufacturer's instructions.
      b. Add to mix at batching plant.
      c. Use water-reducing or high-range water reducing admixture in concrete, as required, for placement and workability.
         1) Water reducers are required to maintain specified maximum water to cement ratios.
   5. High range water reducers (superplasticizers):
      a. Use required for:
         1) All concrete to be pumped except slabs on grade.
         2) All concrete for walls and columns.
         3) Other concrete members at Contractor's option.
      b. Maximum concrete slump before addition of admixture to be 3 IN maximum slump after addition to be 8 IN.
      c. Reference Specification Section 03 31 31 for additional requirements.
   6. Concrete mix proportioning methods for normal weight concrete:
      a. In accordance with Standard Specifications for Road and Bridge Construction, Section 1020.

F. Allowable Shrinkage:
   1. Per Table 1 when tested in accordance with ASTM C157 at 28 Days.
   2. Continue testing to 64 weeks for informational purposes.

TABLE 1

TYPE OF CONCRETE	28 DAY COMPRESSIVE STRENGTH	W/C RATIO	TARGET TOTAL CEMENT	SCM	ASTM C33 Maximum Aggregate Size	AIR CONTENT	ALLOWABLE SHRINKAGE LIMIT
Normal weight concrete w/ power trowel finish	4500 psi	0.42	564	Note 1	1 IN	0 to 2	0.042

Normal weight concrete	4500 psi	0.42	564	Note 1	1 IN	4-1/2 to 7-1/2	0.042

Table 1 Notes:

1. If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to meet total target cement requirement.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Inspections: By Engineer in accordance with IDOT Construction Manual and IDOT standard procedures.

END OF SECTION

SECTION 03 31 31 - CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 31 30 - Concrete, Materials and Proportioning.
   3. Section 07 92 00 - Joint Sealants.

1.2 METHOD OF MEASUREMENT

A. The work specified herein will be measured for payment in Cubic Yards (CU YD) in place. The volume measured for payment will be limited to the dimensions agreed upon with the Engineer before construction.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract unit price per CUYD for CONCRETE STRUCTURES (SPECIAL), which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction, and at no additional cost.

1.5 DEFINITIONS

A. Words and terms used in this Specification Section are defined in ACI CT-13.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.

B. Waterstops, PVC Type:
   1. Acceptable manufacturers:
      a. Greenstreak Plastic Products.
      b. W.R Meadows.
      c. Vinylex Corporation.
      d. Bometals, Inc.

2. Materials:
   a. Virgin polyvinyl chloride compound not containing any scrap or reclaimed materials or pigment.
   b. Cast-in-place type: COE CRD-572.
3. Approved profiles as listed.
   a. Construction joints:
      1) Ribbed: 6 IN wide by 3/8 IN.
      2) Greenstreak Plastic Products Style #679, or equal.
4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum 6 IN from the intersection.
5. Factory prepunched (12 IN centers, each edge) for wire supports.
   a. Provide hog rings or grommets at maximum 12 IN OC along the length of the waterstop at Contractor's option.
6. See Drawings for application and other requirements.

C. Waterstops, Preformed Strip Type:
1. Acceptable manufacturers:
   a. Greenstreak Plastics, Inc. (Hydrotite).
   b. Adeka Ultra Seal USA (MC-2010MN).
   c. DeNeef (Swellseal Plus).
2. Hydrophilic, nonbentonite composition.
3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
4. Volumetric expansion limited to 3 times maximum.
5. See Drawings for application and other requirements.

D. Water Swelling Sealant:
1. Compatible with strip-type waterstop.
2. Single component, gun applied.
3. Moisture cured.
4. Minimum 70 percent volumetric expansion swelling capability.

E. Curing products to conform to Standard Specifications for Road and Bridge Construction, Section 1020.13, except as modified herein.

F. Sand cement grout, non-shrink grout and epoxy grout: See Specification Section 03 31 30.

PART 3 - EXECUTION

3.1 CONCRETE MIXING

A. General:
1. Provide all concrete from a central plant conforming to Checklist for Certification of Ready Mixed Concrete Production Facilities of the NRMCA.
2. Batch, mix, and transport in accordance with ASTM C94/C94M.

B. Control of Admixtures:
1. Control at the batch plant:
   a. All admixtures to be introduced at the batch plant in accordance with manufacturer's recommendations.

b. Charge admixtures into mixer as solutions.
   1) Measure by means of an approved mechanical dispensing device.
   2) Liquid considered a part of mixing water.
   3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
d. Complete addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

2. Control of Admixtures in the field:
   a. Additional quantities of admixtures (with the exception of retarders) may be added in the field provided:
      1) Addition of admixtures shall be under the supervision of the ready mix quality control representative.
      2) Addition of each admixture to be documented on the delivery ticket.
      3) Provide additional mixing per ASTM C94.

C. Tempering and Control of Mixing Water:
   1. Mix concrete only in quantities for immediate use.
   2. Discard concrete which has set.
   3. Discharge concrete from ready mix trucks within time limit and drum revolutions stated in ASTM C94/C94M.
   4. Addition of water at the jobsite:
      a. See Specification Section 03 31 30 for specified water cement ratio and slump.
      b. Do not exceed maximum specified water cement ratio or slump.
      c. Incorporate water by additional mixing equal to at least half of total mixing required.

3.2 PLACING OF CONCRETE

A. General:
   1. Place concrete as such a rate that concrete, which is being integrated with fresh concrete, is still workable.
      a. Select placement equipment and manpower in order to assure timely delivery of concrete into forms to avoid cold joints and placement issues.
   2. Comply with ACI 304R and ACI 304.2R.
   3. Do not begin placing concrete during rain, sleet, or show.
      a. Protect fresh concrete from ensuing inclement weather.
   4. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
   5. Begin work only when work of other trades affecting concrete is complete.
   6. Deposit concrete:
      a. Continuously to avoid cold joints.
   7. Locate construction joints at locations approved by Engineer.
      a. Plan size of crews with due regard for effects of concrete temperature and atmosphere conditions to avoid unplanned cold joints.
   8. Spreaders:

a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
b. Embedded:
   1) Obtain approval of Engineer.
   2) Materials: Concrete or metal.
   3) Ends of metal spreaders coated with plastic coating 2 IN from each end.

9. Deposit concrete as nearly as practicable in its final position to avoid segregation.
   a. Maximum free fall: 4 FT.
   b. Place concrete by means of hopper, elephant trunk or tremie pipe extending down to within 4 FT of surface placed upon.
10. Perform the following operations before bleeding water has an opportunity to collect on surface:
    a. Spread.
    b. Consolidate.
    c. Straightedge.
    d. Darby or bull float.
11. No water shall be added to the concrete surface to ease finishing operation.

B. Cold Weather Concrete Placement:
   1. Comply with ACI 306.1.
   2. Do not place concrete on subgrade that are below 32 DEGF or contain frozen material.
   3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
   4. Temperature of concrete when discharged at site: Per ACI 306.1.
   5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 DEGF, when temperature of surrounding air is 40 DEGF or below at time concrete is placed.
      a. Remove all frost from subgrade, forms and reinforcement before concrete is placed.
   6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 DEGF.
   7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 DEGF.
   8. Follow ACI 360R-10 for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

C. Hot Weather Concrete Placement:
   1. Comply with ACI 305.1.
   2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
   3. Temperature of concrete at point of delivery (i.e. truck discharge) when placed:
      a. Not to exceed 90 DEGF.
      b. Not so high as to cause:
         1) Shrinkage cracks.
         2) Difficulty in placement due to loss of slump.
         3) Flash set.

4. Temperature of forms and reinforcing when placing concrete:
   a. Not to exceed 90 DEGF.
   b. May be reduced by spraying with water to cool below 90 DEGF.
      1) Leave no standing water to contact concrete being placed.
5. Prevent plastic shrinkage cracking and/or slab curling due to evaporation.

D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
   a. Eliminate:
      1) Air or stone pockets.
      2) Honeycombing or pitting.
      3) Planes of weakness.
3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
   a. Size and coordinate external vibrators to specifically match forming system used.
4. Internal vibrators:
   a. Minimum frequency of 8000 vibrations per minute.
   b. Insert and withdraw at points approximately 18 IN apart.
      1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
   c. Use in:
      1) Beams and girders of framed slabs.
      2) Columns and walls.
      3) Vibrating concrete around all waterstops.
   d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other approved means.
6. Do not use vibrators to transport concrete within forms.
7. Provide spare vibrators on jobsite during all concrete placing operations.
8. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
9. Prevent construction equipment, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94/C94M.
2. Horizontal belt conveyors:
   a. Mount at a slope which will not cause segregation or loss of ingredients.
   b. Protect concrete against undue drying or rise in temperature.
   c. Use an arrangement at discharge end to prevent segregation.
   d. Do not allow mortar to adhere to return length of belt.
   e. Discharge conveyor runs into equipment specially designed for spreading

concrete.

3. Metal or metal lined chutes:
   a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
   b. Chutes more than 20 FT long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
   c. Provide end of each chute with a device to prevent segregation.
4. Pumping or pneumatic conveying equipment:
   a. Designed for concrete application and having adequate pumping capacity.
   b. Control pneumatic placement so segregation is avoided in discharged concrete.
   c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1-1/2 IN.
   d. Do not convey concrete through pipe made of aluminum or aluminum alloy.
   e. Provide pumping equipment without Y sections.

3.3 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:
   1. Locate joints as indicated on Contract Drawings or as shown on approved Shop Drawings.
      a. Where construction joint spacing shown on Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Specification Section.
   2. Unplanned construction joints will not be allowed.
      a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
   3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
   4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
      a. At Contractor's option, beam pockets may be formed into concrete walls.
      b. Size pockets to allow beam reinforcing to be placed as detailed on Drawings.
   5. Place beams, girders, column capitals and drop panels at same time as slabs.
   6. Place corbels monolithically with walls.
      a. Locate wall vertical construction joints midway between corbels.
      b. Where only a single corbel is located place it also monolithically with wall and locate wall vertical construction joint a minimum of 3 FT from face of corbel.
   7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
   8. Provide the following joints unless noted otherwise on Drawings:
      a. Roughen joints: horizontal construction joints.
      b. Keyed joints: vertical construction joints.
   9. Roughen construction joints:
      a. Clean the previously hardened concrete interface and remove all laitance.
      b. Intentionally roughen the interface to a full amplitude of 1/4 IN.
   10. Keyways:
      a. Construction joint keyways shall have the following dimensions, unless shown

otherwise on Drawings.

b. Wall keys:
   1) Keyway width, not less than 1/3 and not more than 1/2 the wall thickness measured perpendicular to wall faces.
   2) Keyway depth to be not less than 1-1/2 IN.
   3) Continuous along length of wall.
   4) Place keyway in wall center unless shown otherwise on Drawings.

c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
   1) Keyway height not less than 1/3 and not more than 1/2 the footing or slab thickness.
   2) Keyway depth not less than 1-1/2 IN.
   3) Continuous along footing or slab.
   4) Keyway in footing or slab center unless shown otherwise on Drawings.

d. Beam keyways:
   1) Full width of beam.
   2) Keyway height not less than 5-1/2 IN.
   3) Keyway depth not less than 1-1/2 IN.
   4) Keyway located in initial beam pour, directly above the bottom reinforcing, unless shown otherwise on Drawings.

11. Minimum time before placement of adjoining concrete construction:
    a. All other concrete: 72 HRS.

B. Construction Joints - Spacing Unless Otherwise Specified:
   1. Wall vertical construction joints:
      a. 30 FT maximum centers.
      b. At wall intersections, 10 FT minimum from corner.
   2. Wall horizontal construction joints: As shown on the Drawings.
   3. Floor slab cast on ground, construction joints:
      a. Placements to be approximately square and not to exceed 2000 SQ FT.
      b. Maximum side dimension of a slab pour to be less than:
         1) Twice the length of the short side. 2) 60 FT.
   4. Elevated slab construction joints:
      a. Placements to be approximately square and not to exceed 4000 SQ FT.
      b. Maximum side dimension of a slab pour to be less than:
         1) Twice the length of the short side. 2) 70 FT.

C. Construction Joints - Bonding:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
   2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as outlined below:
   3. Roughen construction joints:
      a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 1/4 IN minimum amplitude.
         1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface, or at the Contractor's option, use an approved chemical retarder which delays but does not prevent setting of the surface of the mortar in accordance with the manufacturer's recommendations.

a) Retarded mortar shall be removed within 24 HRS after placing to produce a clean exposed aggregate bonding surface.

b. Dampen the hardened concrete immediately prior to placing of fresh concrete or grout.
c. Cover the hardened concrete of horizontal joints with a coat of cement grout of similar proportions to the concrete, except substitute fine aggregate for coarse aggregate.
d. Place 2 IN layer of grout in bottoms of walls with waterstops. Grout shall be placed immediately before placing concrete.
   1) Vibrate grout and first layer of concrete simultaneously.
e. Place fresh concrete before the grout has attained its initial set.

4. Keyed construction joints:
   a. Thoroughly clean construction joints and remove all laitance.
   b. Dampen the hardened concrete immediately prior to placing of fresh concrete.

D. Waterstops - General:
1. Waterstop to be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
2. Do not mix different types of waterstop materials in the same structure without specific approval from the Engineer unless shown on Drawings.
3. Preformed strip type:
   a. Locate waterstop at center of wall, unless noted otherwise on Drawings.
      1) Maintain at least 3 IN from edge of concrete.
   b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
   c. Roughened joints shall be especially prepared during concrete placement to provide smooth surface for proper water stop installation.
   d. Use in joints against existing concrete where indicated on Drawings.
4. PVC waterstops:
   a. Position waterstop accurately in joints, with adequate clearance from all reinforcing.
   b. Secure waterstops in correct position using hog rings or grommets spaced 24 IN maximum staggered along each edge full length and passed through the edge of the waterstop.
      1) Tie wire to adjacent reinforcing.
   c. Hold horizontal waterstops in place with continuous supports.
   d. Install according to manufacturer's instructions.
      1) Do not displace reinforcement from required location.
   e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
      1) Use factory fabricated "T" and corner intersection fittings.
      2) Field splice straight runs of material.
   f. Unless otherwise noted, use for all construction joints in new construction for all structures indicated on Drawings.

E. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.

a. Give Contractor whose work is related or integral to concrete, or supported by it, ample notice and opportunity to furnish and install items before placing concrete.

2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

F. Placing Embedded Items:
1. Support against displacement.
2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
3. Provide adequate means for anchoring waterstop in concrete.
a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.4 FINISHING

A. In accordance with Standard Specifications for Road and Bridge Construction, Section 503.

B. Coordinate mixing and placing with finishing.

3.5 INSTALLATION OF GROUT

A. Grout Schedule of Use:
1. Sand cement grout:
a. Fill keyways if precast HCU.
2. Non-shrinking non-metallic grout:
a. Filling form tie holes.
b. Under column and beam base plates.
c. Other uses indicated on the Drawings.
3. Epoxy grout:
a. Patching cavities in concrete.
b. Grouting of dowels and anchor bolts into existing concrete.
c. Grouting of equipment base plates where driving motor is 500 HP and above.
d. Other uses indicated on the Drawings.

B. Grout Installation:
1. Sand cement grout:
a. Fill keyways between precast concrete hollow core slabs with sand cement grout.
b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
c. Cure grout by one of methods specified.
2. Non-shrink non-metallic grout:
a. Clean concrete surface to receive grout.
b. Saturate concrete with water for 24 HRS prior to grouting.
c. Mix in a mechanical mixer.
d. Use no more water than necessary to produce flowable grout.
e. Place in accordance with manufacturer's instructions.
f. Provide under beam, column, and equipment base plates, in joints between

precast concrete filter slabs, and in other locations indicated on the Drawings.

g. Completely fill all spaces and cavities below the top of base plates.
h. Provide forms where base plates and bed plates do not confine grout.
i. Where exposed to view, finish grout edges smooth.
j. Except where a slope is indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.

3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill all cavities and spaces around dowels and anchors without voids.
   d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as required to assure proper placement.

3.6 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   1. Follow recommendations of ACI 308.1 except as modified herein.
   2. All traffic shall be kept from the surface as necessary to protect the concrete but not less than the first 48 HRS of curing.

B. Method of Curing and Protection:
   1. In accordance with Standard Specifications for Road and Bridge Construction, Section 1020.12.

C. Cold Weather:
   1. In accordance with Standard Specifications for Road and Bridge Construction, Section 1020

D. Hot Weather:
   1. In accordance with Standard Specifications for Road and Bridge Construction, Section 1020

3.7 FIELD QUALITY CONTROL

A. Inspections:
   1. By Engineer in accordance with IDOT Construction Manual and IDOT standard procedures.
   2. Waterstops:
      a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
      b. Frequency:
         1) Prior to each concrete pour
      c. Testing PVC Waterstop Joints:

1) Samples of field fabricated waterstop butt joints may be selected at random by the Engineer for testing by a laboratory at the Engineer's expense.
   a) When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

END OF SECTION

SECTION 03 42 00 - PRECAST AND PRESTRESSED CONCRETE BUILDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Design and fabrication of all precast and prestressed concrete members including:
      a. Wall panels, insulated and uninsulated.
      b. Double-tee units.
      c. Hollow-core units.
      d. Columns and beams.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 15 19 - Anchorage to Concrete.
   3. Section 03 31 30 - Concrete, Materials and Proportioning.
   4. Section 04 01 20 - Masonry Cleaning.
   5. Section 07 92 00 - Joint Sealants.
   6. Section 09 96 00 - Painting and High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PRECAST PUMP STATION BUILDING.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      g. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      h. A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      i. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      j. C33, Standard Specification for Concrete Aggregates.

k. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
l. C138, Standard Test Method of Test for Density (Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
m. C143, Standard Test Method for Slump of Hydraulic Cement Concrete.
n. C150, Standard Specification for Portland Cement.
o. C172, Standard Practice for Sampling Freshly Mixed Concrete.
p. C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
q. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
r. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
s. D2240, Standard Test Method for Rubber Property - Durometer Hardness.

3. American Welding Society (AWS):
   a. A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. D1.1, Structural Welding Code Steel.
   d. D1.4, Structural Welding Code Reinforcing Steel.
4. International Accreditation Service (IAS).
5. Occupational Safety and Health Administration (OSHA).
6. Prestressed Concrete Institute (PCI):
   a. MNL-116, Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
   b. MNL-117, Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
   c. MNL-120, PCI Design Handbook - Precast and Prestressed Concrete.
7. Building Code:
   a. International Code Conference (ICC):
      1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.
8. Energy Code:
   a. International Code Conference (ICC):
      1) International Energy Conservation Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Provide precast and pre-stressed concrete units produced by an active member of PCI.
   2. Plant to be certified by the Precast/Prestressed Concrete Institute, Plant Certification Program:
      a. Certification Code A1: Architectural Units.
      b. Certification Code C3A: Prestressed Straight Strand Structural Members with an Architectural Finish.
      c. Certification Code C4A: Prestressed Deflected Strand Structural Members with an Architectural Finish.
      d. Plant shall have been certified within past year from bid date.

3. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a minimum of 10 years.
4. Assure manufacturer's testing facilities meet requirements PCI MNL-116 or PCI MNL-117 as applicable.
5. Engineer for all precast or prestressed system and members: Professional Engineer licensed in the State of Illinois.
   a. Engineer to have minimum five (5) years of experience in design of precast and prestressed members with scope similar to this Project.
6. Welding operators and processes to be qualified in accordance with:
   a. AWS D1.1 for welding steel shapes and plates.
   b. AWS D1.4 for welding reinforcing bars.
7. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.
8. Erector shall have minimum of 10 years of experience in erection of precast units similar to units required.

1.4 DEFINITIONS

A. Galvanizing:
   1. Hot-dip galvanizing per ASTM A123 or ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

B. Architectural Concrete Surfaces:
   1. Concrete that will be permanently exposed to view and therefore requiring special care in the selection of materials, placing and finishing to obtain the desired appearance, includes but is not limited to:
      a. Exterior and interior faces of exterior wall panels.
      b. Interior wall panels.
      c. Interior faces of structural precast members.
         1) May include columns, beams, roof tees, hollow core slabs, and lintels.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the administration of the submittal process..
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer’s installation instructions.
      c. Sizes, types and manufacturer of bearing pads.
      d. Hardware to be utilized to support suspended appurtenances.
   3. General:
      a. Prior to submittal to the Engineer for review and action, all Shop Drawings shall be processed by the Contractor, the electrical subcontractor and any other subcontractors having work that impacts the fabrication of the precast members.
         1) Provide certification letter as cover sheet to each submittal confirming that

all impacted trades requiring block-outs, sleeves or items cast into the precast members have reviewed the submittal and coordinated any work associated with the precast fabrication.

b. All Drawings, including erection Drawings, certifications and calculations shall be sealed and signed by a professional Structural or Civil Engineer registered in the State of Illinois.
   1) Provide certification stating calculations provided have been prepared specifically for this Project and that they match and pertain to the Shop Drawings provided.
   2) Provide a summary document as part of the above certification listing the design criteria used for precast design including:
      a) Appropriate codes and standards.
      b) Snow loads.
      c) Live loads.
      d) Wind loads.
      e) Seismic loads.
      f) Equipment loads.

4. Drawings:
   a. Drawings for all precast units, their connections and supports showing:
      1) Plan view with column lines of all floor and roof precast members showing:
         a) Arrangement of units, member location, member size, connections and supports.
         b) Location of columns, pilasters and supporting wall members.
         c) Size and location of all openings.
         d) Size, number, and locations of all embedded metal items and connections.
         e) Required concrete strengths.
         f) Estimated cambers and deflections.
         g) Identification of each unit using same standard marking numbers as used to mark actual units.
            (1) Mark numbers shall be unique for all members supplied under this Contract.
         h) Minimum plan scale: 1/8 IN = 1 FT.
      2) Elevation view with column lines of all precast walls showing:
         a) Arrangement of wall panels, columns, pilasters, member location, member size, connections and support locations.
         b) Details of special design or shapes, lifting and erection embedments (both temporary and permanent).
         c) Estimated cambers and deflections for wall panels.
         d) Methods of storage and handling architectural wall panels.
         e) Size and location of openings.
         f) Size, number, and locations of embedded items and connections.
         g) Required concrete strengths.
         h) Identification of each unit using same standard marking numbers as used to mark actual units.
            (1) Mark numbers shall be unique for all members supplied under this Contract.
         i) Minimum elevation scale: 1/8 IN = 1 FT.

j) Minimum detail scale: 1-1/2 IN = 1 FT.
k) Minimum individual panel elevation scale: 1/4 IN = 1 FT.

3) Connection details:
a) Minimum detail scale: 1-1/2 IN = 1 FT.
b) Summary report of precast loads and reactions to foundations or other supporting elements.
(1) Submit service level reactions for individual base loads (i.e. dead load, live load, wind load, seismic load, etc.).
(2) Submit load combinations.
c) Method proposed for grouting concealed connections and for repairing damage to panels as a result of erection or construction activities.

5. Calculations:
a. Provide calculations for all members and connections.
b. Perform calculations using the dead load of the members plus the superimposed uniform and concentrated loads shown on the Drawings and indicated in this Specification Section.
1) Indicate the following:
a) Design for maximum moment, maximum shear and maximum torsion, compression and tension.
b) Final top and bottom flexural stresses resulting from the stresses due to maximum moment and prestress force.
c) Ultimate moment capacity.
d) Final top and bottom flexural stresses, ultimate moment capacity, and ultimate shear capacity, if affected, for members with reduced cross sections due to openings or penetrations.
e) When required on Drawings, a check for no tension in top and bottom of members due to prestress force and member dead load plus superimposed loads indicated on Drawings and in this Specification Section.
f) Column design and load bearing panel design for maximum axial load and maximum moment.
g) Connection design for each support point for each precast member.
(1) Include design for all items through the connection load path including embedded portion in precast member, embedded portion in supporting structure and any connection bolts, welds or other miscellaneous pieces required for proper design but not shown on the Drawings.
c. Calculations will not be reviewed and are submitted for record purposes only.
6. Concrete mix design(s).
7. Copies of source quality control tests, including compressive strength and air content.
8. Fabricator's quality control documentation for inspection of completed work as required by the Building Code Chapter 17.
9. Certifications:
a. Certification that fabricator’s plant complies with PCI Manual referenced.
b. Certification that fabricator's plant is currently accredited by IAS as an approved fabricator in accordance with all applicable Building Codes.
c. Welder and welding process certification.

d. Certification of erector qualifications.
e. Certification from precast manufacturer for each field-drilled hole in precast double tee stem.

B. Samples:
1. Before fabrication:
a. Four (4) sets of three (3) 12 x 12 x 2 IN samples of precast concrete for each type of specified finish and color showing color and texture range to be expected for Engineer's review and approval.
b. Label samples to indicate name of Project, fabricator, type, color and source of cement and aggregate, the type of finish and the date the sample was made.
1) One (1) set of approved samples will be returned to the precast manufacturer, two (2) sets will be kept at Engineers office and one (1) set will be kept at the Project site for comparison to full sized sample.
2. Full-sized samples:
a. After approval of small samples, fabricate and deliver to site one (1) full-size sample of each style of precast unit.
b. After Engineer's review and approval, samples may be incorporated in the work and serve as standard of comparison for other units.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Precast and prestressed concrete units:
a. ATMI Precast.
b. AVAN Precast Concrete Products, Inc.
c. County Materials Corporation - Salem, IL.
d. Dukane Precast, Inc.
e. Mid-States Concrete Industries, LLC.
2. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Div., TRW, Inc.
b. KSM Division, Omark Industries.
3. Bearing pads:
a. JVI, Inc.
4. Insulation:
a. Dow Building Systems.
5. Integral water repellent:
a. GCP Applied Technologies, Inc.

B. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted

without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Embedded Steel Plates and Shapes:
   1. Carbon steel:
      a. ASTM A36 or equal.
      b. Minimum yield strength: 36 ksi.
      c. Galvanized, ASTM A123, minimum 2.0 OZ zinc per square foot of metal surface.
   2. Welding electrodes: In accordance with AWS for metal alloy being welded.

B. Bearing Pads:
   1. Under hollow core slabs and solid slabs:
      a. Plastic bearing strips.
      b. Minimum compressive strength: 8,000 PSI with no fracture at 26,000 PSI.
      c. Korolath of New England, Inc.
   2. For all other locations:
      a. Random oriented fiber (ROF) bearing pad.
      b. Shore A hardness: 70 to 90 per ASTM D2240.
      c. Capable of supporting a compressive stress of 3,000 PSI with no cracking, splitting or delaminating in the internal portions of the pad.
      d. JVI, Inc. "Masticord."

C. Cement:
   1. Architectural concrete surfaces:
      a. Exterior:
         1) ASTM C150, Type I or III.
         2) Color: White.
      b. Interior:
         1) ASTM C150, Type I or III.
         2) Color: Gray.
   2. All other components:
      a. ASTM C150, Type I or III.
      b. Color: Gray.

D. Aggregate:
   1. ASTM C33.
   2. Architectural concrete surfaces:
      a. Exterior:
         1) Coarse aggregate (limestone):
            a) Color: IDOT Standard .

b) Size: 1/4 to 1/2 IN.
2) Fine aggregate (crushed limestone):
a) Color: IDOT Standard.
b) Size: 1/8 to 1/4 IN.
b. Interior:
1) Coarse aggregate (limestone):
a) Color: Natural.
b) Size: 1/4 to 1/2 IN.
2) Fine aggregate (limestone):
a) Color: Natural.
b) Size: 1/8 to 1/4 IN.
3. Non-architectural concrete surfaces:
a. See Specification Section 03 31 30.
b. Coarse aggregate:
1) Size 67 gradation.
2) Provide aggregate approved for bridge construction by the State Highway Department where the precast units are fabricated or in the State where the Project is located.
c. Fine aggregate: Natural (not manufactured).

E. Water:
1. Potable, clean.
2. Free of oils, acids, and organic matter.

F. Prestressing Strands:
1. Either 250K or 270K high tensile strength uncoated seven-wire strand.
2. Manufacture and test strands in accordance with ASTM A416.

G. Reinforcing Steel and Welded Wire Fabric:
1. Reinforcing bars to be welded: ASTM A706.
2. All other reinforcing steel and welded wire fabric: In accordance with Standard Specifications for Road and Bridge Construction, Section 508.

H. Headed Studs:
1. ASTM A108.
2. Minimum yield strength: 50,000 PSI.
3. Minimum tensile strength: 60,000 PSI.

I. Deformed Bar Anchors:
1. ASTM A496 or ASTM A1064.
2. Minimum tensile strength: 80,000 PSI.
3. Minimum yield strength: 70,000 PSI.

J. Electrodes:
1. E70 series conforming to AWS A5.1 or AWS A5.5 for welding steel shapes and plates.
2. E90 series conforming to AWS A5.5 for welding rebar.

K. Sand cement grout in keyways between hollow core slabs.
1. See Specification Section 03 31 30.

L. Insulation:

1. Extruded polystyrene foam insulation:
   a. ASTM C578, Type IV.
   b. Density: 25 PSI.
   c. Thickness: 3 IN.
   d. Long-term thermal resistance (LTTR) @ 75 DEGF: 5.0 per IN.
   e. Dow "Styrofoam Square Edge."

M. Sealants: See Specification Section 07 92 00.

N. Integral Water Repellent Admixture:
   1. Factory prepared, ready to use liquid.
   2. Dispensed into the concrete mix at time of batching and the charging of the mixer in accordance with manufacturer's directions.
   3. GCP Applied Technologies, Inc., "Darapel."

2.3 DESIGN

A. General Design Requirements:
   1. Design units and connections in strict accordance with the Building Code, ACI 318 and PCI MNL 120.
      a. Notify Engineer when sizes and precast members shown on Drawings cannot be designed or fabricated.
   2. Design loads:
      a. Roof dead load, live load and snow load: Design units for the super-imposed loads indicated on the Drawings.
         1) Loads are unfactored unless otherwise noted.
      b. Equipment loads:
         1) See Drawings for major equipment loads.
         2) Design members for concentrated loads placed in their actual locations.
         3) Verify weights and locations of concentrated loads.
      c. Wind load: See Drawings for wind load criteria.
      d. Seismic load: See Drawings for seismic load criteria.
   3. Design units taking into account reduced cross section at openings and penetrations.
   4. Provide all reinforcing in units as indicated.
      a. Where not indicated, design and provide all reinforcing and prestressing strands subject to approval of Engineer.
   5. Due to presence of corrosive atmosphere, design prestressed members where indicated on Drawings for no tension in top and/or bottom of members resulting from loads indicated on Drawings and in this Specification Section.
   6. Design the flanges of double tee members to support the concentrated weight of equipment and equipment curbs.
      a. Alternatively, coordinate the arrangement and strength of the equipment roof curbs such that the weight of roof supported equipment is transferred by the curbs to the double tee legs.

B. Specific Design Requirements:
   1. Roof framing members:
      a. Roof system to act as a rigid diaphragm to distribute lateral loads to the shear walls indicated on the Drawings.

2. Columns and pilasters:
   a. Design for all axial, bending and shear forces due to supporting loads including eccentric loads.
3. Wall panels:
   a. Design wall panels to support vertical loads including eccentricities where panels are indicated to provide vertical support.
   b. Design all wall panels as non-composite panels.
   c. Design wall panels to resist out of plane lateral loads including wind and seismic load in accordance with the Building Code.
   d. Design wall panels where indicated as shear walls on Drawings to resist in plane lateral loads including wind and seismic loads in accordance with the Building Code.
      1) Design shear wall to resist the lateral loads indicated on the Drawings or the lateral loads developed through analysis of the structure, whichever requires the stronger component.
   e. Design top connections of interior walls to roof framing members as a vertical slip connection where walls are not intended to support gravity loads.
      1) Coordinate the amount of vertical slip with the deflection of the roof framing members.
   f. Calculate lateral drift at expansion joints and confirm adequate structural separation to avoid damaging contact based on the separations shown on the Drawings.
   g. Design wall panels to support additional loads where indicated on the Drawings.
4. Connections:
   a. Design and provide concealed connections whenever possible and where indicated on Drawings.
      1) Minimize exposed steel to open tank areas.
      2) Where steel must be exposed, provide galvanized steel.
   b. Precast connections shown on the Drawings are diagrammatic showing possible connection concepts.
      1) Other connections may be acceptable subject to approval of the Engineer.
   c. Design and provide all connection pieces necessary to connect all precast members to the supporting structure shown on Drawings.
   d. Design connections to allow rotation and/or movement as appropriate to avoid damage to connections, supporting members, joint sealants and other building components.
   e. For connection details to cast-in-place concrete work or concrete masonry work that are not fully detailed on the Drawings, design, detail, furnish and install all additional embedded connection items not shown on the Contract Drawings as required to provide fully compatible and workable connections.

2.4 MIXES

A. General:
   1. Design mix in compliance with ACI 318 and the latest edition of PCI MNL 120.
   2. Concrete mix shall be designed by the precast manufacturer to best suit fabrication of units based on minimum compressive strength specified and finish specified.

a. Mix design shall be acceptable to the Engineer.

B. Interior wythe:
1. Concrete compressive strength: Minimum 5,000 PSI at 28 days.
2. Maximum water cement ratio: 0.42.
3. Air content: 4 1/2 to 7 1/2 PCT.
4. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.
5. Do not begin fabrication of units until concrete mix design(s) have been approved by Engineer.

C. Architectural Concrete Surfaces:
1. Stripping release strength:
a. Non-structural sections and pieces: Minimum 2500 PSI.
b. Structural sections and pieces: Minimum 3500 PSI.
2. Concrete compressive strength: Minimum 5,000 PSI at 28 days.
3. Concrete air content: 4 to 6 PCT.
4. Integral water repellent:
a. Dosage rates shall be determined by the manufacturer to provide the following results:
1) Final in place 28 day cured panel water vapor perm rating of not greater than 1.0.

2.5 FABRICATION

A. Do not fabricate units until Shop Drawings have been approved by Engineer and returned to Contractor and support locations have been field verified by Contractor.

B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with both PCI MNL-116 and PCI MNL-120.

C. Architectural panels to meet PCI MNL-117 and PCI MNL-120.

D. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.
1. Provide 1/2 IN by 45 degree chamfer on all vertical exposed wall panel and column edges.

E. Install insulation for insulated wall panels in a continuous layer, full extent of panel height and width.
1. Install insulation in compliance with Energy Code requirements for continuous insulation.
2. Where multiple layers of insulation are provided, stagger all joints minimum 12 IN.
3. Provide solid concrete areas where necessary for structural integrity, embeds or connections.
a. Minimize solid concrete areas to provide optimum thermal performance.
4. Hold back insulation from exposed jambs, sills and heads of openings as necessary to provide adequate anchorage for doors, windows, louvers or similar items.
5. Insulation may be omitted in parapets, above the plane of roof insulation.

F. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.
   1. Finish all repairs to match adjacent surface texture and color.

G. Where units are to receive concrete topping, provide units having heavy broom finish on top surface for bond.
   1. Provide roughness of top surface to provide bond with topping and design for horizontal shear at topping and unit interface in accordance with requirements of ACI 318, Paragraph 17.5.
   2. Make all other surfaces smooth.

H. Incorporate embedded plates, angles, and flange welding strips into members at time of manufacture.
   1. Provide embedded items as shown on the Drawings unless prior approval is received from Engineer to do otherwise.
   2. Provide embedded items as required by precaster's Design Engineer.
   3. Provide flange welding strips as required by design.
   4. Provide welding strips on all flange edges of all double tee units.
   5. Cast lifting handles into units at or near support points.
      a. Where practicable, locate lifting handles in edges of panels not exposed to view after erection.
      b. Remove exposed lifting handles after units are erected.
         1) Cut lifting handles off below the surface, treat cut surface to prevent rusting and grout the hole.
         2) Provide a finish to match adjacent surface texture and color.
            a) Treat patched area with water repellent to provide same degree of protection as surrounding surface when applicable.

I. Coordinate embedded items required by other trades including, but not limited to, conduits and boxes for electrical or security work.

J. Cast openings larger than 12 IN SQ or 12 IN DIA in units at time of manufacture.
   1. Make smaller openings by neat cutting or neat drilling by trades requiring them.
   2. Coordinate sizes and locations of all openings:
      a. Before fabrication of units.
      b. As required to avoid damage to member reinforcing.

K. Make provisions for support of suspended ceilings, lighting fixtures, ducts, piping, conduits and other suspended work.
   1. When drilled expansion bolts or powder-driven fasteners are approved for use, coordinate prestress strand location with prestress concrete member supplier so that drilled expansion bolts or powder-driven fasteners do not hit or are drilled or driven into prestress strands.
   2. Post-installed anchors or powder driven fasteners in slabs and tee ribs shall be installed only with written approval of precast supplier.
      a. Anchors must be coordinated with reinforcing locations to avoid jeopardizing long-term integrity of members.
      b. Damage to strands by post-installed anchor shall be grounds for Engineer rejection of precast units.
      c. Repair any damage caused by such installation.
      d. Submit certification from precast manufacturer that each field-drilled hole will

not damage precast member or it's reinforcing.

3. Install powder-driven fasteners by means of a low velocity powder-actuated tool complying with requirements of OSHA.
   a. Assure that the load to be supported by each powder-driven fastener does not exceed the maximum allowable load recommended by the bolt or fastener manufacturer for the concrete strength encountered and for the type, size and embedment length of driven fastener installed.

L. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.

M. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.

N. Minimum concrete compressive strength:
   1. At time of strand release: 3500 PSI.
   2. During detensioning, avoid shock, overloading or unbalanced loading.

O. Mark each unit as indicated on the erection plans.
   1. Place mark on non-exposed-to-view surface.

P. Coat or finish ends of exposed prestressing strands to prevent rusting.

Q. Fabricate the following types of precast and prestressed units (all units to be made with normal weight concrete unless noted otherwise on Drawings):
   1. Prestressed double tees of sizes indicated on Drawings.
      a. Weight of double tees without 2 IN concrete topping, based on the nominal section width, not to exceed the following:

DEPTH	NORMAL WEIGHT CONCRETE
32 IN	75 PSF

   2. Prestressed hollow core slabs of sizes indicated.
      a. Weight of hollow core slabs without 2 IN concrete topping not to exceed the following:

DEPTH	NORMAL WEIGHT CONCRETE
8 IN	70 PSF

   3. Precast concrete beams and columns as shown on Drawings:
      a. Reinforce as indicated.
         1) If reinforcement is not indicated, design and provide reinforcement as required to support maximum torsion, shear, moment and axial loads.
      b. See Paragraph 2.4.B. of this Specification Section for specific design requirements.
      c. Provide beam and column connections as indicated on Drawings and as required to support all loads subject to Engineer's approval.
   4. Precast wall panels:
      a. Design and provide reinforcement as required to resist all loads applied to the

panel.
b. See Paragraph 2.4.B. of this Specification Section for specific design requirements.
c. Provide connections as indicated on Drawings and as required to support all loads subject to Engineer's approval.
1) Provide concealed connections whenever possible.
d. Where drilled in anchors are shown on the Drawings, coordinate the location of insulation as required to develop the required load in the anchors.
e. Provide insulation in all exterior wall panels and where noted in interior wall panels.

R. Tolerances:
1. Per PCI MNL-116 and PCI MNL-117, as applicable except as defined below.
a. Openings in precast shall be coordinated with manufacturer of door framing, overhead doors, louvers, windows, curtainwall, piping, ductwork and any other penetration requiring additional installation tolerances required for specific component involved.

S. Forms:
1. Cast units in heavy forms on casting beds of concrete or other suitable, rigid construction.
2. Provide forms adequately braced and free of dents, gouges, or other irregularities.

T. Finish:
1. Exposed surfaces of precast concrete:
a. Architectural wall panels:
1) All exterior wall panels are considered Architectural wall panels.
2) Exterior wall panels:
a) Fine texture acid etched finish per approved samples.
b) Reveals and exposed aggregate polished smooth accent bands as shown on Drawings.
c) Color: As specified in Article 2.3 of this Specification Section.
d) Acid etched finish on all exposed exterior surfaces; provide medium texture brush blast finish on all exposed interior surfaces.
e) Exterior wall panels to have like finishes:
(1) Interior surface of all exterior wall panels to receive a light texture abrasive blasted finish.
(2) Exterior surfaces of exterior wall panels to receive Fine texture acid etched finish.
(a) See Exterior Elevations in the Drawings.
3) Interior wall panels and the interior surface of exterior wall panels:
a) All surfaces are to receive a uniform light texture abrasive blast finish per approved samples.
b) Color: Standard gray per mix specified in Article 2.3 of this Specification Section.

2.6 SOURCE QUALITY CONTROL

A. When approved by Engineer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of

Precast/Prestressed Concrete Institute, Plant Certification Program.

B. Conduct tests on precast concrete using the following procedures:
   1. If the precast manufacturer's quality control program requires more frequent or more stringent testing requirements, the manufacturer's quality control program will take precedence over the specific type of test.
   2. Perform concrete tests as specified. Frequency of tests: Per PCI MNL-116 or PCI MNL-117 as applicable.
   3. Secure concrete samples in accordance with ASTM C172.
   4. For each strength test mold and cure cylinders from each sample in accordance with ASTM C31.
   5. Test cylinders in accordance with ASTM C39.
   6. Minimum testing requirements: Per PCI MNL 116 or PCI MNL 117 as applicable.
   7. Acceptance of concrete strength: Per PCI MNL 116.
   8. Determine slump of concrete sample for each strength test.
      a. Determine slump in accordance with ASTM C143.
   9. Determine air content of concrete sample for each strength test in accordance with either ASTM C231, ASTM C173, or ASTM C138.
   10. Determine temperature of concrete sample for each strength test.

C. Inspect quality of units prior to shipment.

D. Should products delivered to site be rejected due to materials or workmanship, discontinue delivery until defects in materials or workmanship have been corrected and certified in writing to the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify acceptability and location of supports to receive units.
   1. Check bearing surfaces to determine that they are level and uniform.

B. Verify compressive strengths of concrete and masonry supports.
   1. Do not start erection of units until supports have reached their 28-day required compressive strengths.

3.2 ERECTION

A. Sequence erection to provide a balance of loads across walls, beams and columns.

B. Give consideration to possible lack of stability or capacity of partially completed frame or structure.

C. Contractor to be responsible for guying, shoring, and bracing of frame, walls and individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.

D. Use only erection equipment adequate for placing units at lines and elevations indicated on Drawings.
   1. Do not damage units or existing construction during erection.
   2. Erect units using lifting handles cast into the units.

E. Place each leg of all double tees on a bearing pad held 1 IN back from edge of support.
   1. Pad dimensions equal to length of bearing -1 IN by bearing width +2 IN.
   2. Minimum pad thickness: 3/8 IN.

F. Place hollow core slabs on continuous 1/4 IN thick bearing pad so that width equals bearing length -1 IN.

G. Place precast concrete columns and wall panels on shims; grout voids with non-shrink grout.
   1. Hold back grout and provide backer rod or bond breaker tape and sealant in accordance with Specification Section 07 92 00.
   2. At panels bearing at or above grade, seal both sides of panel base joint.
   3. At panels bearing below grade:
      a. Seal exterior panel base joint prior to backfilling and/or placement of site paving.
      b. Provide compressible filler and sealant or backer rod and sealant as appropriate for interior slab condition.

H. Provide a bearing pad on the top of all precast concrete columns.
   1. Pad to cover entire top surface of column except hold pad back 1 IN from face of column all around.

I. After erection, verify that there is no direct contact between bottom of units and supporting members.
   1. Where direct contact occurs, install additional layers of bearing material to raise units off supports.

J. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4.
   1. When welding galvanized members, remove galvanizing at welds prior to welding.

K. Make joint between units 1/2 IN except as otherwise indicated on Drawings.

L. Secure units by welding and/or bolting.
   1. Provide one (1) flat and one (1) lock washer with each bolt and nut.
      a. Set units on shims where indicated or necessary for level, uniform bearing.

M. After panels have been erected and welded and/or bolted to building frame, prepare steel and repair all damaged galvanized surfaces in accordance with Specification Section 05 50 00.

N. Seal all precast joints as specified in Specification Section 07 92 00 and as indicated on Drawings.

O. Erect units within the following tolerance limits:
   1. Clearances between precast and structural frame: 1 IN minimum.
   2. Joints:
      a. Face width: ±3/16 IN.
      b. Taper in any length: (1 IN 500) to maximum 1/4 IN.
      c. Step in face: 1/4 IN.
      d. Jog in alignment of edge: 1/4 IN.

P. Fill all keyways between hollow core slabs with concrete sand cement grout.
   1. See Specification Section 03 31 30.

Q. After all precast units are erected and all precast unit connections have been made, prepare and repair all damaged galvanized surfaces of the connections in accordance with Specification Section 05 50 00.

3.3 FIELD QUALITY CONTROL

A. Inspection and Testing:
   1. By Engineer in accordance with IDOT Construction Manual and IDOT standard procedures.

3.4 CLEANING

A. After completion of setting, repair and sealing, clean all precast work thoroughly by scrubbing with fiber brushes, detergent, and clean water.
   1. Refer to Specification Section 04 01 20 for detergent cleaner.

B. Leave precast units clean and free of traces of cleaning compound.

END OF SECTION

SECTION 03 45 00 - ARCHITECTURAL PRECAST CONCRETE (APC)

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Architectural Precast Concrete (APC) in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PRECAST PUMP STATION BUILDING.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications:
   1. Firm experienced in producing architectural precast concrete units similar to those indicated and with a record of successful performance.
   2. PCI Certified for Group A, Category A1-Architectural Cladding and Load Bearing Units.
   3. Capacity to produce required units without delaying Work.
   4. Assume responsibility for engineering of APC units to comply with Building Code requirements as locally adopted.

B. Engineer Qualifications:
   1. Comply with Section 01 71 21, Specialty Engineering Requirements.

C. Erector Qualifications:
   1. Certificate of Compliance furnished by PCI designating qualification in Category A (Architectural Systems) for non-loadbearing members.
   2. Certify welders according to AWS D1.1: Structural Welding Code – Steel and AWS D1.4: Structural Welding Code – Reinforcing Steel.

D. Testing Agency Qualifications:
   1. An independent testing agency, acceptable to authorities having jurisdiction and qualified to conduct the testing indicated.

E. Reference Standards:
   1. ACI 318 Building Code Requirements for Structural Concrete.
   2. PCI MNL117 Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
   3. ASTM A27/A27M Steel Castings, Carbon for General Application.
   4. ASTM A36/A36M Carbon Structural Steel.
   5. ASTM A47/A47M Ferritic Malleable Iron Castings.
   6. ASTM A108 Steel Bar, Carbon and Alloy, Cold Finished.
   7. ASTM A123/A123M Zinc (Hot-Dipped Galvanized) Coatings of Iron and Steel Products.
   8. ASTM A185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement.
   9. ASTM A283/A283M Low and Intermediate Tensile Strength Carbon Steel Plates.

10. ASTM A307 Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
11. ASTM A500/A500M Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
12. ASTM A563 Carbon and Alloy Steel Nuts.
13. ASTM A572/A572M High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
14. ASTM A615/A615M Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
15. ASTM A1064/A1064M Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
16. ASTM C33/C33M Concrete Aggregates.
17. ASTM C39/C39M Compressive Strength of Cylindrical Concrete Specimens.
18. ASTM C231/C231M Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260/C260M Specifications for Air-Entraining Admixtures for Concrete.
20. ASTM C494/C494M Specifications for Chemical Admixtures for Concrete.
21. ASTM C578 Rigid, Cellular Polystyrene Thermal Insulation.
22. ASTM C642 Test for Density, Absorption, and Voids in Hardened Concrete.
23. ASTM C979/C979M Pigments for Integrally Colored Concrete.
24. ASTM C1107/C110M Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).

F. Testing:
   1. Test one set of cylinders for each 50 cubic yards of concrete, but not less than one set for each day's pour.
      a. Test for air content each time cylinders are made, in accordance with ASTM C231.
      b. Test for water absorption in accordance with ASTM C642 or PCI MNL 117.
      c. Test cylinders in accordance with ASTM C39. One at 7 days and two at 28 days.

G. Fabrication Tolerances: Refer to Part 2.

H. Erection Tolerances: Refer to Part 3.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

PART 2 - RODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Architectural Precast Concrete (APC):
   1. Base: Mid-States Concrete Industries, LLC.
   2. Optional:
      a. ATMI Precast.
      b. AVAN Precast Concrete Products, Inc

c. Coreslab Structures Inc.
d. County Materials Corporation - Salem, IL Dukane Precast, Inc.

B. Thin Brick Facings:
1. Base:
a. Endicott Clay Products.
2. Optional:
a. Pacific Clay.

C. Rust inhibitive paint:
1. Base:
a. Tnemec.
b. ZRC Worldwide.

D. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 DESIGN CRITERIA

A. Comply with ACI 318 and the design recommendations of PCI MNL 120: PCI Design Handbook – Precast and Prestressed Concrete, applicable to types of architectural precast concrete units indicated.

B. Design units and connections to satisfy requirements of building codes.

C. Provide architectural precast concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated:
1. Include effect from adjacent attached construction.
2. Wind pressure, and/or earthquake lateral forces.
3. Live Loads.
4. Dead load of unit plus superimposed loads.
5. Handling, transportation, and erection forces.
6. Temperature stresses appropriate for project site and conditions.
7. Shrinkage stresses.

D. Design framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live load deflection,

shrinkage and creep of primary building structure, and other building movements as follows:
1. Upward and downward movement of L/300 for floors and L/200 for roofs.

E. Show, by engineering calculations, embedded connections can adequately support anticipated loads.
1. When approved by Engineer, load tests may be substituted for calculations.

F. Design, detail and provide internal reinforcing and embedded connection hardware.

G. Reinforce units with welded wire fabric or reinforcing bars as needed to satisfy design criteria or provide following minimum reinforcing, whichever is greater:
1. Unit thickness up to 4 IN : One layer 4 x 4 - W4.0 x W4.0 .
2. Unit thickness over 4 IN : Two layers 4 x 4 - W4.0 x W4.0 .

H. Anchorages for APC:
1. Provide anchors, as determined through testing, in numbers, types and locations as required to satisfy the performance criteria.
2. Also see minimum placement criteria specified in Part 2.

I. When unit is supported from rigid base, design connections to permit reasonable amount of independent vertical movement of structural frame.

J. Attach connections placing lateral loads on structural members to elements capable of resisting forces without reinforcing, unless such reinforcing is provided by erector at no additional cost and in manner acceptable to the Engineer

2.3 FORM MATERIALS

A. Forms:
1. Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated.
2. Non-reactive with concrete and suitable for producing required finishes.

B. Form Liners:
1. Units of face design, texture, arrangement, and configuration indicated or to match precast Design Reference Sample.
2. Provide solid backing and form supports to ensure that form liners remain in place during concrete placement.

C. Release Agents:
1. Commercially produced liquid release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.4 REINFORCING MATERIALS

A. Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and wire in place.

B. Use products with Corrosion Resistant Coatings of type indicated below when concrete cover on exterior face is less than 1-1/2 IN or interior face is less than 3/4 IN . Otherwise,

uncoated reinforcing may be used.

C. Reinforcing Bars:
   1. Welded bars: ASTM A706.
D. Welded Wire Reinforcement:
   1. Galvanized and chromate wash treated.
   2. Plain: ASTM A185, flat sheet.
E. Corrosion Resistant Coatings:
   1. Hot dip Galvanizing (HDG) Coating:
      a. Reinforcing bars and wire mesh: ASTM A123 applied after welding/fabrication.
      b. ASTM A767, Class II zinc coated, hot dip galvanized (HDG) and chromate wash treated after fabrication and bending.

2.5 CONCRETE MATERIALS

A. Design Reference Sample:
   1. Light blasted finish - sample Number 153 as illustrated in Architectural Precast Concrete – Color and Texture Selection Guide, published by PCI.
   2. Polished finish - sample Number 558 as illustrated in Architectural Precast Concrete – Color and Texture Selection Guide, published by PCI.
B. Portland Cement:
   1. ASTM C150, Type I or III.
   2. Same type, brand, and mill source throughout production.
   3. Cement Color:
      a. Face Mixes (portions of units exposed to view):
         1) As necessary to reproduce coloration of Design Reference Sample.
         2) White portland cement.
         3) Blend of white and gray portland cement.
      b. Backup mixes (portions of units not exposed to view):
         1) Contractors option.
C. Normal Weight Aggregates:
   1. Comply with ASTM C33 except as modified by PCI MNL 117:
      a. Employ coarse aggregates complying with Class 5S.
   2. Stockpile fine and coarse aggregates for each type of exposed finish from a single source for entire project.
   3. Face Mix Coarse Aggregates:
      a. Selected, hard, and durable; free of material that reacts with cement or causes staining.
      b. Color: To match selected Design Reference Sample.
      c. Gradation:
         1) To match selected Design Reference Sample.
   4. Face Mix Fine Aggregates:
      a. Selected, natural or manufactured sand of the same material as coarse aggregate, unless otherwise approved by Engineer.
      b. Color: To match selected Design Reference Sample.
D. Coloring Admixture:
   1. Pigment: As required by Design Reference Sample.

2. ASTM C979, synthetic or natural mineral oxide pigments or colored water reducing admixtures, temperature stable and non-fading.
3. Lime and alkali resistant.
4. Limit type and amount used so as not to reduce quality of concrete.

E. Water:
1. Potable; clean, fresh, free from oil, acid, organic matter or other deleterious substances that may affect color, stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

F. Air Entraining Admixture:
1. ASTM C260, certified by manufacturer to be compatible with other required admixtures.

G. Water Reducing Admixture: ASTM C494, Type A.

H. Retarding Admixture: ASTM C494, Type B.

I. Water Reducing and Retarding Admixture: ASTM C494, Type D

J. Water Reducing and Accelerating Admixture: ASTM C494, Type E.

K. High Range, Water Reducing Admixture: ASTM C494, Type F.

L. High Range, Water Reducing and Retarding Admixture: ASTM C494, Type G.

M. Plasticizing Admixture for Flowable Concrete: ASTM C1017.

N. Admixtures containing calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture are not permitted.

2.6 CARBON STEEL CONNECTION MATERIALS

A. Carbon Steel Shapes and Plates:
1. ASTM A36 except silicon content in the range of 0 to 0.03 percent.
   a. 0.15 to 0.25 percent for materials to be galvanized.
   b. Steel with chemistry conforming to the formula Si + 2.5P less than or equal to 0.09 is also acceptable.
2. ASTM A283 for Carbon Steel Plate.

B. Carbon Steel Headed Studs:
1. ASTM A108, Grades 1018 through 1020, cold finished and bearing the minimum mechanical properties for studs as indicated under MNL 117, Table 3.2.3.; AWS D1.1, Type A or B, with arc shields.

C. Malleable Iron Castings: ASTM A47, Grade 32510 or 35028.

D. Carbon Steel Castings: ASTM A27, Grade U-60-30.

E. High Strength, Low Alloy Structural Steel:
1. ASTM A572 except silicon content in the range of 0 to 0.03 percent.
   a. 0.15 to 0.25 percent for materials to be galvanized.
   b. Steel with chemistry conforming to the formula Si + 2.5P less than or equal to 0.09 is also acceptable.

F. Carbon Steel Structural Tubing: ASTM A500, Grade B.

G. Wrought Carbon Steel Bars: ASTM A675, Grade 65.

H. Deformed Steel Wire or Bar Anchors: ASTM A1064/A1064M or ASTM A706.

I. Carbon Steel Bolts and Studs:
   1. Hex head bolts and studs: ASTM A307, Grade A.
   2. Nuts: ASTM A563, Grade A.
   3. Flat, unhardened steel washers: ASTM F844.
   4. Headed studs or deformed bar anchors:
      a. Headed studs having minimum tensile strength of 60,000 PSI , minimum yield strength of 52,000 PSI , ASTM A108.
      b. Deformed bar anchors having minimum tensile strength of 80,000 PSI , minimum yield strength of 70,000 PSI , ASTM A1064/A1064M.

J. High Strength Bolts and Nuts:
   1. Heavy structural steel hex bolts: ASTM A325 or ASTM A490, Type 1,
   2. Heavy carbon steel hex nuts: ASTM A563.
   3. Hardened carbon steel washers: ASTM F436.

K. Protective Finish:
   1. Exterior steel items and items indicated for galvanizing:
      a. Apply zinc coating by hot dip process according to ASTM A123 after fabrication or ASTM A153 as applicable.

2.7 STAINLESS STEEL CONNECTION MATERIALS

A. Plate:
   1. ASTM A666, Type 304, of grade suitable for application.

B. Hex-head bolts, Studs, Nuts and Washers: ASTM F593, alloy 304 or 316.
   1. Lubricate threads with an anti-seize thread lubricant during assembly.

C. Headed Studs:
   1. ASTM A276 and bearing the minimum mechanical properties for studs as indicated under MNL 117, Table 3.2.3.

2.8 BEARING PADS AND OTHER ACCESSORIES

A. Provide bearing pads for architectural precast concrete units as follows:
   1. Elastomeric Pads:
      a. AASHTO M 251, plain, vulcanized, 100 percent neoprene.
      b. Surface hardness: 50 to 70 Shore A durometer according to ASTM D2240.
      c. Minimum tensile strength: 2250 PSI per ASTM D412.
   2. Fiber Reinforced Elastomeric Pads:
      a. Preformed, randomly oriented synthetic fibers set in elastomer.
      b. Surface hardness: 70 to 90 Shore A durometer according to ASTM D2240.
      c. Capable of supporting a compressive stress of 3300 PSI with no cracking, splitting or delaminating in the internal portions of the pad.
      d. Test one specimen for each 200 pads used in the project.
   3. Fabric Reinforced Elastomeric Pads:
      a. Preformed, horizontally layered cotton duck fabric bonded to an elastomer.

b. Surface hardness: 80 to 100 Shore A durometer according to ASTM D2240.
c. Conforming to Division II, Section 18.10.2 of AASHTO LRFD Bridge Design Specifications, or Military Specification, MIL-C-882D.

4. Frictionless Pads:
   a. Teflon, glass fiber reinforced; bonded to stainless or mild steel plates, of type required for in-service stress.
5. High-Density Plastic:
   a. Multimonomer, non-leaching, plastic strip.

B. Reglets and Counterflashing:
1. Specified in Section 07 62 00.
2. Fabricator to obtain reglet material specified and cast reglets into APC pieces.

C. Accessories:
1. Provide clips, hangers, plastic or steel shims, and other accessories required to install architectural precast concrete units.

2.9 THIN BRICK UNITS AND ACCESSORIES

A. Thin Brick Units:
1. Exterior grade, type TBX brick.
2. Comply with PCI Standard for Thin Brick.
3. Minimum Thickness, plus or minus 1/16 IN :
   a. 1/2 IN .
4. Face Dimensions, actual:
   a. Modular: 7-5/8 IN long x 2-1/4 IN tall
5. Special Shapes: Include corners, edge corners, and end edge corners.
6. Include other special shapes indicated.
7. Bond Strength to concrete:
   a. Shear bond strength of 150 PSI when tested per ASTM C482.
   b. Tensile bond strength of 150 PSI when tested per ASTM E488.
8. Initial Rate of Absorption:
   a. Less than 30g/30 IN^2 per minute when tested per ASTM C67.
   b. Units with higher IRA should be wetted before placement to improve bond.
9. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked or dovetailed.
10. Base Product: Endicott Clay Products.
    a. Rose Blend, Red Blend, or Ruby Red Blend . Submitt samples to Engineer for selection.
    b. Finish: Smooth

2.10 INSULATED PANEL ACCESSORIES

A. Extruded Polystyrene (XPS) Board Insulation:
1. Rigid cellular polystyrene thermal insulation complying with ASTM C578, Type IV.
2. Edges:
   a. Square edges.
   b. Shiplap edges.
3. Minimum aged thermal value per unit thickness: 5.0 R per IN .

4. Required Thickness: 3 IN.

B. Polyisocyanurate (PISO) Board Insulation:
   1. Rigid cellular polyisocyanurate thermal insulation complying with ASTM C591.
   2. Edges: Square edges.
   3. Minimum Thermal value per unit thickness (aged): 5.6 R per IN .
   4. Required Thickness:3 IN .

C. Wythe Connectors:
   1. Devices specifically manufactured to connect wythes of precast concrete panels:
      a. Base:
         1) Bent galvanized reinforcing bars or welded wire trusses.
      b. Optional
         1) Glass-fiber and vinyl-ester polymer connectors.
         2) Epoxy coated carbon fiber grid.

2.11 CONCRETE MIX DESIGN

A. Maximum Water Absorption:
   1. 6 percent by weight, equal to 14 percent by volume, tested according to PCI MNL 117.

B. Air-Entrainment:
   1. Provide concrete containing air-entraining admixture producing air content between 6 and 8 percent including entrapped air.

C. Normal Weight Concrete Face and Backup Mixes:
   1. Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on project, to provide normal weight concrete with the following properties:
      a. Minimum Compressive Strength (28 Days): 5000 PSI.
      b. Maximum Water-Cementitious Materials Ratio: 0.45.

D. Lightweight Concrete (for Backup Mixes only):
   1. Proportion mixes by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:

2.12 MOLD FABRICATION

A. Molds:
   1. Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete placement and vibration operations and temperature changes and for prestressing and de-tensioning operations.
   2. Coat contact surfaces of molds with release agent before reinforcement is placed.
   3. Avoid contamination of reinforcement and prestressing tendons by release agent.

B. Form Liners:
   1. Place form liners accurately to provide finished surface texture indicated.
   2. Provide solid backing and supports to maintain stability of liners during placing of concrete.
   3. Coat form liner with form-release agent.

C. Maintain molds to provide completed architectural precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

D. Form joints are not permitted on faces exposed to view in the finished work.

2.13 PANEL FABRICATION

A. Mark each unit for identification and date of casting.

B. Locate holes, inserts and other lifting mechanisms in non-finished surfaces.

C. APC Panel-to-Panel Joints:
   1. Typical:
      a. Unless otherwise shown provide for uniform joint widths of 3/4 IN .
   2. Corners:
      a. 3/4 IN wide quirk miter joints where panel joint occurs at external angles.

D. Panel Edge and Corner Treatment:
   1. Uniformly chamfered or as otherwise indicated.

E. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware:
   1. Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements.
   2. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

F. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on drawings.
   1. Cast-in openings larger than 10 IN in any dimension.
   2. Do not drill or cut prestressing strand.

G. Reinforcement:
   1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete.
      a. When damage to epoxy coated reinforcing exceeds limits specified ASTM A775 repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
   2. Accurately position, support and secure reinforcement during concrete placement and consolidation operations.
      a. Completely conceal support devices to prevent exposure on finished surfaces.
   3. Install welded wire reinforcement in lengths as long as practicable.
      a. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design.
      b. Offset laps of adjoining widths to prevent continuous laps in either direction.

H. Prestress tendons for architectural precast concrete units by either pre-tensioning or post-tensioning methods.
   1. De-tension or post-tension prestressed architectural precast concrete units after concrete has reached its indicated minimum design release compressive strength as established by test cylinders.
   2. Protect strand ends and anchorages to prevent corrosion and rust spots.

I. Place concrete in a continuous operation to prevent seams or planes of weakness

from forming in precast concrete units.

J. Comply with ACI 305R recommendations for hot weather concrete placement.

K. Comply with ACI 306.1 procedures for cold weather concrete placement.

L. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings as indicated on erection drawings.

M. Repair damaged architectural precast concrete units to meet acceptability requirements of PCI MNL 117.

2.14 PANEL FABRICATION - THIN BRICK FACED UNITS

A. Place form liner templates accurately to provide grid for brick facings.

B. Provide solid backing and supports to maintain stability of liners while placing bricks and during placing of concrete.

C. Bond Pattern: Running Bond with nominal 3/8 IN joints.

D. Clean faces and joints of brick facing after stripped from forms.

2.15 FABRICATION TOLERANCES

A. Fabricate architectural precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with the following product tolerances.
   1. Overall Height and Width of Units, Measured at the Face Exposed to View:
      a. 10 FT or under: Plus or minus 1/8 IN.
      b. 10 FT to 20 FT: Plus 1/8 IN, minus 3/16 IN.
      c. 20 FT to 40 FT: Plus 1/8 IN, minus 1/4 IN.
      d. Each additional 10 FT: Plus or minus (1 IN 2000) to maximum 1/16 IN per 10 FT.
   2. Overall Height and Width of Units, Measured at the Face Not Exposed to View: As follows:
      a. 10 FT or under: Plus or minus 1/4 IN.
      b. 10 FT to 20 FT: Plus 1/4 IN, minus 3/8 IN.
      c. 20 FT to 30 FT: Plus or minus 3/8 IN.
      d. Each additional 10 FT: Plus or minus 1/8 IN.
   3. Total Thickness or Flange Thickness: Plus 1/4 IN, minus 1/8 IN.
   4. Rib Thickness: Plus or Minus 1/8 IN.
   5. Rib to Edge of Flange: Plus or Minus 1/8 IN.
   6. Distance between Ribs: Plus or Minus 1/8 IN.
   7. Alignment of ribbed members:
      a. 3/16 IN up to 40 FT.
      b. 1/4 IN in 40 FT or more.
   8. Variation from Square: Plus or Minus 1/8 IN per 72 IN up to 1/4 IN.
   9. Length and Width of Block outs and Openings within One Unit: Plus/minus 1/4 IN.
   10. Location and Dimension of Block outs Hidden from View and Used for HVAC and Utility Penetrations: Plus or Minus Plus/minus 3/4 IN.
   11. Dimensions of Haunches: Plus or Minus 1/4 IN.

12. Haunch Bearing Surface Deviation from Specified Plane: Plus or Minus 1/8 IN.
13. Difference in Relative Position of Adjacent Haunch Bearing Surfaces from Specified Relative Position: Plus or Minus 1/4 IN.
14. Bowing: Plus or Minus L/360, maximum 3/4 IN.
    a. Differential bowing between adjacent members: 1/4 IN.
15. Angular deviation of plane of side mold: (1 IN 100) to maximum 1/16 IN.
16. Jog in alignment of edge: 1/4 IN.
17. Local Smoothness: 1/4 IN per 10 FT.
18. Maximum Warp (One corner out of plane of other three): (1 IN 200) 1/16 IN per foot from nearest adjacent corner.
19. Tipping and Flushness of Plates: Plus or Minus 1/4 IN.
20. Dimensions of Architectural Features and Rustications: Plus or Minus 1/8 IN.
21. Dimensions not listed above: In any length: (1 IN 2000) to maximum 1/8 IN.

B. Position Tolerances: For cast-in items measured from datum line location, as indicated on Shop Drawings.
    1. Weld Plates: Plus or Minus 1 IN.
    2. Inserts: Plus or Minus 1/2 IN.
    3. Handling Devices: Plus or Minus 3 IN.
    4. Reinforcing Steel and Welded Wire Reinforcement: Plus or Minus 1/4 IN where position has structural implications or affects concrete cover; otherwise, Plus or Minus 1/2 IN.
    5. Reinforcing Steel Extending out of Member: Plus or Minus 1/2 IN of plan dimensions.
    6. Tendons: Plus or Minus 1/4 IN, vertical; Plus or Minus 1 IN horizontal.
    7. Location of Rustication Joints: Plus or Minus 1/8 IN.
    8. Location of Opening within Panel: Plus or Minus 1/4 IN.
    9. Location of Flashing Reglets: Plus or Minus 1/4 IN.
    10. Location of Flashing Reglets at Edge of Panel: Plus or Minus 1/8 IN.
    11. Reglets for Glazing Gaskets: Plus or Minus 1/8 IN.
    12. Electrical Outlets, Hose Bibs: Plus or Minus 1/2 IN.
    13. Location of Bearing surface from End of Member: Plus or Minus 1/4 IN.
    14. Allowable Rotation of Plate, Channel Inserts, Electrical Boxes: 2-degree rotation or 1/4 IN maximum over the full dimension of the unit.
    15. Position of Sleeve: Plus or Minus 1/2 IN.
    16. Location of Window Washer Track or Buttons: Plus or Minus 1/8 IN.

2.16 FABRICATION TOLERANCES – BRICK FACED UNITS

A. The number of bricks allowed these misalignments is limited to 2 percent of the total bricks within a single panel.
    1. Alignment of mortar joints:
        a. Jog in Alignment: 1/8 IN .
        b. Alignment with Panel Centerline: Plus or Minus 1/8 IN 3 mm.
    2. Variation in Width of Exposed Mortar Joints: Plus or Minus 1/8 IN 3 mm.
    3. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 IN ; Minus 1/4 IN < depth of form liner joint.
    4. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 IN ; Minus 1/8 IN .

5. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 IN ; Minus 1/4 IN < depth of form liner joint.

2.17 FINISHES

A. Panel faces shall be free of joint marks, grain, and other obvious defects.

B. Corners, including false joints shall be uniform, straight and sharp.

C. Exposed Face and Edge Surfaces:
   1. Match colors and textures of Design Reference Sample.
   2. Abrasive Blast Finish:
      a. Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
   3. Polished Finish:
      a. Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.

D. Finishes of other Exposed Surfaces:
   1. Panel Tops Returns (i.e. parapet and sill): Finish to match face surface finish.
   2. Panel Bottom Returns (i.e. soffits): Finish to match face surface finish.
   3. Back of Panel (i.e. interior): Finish to be steel trowel with light sandblast.

E. Unexposed surfaces:
   1. Smooth steel trowel finish.
   2. Float finish.

2.18 SOURCE QUALITY CONTROL

A. Quality Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements.
   1. If using self consolidating concrete: Also test and inspect according to PCI Interim Guidelines for the Use of Self-Consolidating Concrete.

B. Strength of precast concrete units will be considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

2.19 RELATED ITEMS SPECIFIED ELSEWHERE

A. Cast-in-Place Concrete: Specified in elsewhere in Division 03.

B. Structural Steel for connection attachment to structural steel framing: Specified in Section 05 12 00 or Section 05 12 10.

C. Sheet Metal Flashing and Trim: Specified in Section 07 62 00.

D. Backer Rod and Sealants: As specified in Section 07 92 13.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with

requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
2. Start of installation constitutes acceptance of surfaces and conditions.

B. Do not install precast concrete units until supporting cast-in place concrete building structural framing has attained minimum allowable design compressive strength or supporting steel or other structure is structurally ready to receive loads from precast.

3.2 ERECTION

A. Perform erection under supervision of qualified superintendent.
B. Employ only skilled and experienced personnel and equipment capable of properly installing units.
C. Erect architectural precast concrete level, plumb and square within the specified allowable tolerances.
D. Connect APC units in position by bolting, welding, grouting, or as otherwise indicated on approved erection drawings.
   1. Remove temporary shims, wedges, and spacers as soon as practical after connecting and/or grouting are completed.
   2. Disruption of roof flashing continuity by connections is not permitted; concealment within roof insulation is acceptable.
E. Welding:
   1. Protect architectural precast concrete units and bearing pads from damage by field welding or cutting operations and provide noncombustible shields as required.
   2. Welds not specified shall be continuous fillet welds, using not less than the minimum fillet as specified by AWS.
   3. Protective Coating Repair:
      a. Clean weld affected metal surfaces with chipping hammer followed by brushing then apply a minimum 0.004 IN thick coat of galvanized repair paint to galvanized surfaces in conformance with ASTM A780.
F. Bolted Connections:
   1. At bolted connections, use lock washers, tack welding, or other acceptable means to prevent loosening of nuts after final adjustment.
G. Grouting Connections:
   1. Grout connections where required or indicated.
   2. Retain grout in place until hard enough to support itself.
   3. Pack spaces with stiff grout material, tamping until voids are completely filled.
   4. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
   5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.

3.3 ERECTION TOLERANCES

A. Erect architectural precast concrete units level, plumb, square, and true, without

exceeding the following non-cumulative erection tolerances;

1. Total deviation equal to maximum allowance specified for the structural frame.
2. Plan Location from Building Grid Datum: Plus or Minus 1/2 IN.
3. Plan Location from Centerline of Steel: Plus or Minus 1/2 IN.
4. Top Elevation from Nominal Top Elevation:
   a. Exposed Individual Panel: Plus or Minus 1/4 IN.
   b. Non-exposed Individual Panel: Plus or Minus 1/2 IN.
   c. Exposed Panel Relative to Adjacent Panel: 1/4 IN.
   d. Non-exposed Panel Relative to Adjacent Panel: 1/2 IN.
5. Support Elevation from Nominal Support Elevation: As follows:
   a. Maximum Low: 1/2 IN.
   b. Maximum High: 1/4 IN.
6. Maximum Plumb Variation:
   a. Over the Lesser of Height of Structure or 100 FT: 1 IN.
   b. Plumb in Any 10 FT of Element Height: 1/4 IN.
7. Maximum Jog in Alignment of Matching Edges: 1/4 IN.
8. Joint Face Width (governs over Joint Taper):
   a. Maximum deviation from Specified Width: Plus or Minus 3/16 IN.
   b. Step in face: 1/4 IN.
9. Maximum Joint Taper:
   a. Total: 3/8 IN.
   b. In 10 FT: 1/4 IN.
10. Maximum Jog in Alignment of Matching Faces: 1/4 IN.
11. Differential Bowing or Camber, as Erected, between Adjacent Members of Same Design: 1/4 IN.
12. Opening Height between Spandrels: Plus or Minus 1/4 IN.

3.4 JOINT SEALANTS

A. Seal architectural precast concrete work as specified in Section 07 92 13.

3.5 FIELD QUALITY CONTROL

A. Field Testing: Testing to conform with the provisions of IDOT standard specifications.

3.6 REPAIRS

A. Repairs will be permitted provided structural adequacy of units and appearance are not impaired.

B. Replace units which exhibit damage to surfaces, finish, corners or edges which will be exposed to view after setting in place, or which is broken or cracked due to shrinkage, temperature, transportation, handling or erection.
   1. When approved in writing by Engineer, unit may be repaired in place.
   2. Perform such work at no additional cost.

C. Acceptance of units, repaired pursuant to written approval, is contingent upon repairs being skillfully done so as to be sound, permanent, flush with adjacent surfaces and of color and texture matching similar adjoining surfaces and indicating no apparent line of demarcation between original and repaired work, when viewed from a distance of 20

FT.

D. Remove and replace other work damaged by removal of defective precast members, at no additional cost.

E. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.

F. Remove and replace damaged APC units when repairs do not meet requirements.

3.7 CLEANING

A. Clean surfaces of precast concrete to be exposed to view prior to shipping.

B. Clean mortar, plaster, fireproofing, weld slag, and any other deleterious material from concrete surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
   1. Protect other work from staining or damage due to cleaning operations.
   2. Coordinate cleaning of precast units with cleaning of glass and other work.
   3. Pre-clean soiled surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water.
   4. Perform cleaning procedures using product specified in Section 04 05 10 or as otherwise recommended by precast concrete fabricator.
      a. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.
   5. Start at top of building and proceed downward.
   6. Leave precast units clean, free of traces of cleaning compound and with joints watertight.

END OF SECTION

DIVISION 04
MASONRY

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SECTION 04 01 20 - MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Masonry cleaning.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow 7 days after completion of masonry work before start of cleaning.

B. Remove excess mortar using wooden paddles and scrapers.

C. Protect adjacent surfaces not to be cleaned.

3.2 APPLICATION

A. Protect adjacent surfaces subject to potential damage by cleaning solution.

B. Apply masonry cleaner to exposed-to-view masonry surfaces.
   1. Do not use wire brushes.
   2. Use only tools free of rust.
   3. Apply solution using fibered wall-washing brush.

C. Thoroughly rinse and pre-soak walls.

D. Flush all loose mortar and dirt from surface.

E. Wet to prevent "run-off" streaking.

F. Scrape off mortar and reapply cleaning solution.

G. After scrubbing, clean thoroughly with pressurized water.

H. Apply neutralizing rinse as recommended by manufacturer.

END OF SECTION

SECTION 04 05 13 - MASONRY MORTAR AND GROUT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Masonry mortar.
   2. Masonry grout.
   3. Integral water repellent admixture.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 04 23 00 - Glass Unit Masonry.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
      b. C144, Standard Specification for Aggregate for Masonry Mortar.
      c. C150, Standard Specification for Portland Cement.
      d. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
      e. C270, Standard Specification for Mortar for Unit Masonry.
      f. C404, Standard Specification for Aggregates for Masonry Grout.
      g. C476, Standard Specification for Grout for Masonry.
      h. C1019, Standard Test Method for Sampling and Testing Grout.
      i. C1093, Standard Practice for Accreditation of Testing Agencies for Masonry.
      j. C1384, Standard Specification for Admixtures for Masonry Mortars.
   2. Masonry Standards Joint Committee (MSJC):
      a. Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602); referred to herein as MSJC Specification.
   3. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Preconstruction Testing Laboratory shall be an independent agency qualified in accordance with ASTM C1093 for performing the testing indicated.
      a. Testing Laboratory shall have a minimum of 10 years of experience in the testing of mortar and grout.
      b. Technician conducting tests shall have minimum of five (5) years of experience in the testing of mortar and grout.

C. Mock-Ups:

1. Provide mortar and grout for mock-up specified in Specification Section 04 23 00.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement:
   1. ASTM C150, Type I or II.
   2. No air entrainment.
   3. Natural color.
   4. Maximum percent of alkalis: 0.60 IN accordance with ASTM C150, Table 1A.

B. Hydrated Lime:
   1. ASTM C207, Type S.
   2. Type SA not acceptable.
   3. Lime substitutes are not acceptable.

C. Mortar Aggregate: ASTM C144, free of gypsum.

D. Grout Aggregate: ASTM C404.

E. Water: Potable.

F. Integral Water Repellent Admixture:
   1. Liquid polymeric admixture: ASTM C1384.
   2. Verify compatibility with liquid water repellent admixture being used in the fabrication of concrete masonry units.

2.2 MIXES

A. Mortar and grout shall comply with MSJC Specification and Building Code.

B. Type "S" mortar shall be used:
   1. Comply with ASTM C270, Table No. 1, Cement-Lime Mortar.
      a. Do not use masonry cement or mortar cement.
      b. No fly ash additives will be accepted.
   2. Mix materials minimum of three (3) minutes and maximum of five (5) minutes.
   3. Adjust consistency to satisfaction of mason.
   4. Do not use admixtures unless otherwise indicated.
   5. Provide integral water repellent admixture in mortar used for:
      a. Exterior concrete masonry work.
      b. Interior concrete masonry work in wet areas.

6. Do not use integral water repellent admixture in mortar for brick.

C. Masonry Grout:
   1. ASTM C476.
      a. Minimum 28-day compressive strength: 2,000 PSI.
      b. Slump: 8 to 11 IN.
   2. Mix 5 minutes minimum.
   3. No admixtures allowed.
   4. At Contractor's option, premixed or preblended grout meeting the above minimum requirements may be used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and MSJC Specification.

B. Mortar:
   1. If standard gray mortar begins to stiffen, it may be retempered by adding water and remixing
      a. Standard gray mortar shall not be retempered more than one (1) time.
   2. All mortar must be used within 2-1/2 HRS maximum after initial mixing per MSJC Specification.
   3. Engineer reserves right to alter mix design based on initial rate of absorption of masonry units.
   4. Set Glass Unit Masonryusing type S mortar.
      a. Rake mortar from joint as recommended by the unit manufacturer.
      b. Tuckpoint raked joints using pointing grout.
         1) Install pointing grout in accordance with ANSI A108.10 and masonry unit manufacturer’s published instructions.
         2) Use polymer modified sanded pointing grout for joints in:
            a) Exterior masonry.

3.2 FIELD QUALITY CONTROL

A. Masonry Mortar and Grout Testing and Inspection: Testing to conform with the provisions of IDOT standard specifications.

END OF SECTION

SECTION 04 05 23 - MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Masonry accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 04 23 00 - Glass Unit Masonry.
   3. Section 05 50 00 - Metal Fabrications.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
      b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      d. A951, Standard Specification for Steel Wire for Masonry Joint Reinforcement.
      e. A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
      f. D412, Standard Test Method for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
      g. D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
      h. D2000, Standard Classification System for Rubber Products in Automotive Applications.
      i. D2240, Standard Test Method for Rubber Property—Durometer Hardness.
   2. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Masonry anchors, horizontal joint reinforcing and miscellaneous anchors:
      a. Heckman.
      b. Hohmann & Barnard, Inc.
      c. Wire Bond.
   2. Thru wall flashing:
      a. EPDM:
         1) Carlisle Syntech Systems, Inc.
         2) Firestone Building Products Co.
      b. Stainless steel:
         1) Heckman Building Products.
         2) Hohmann & Barnard, Inc.

2.2 MANUFACTURED UNITS

A. Thru Wall Flashing:
   1. 40 MIL EPDM manufactured specifically for thru wall flashing.
      a. Tear resistance: ASTM D624, 150 LB/IN minimum.
      b. Width as necessary.
         1) Provide single piece full width, no horizontal joints will be allowed unless approved in writing by Engineer.
      c. Factory precut wherever possible.
      d. Factory fabricated inside corners, outside corners, and end dams.

B. Flashing Adhesive: As recommended by flashing manufacturer for sealing laps, sealing to vertical masonry and concrete surfaces and sealing to stainless steel surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Thru Wall Flashing and Stainless Steel Drip:
   1. Install to provide positive drainage of cavity moisture.
   2. Extend stainless steel drip beyond the exterior face of the wall to minimum distance possible while still allowing drip to perform intended purpose.
   3. Extend flashing horizontally beyond each edge of lintel or sills to next vertical mortar joint but not less than 4 IN and turn up edge one (1) full veneer course.
      a. Seal all joints.
   4. Where thru wall flashing steps up or down in the wall, provide end dam at step.
      a. End dam shall extend up or down to tie into thru wall flashing step.
      b. Seal all joints for continuous watertight barrier.
   5. Lap stainless steel drip minimum of 2 IN and bond two (2) pieces together using

stainless steel pop rivets and two (2) beads of lap sealant.

6. At concrete masonry unit back-up, install upper edge of flashing into block joint.
7. At concrete back-up, secure upper edge of flashing into reglet and seal.
8. Adhere vertical surface of flashing to back-up wall with adhesive recommended by flashing manufacturer.
9. Extend flashing minimum of 6 IN above top of weep joint mortar protection system.
10. Lap and seal flashing at all inside and outside corners to provide continuous uninterrupted barrier.

END OF SECTION

SECTION 04 23 00 - GLASS UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Glass unit masonry construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 04 05 13 - Cement and Lime Mortars.
   3. Section 04 05 23 - Masonry Accessories.
   4. Section 07 92 00 - Joint Sealants.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A276, Standard Specification for Stainless Steel Bars and Shapes.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Solid glass unit masonry and accessories:
      a. Base: Pittsburgh Corning Corp.
         1) Vistabrik Solid Glass Block.
      b. Optional: Approved equal by, Glass Block Co.
   2. Integral waterproofer:
      a. Sonneborn Building Products.
   3. Asphalt emulsion:
      a. Karnak Chemical Corporation.

b. Sonneborn Building Products.

4. Other materials:
   a. As noted.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 COMPONENTS

A. Solid Glass Masonry Units:
   1. Thickness: 3-7/8 IN.
   2. Size: 7-3/4 x 7-3/4 IN.
   3. Pattern: PC Glass Block "ESSEX AA" pattern, or approved equal.
   4. Color: Clear.

2.3 ACCESSORIES

A. Panel Reinforcing and Panel Anchors: See Specification Section 04 05 23.

B. Mortar: See Specification Section 04 05 13.

C. Sealants: See Specification Section 07 92 00.

D. Expansion Strip: Glass masonry unit manufacturer's standard.

E. Asphalt Emulsion: Non-fibrated, non-flammable type as recommended by glass masonry unit manufacturers.

F. Packing (Backer Rod): Polyethylene foam or as recommended by glass masonry unit manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Verify that anchors and flashings are correct.

C. General:
   1. Build walls to thickness indicated.
   2. Build in flashing, reinforcing, and related items.
   3. Do not cut glass masonry units.
   4. Install in stack bond.
   5. Avoid use of less than half size units.
   6. Do not install damaged units.

D. Laying and Tooling:
   1. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints.
      a. Properly locate openings, movement type joints, returns and offsets.
   2. Coat all sills with asphalt emulsion prior to placing mortar bed.
      a. Allow to dry minimum 2 HRS before placing mortar.
      b. Limit asphalt emulsion to area which will be covered by masonry units.
   3. Lay masonry units with completely filled bed and head joints.
      a. Butter ends with sufficient mortar to fill head joints and shove into place.
      b. Do not slush head joints.
      c. Do not tap into place with steel tools.
      d. See Specification Section 04 05 13 for mortar requirements.
   4. Maintain nominal 1/4 IN joint widths.
      a. Tool joints smooth and concave.
   5. During tooling of joints, enlarge any voids or holes, and completely fill with mortar.
   6. Point-up all joints at corners, openings and adjacent work to provide neat, uniform appearance.
   7. Remove masonry disturbed after laying.
      a. Clean and relay in fresh mortar.
      b. Do not pound units to fit.
      c. If adjustments are required, remove units, clean, and reset in fresh mortar.
   8. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course.
      a. Remove loose units and mortar prior to laying fresh masonry.
   9. As work progresses, build-in items indicated and specified.
      a. Fill in solidly with mortar around built-in items.
      b. Do not set units tight to other work except at sill; provide minimum 3/16 IN and maximum 3/8 IN space between units and structural elements unless noted otherwise on Drawings.
      c. Install expansion strip at all heads and jambs.

E. Reinforcing: See Specification Section 04 05 23.

F. Sealants:
   1. Place backer rod into spaces between glass masonry units and surrounding construction then seal with sealant.
   2. See Specification Section 07 92 00 for sealant requirements.

3.2 FIELD QUALITY CONTROL

A. Do not install units if mean temperature or temperature of units is 40 DEGF or less.

B. Protect against weather.
   1. When work is not in progress cover top of walls with translucent waterproof membrane, extend at least 4 FT down both sides of walls and anchor in place.

C. Protect against cold weather as specified in Specification Section 04 05 50.

D. Remove and replace loose, stained, or damaged units.
   1. Provide new units to match.
   2. Install in fresh mortar.
   3. Point to eliminate evidence of replacement.

E. Clean surplus mortar from face of unit at time joints are tooled; wipe dry.

F. Tolerances:
   1. From plumb, in lines and surfaces of columns, walls and arises:
      a. In 10 FT: 1 IN 100.
      b. In 40 FT or more: 1 IN 800.
   2. From plumb, for external corners, control joints and other conspicuous lines:
      a. In any story or 20 FT maximum: 1 IN 200.
      b. In 40 FT or more: 1 IN 800.
   3. From level or grades indicated on Drawings for exposed lintel, sills, parapets, horizontal grooves and other conspicuous lines:
      a. In any bay or 20 FT maximum: 1 IN 200.
      b. In 40 FT or more: 1 IN 800.
   4. Linear building lines from established position in plan and related portion of columns, walls, and partitions:
      a. In any bay or 20 FT maximum: 1 IN 100.
      b. In 40 FT or more: 1 IN 600.
   5. Cross-sectional dimensions of columns and thickness of walls: a. -1/4 IN.
      b. +1/2 IN.

END OF SECTION

DIVISION 05
METALS

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SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
   2. Design of all temporary bracing not indicated on Drawings.
   3. Design of systems and components, including but not limited to:
      a. Stairs.
      b. Landings.
      c. Modular framing system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 03 - Concrete.
   3. Section 03 09 00 - Concrete.
   4. Section 03 15 19 - Anchorage to Concrete.
   5. Section 03 31 30 - Concrete, Materials and Proportioning.
   6. Section 05 14 00 - Structural Aluminum.
   7. Section 06 82 00 - Fiberglass Reinforced Plastic Fabrication.
   8. Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM 1, Aluminum Design Manual.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   3. American Institute of Steel Construction (AISC):
      a. 325, Manual of Steel Construction.
      b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
   4. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads for Buildings and Other Structures.
   5. ASTM International (ASTM):
      a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. A36, Standard Specification for Carbon Structural Steel.
      c. A47, Standard Specification for Ferritic Malleable Iron Castings.
      d. A48, Standard Specification for Gray Iron Castings.

e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
i. A197, Standard Specification for Cupola Malleable Iron.
j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
q. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
r. A536, Standard Specification for Ductile Iron Castings.
s. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
t. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
u. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
v. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
w. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
x. A992, Standard Specification for Steel for Structural Shapes.
y. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
z. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
aa. B26, Standard Specification for Aluminum-Alloy Sand Castings.
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
dd. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ee. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

ff. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
gg. F467, Standard Specification for Nonferrous Nuts for General Use.
hh. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
ii. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
jj. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
kk. F1789, Standard Terminology for F16 Mechanical Fasteners.

6. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.2, Structural Welding Code - Aluminum.
   d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
7. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
   c. MBG 531, Metal Bar Grating Manual.
8. NACE International (NACE).
9. Nickel Development Institute (NiDI):
   a. Publication 11 007, Guidelines for the welded fabrication of nickel-containing stainless steels for corrosion resistant services.
10. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
11. Building Code:
    a. International Code Council (ICC):
       1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
   2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of Illinois.

1.4 DEFINITIONS

A. Fasteners: As defined in ASTM F1789.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Hardware: As defined in ASTM A153/A153M.

D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the

field at the Project site.
2. Installer and applicator are synonymous.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Div., TRW Inc.
b. Stud Welding Products, Inc.
2. Mechanical anchor bolts: See Section 03 15 19.
3. Epoxy adhesive anchor bolts: See Section 03 15 19.
4. Self-tapping concrete anchors: See Section 03 15 19.
5. Ladder safety extension post: Bilco.

B. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Steel:
1. Structural:
a. W-shapes and WT-shapes: ASTM A992, Grade 50.
b. All other plates and rolled sections: ASTM A36.
2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
3. Structural tubing:
a. ASTM A500, Grade B (46 ksi minimum yield).

B. High-Strength Bolts, Nuts and Washers:
   1. ASTM A325 with ASTM A563 nuts galvanized:
   2. High-strength bolts:
      a. Provide two (2) ASTM F436 washers for all bolts galvanized.
      b. Provide beveled washers at connections of sloped/tapered sections.
   3. High-strength bolts with compressible washer type direct tension indicators (DTI), ASTM F959.
      a. Provide at Contractor's option and subject to approval of Engineer.
   4. Alternate high-strength design: Provide at Contractor's option and subject to approval of Engineer.
   5. Bolts and nuts:
      a. ASTM A307, Grade A.
   6. Welding electrodes: AWS D1.1, E70 Series.
   7. Crane Rails:
      a. Controlled-cooled, open-hearth carbon steel ASCE (American Society of Civil Engineers) rails per ASTM A2, Class A, #1 rails, unless noted otherwise, of size and weight indicated.
         1) Furnish rails with milled tight end joints suitable for crane service, with standard drilling, removable end stops and all related accessories required, including:
            a) Joint bars: Match rail section and properties, drilled to match rail drilling.
            b) Joint bar bolts and nuts: High strength.
            c) Hardened washer: ASTM F436 for bar bolts.
            d) Except as indicated otherwise, two-bolt type fixed or floating rail clamps to suit the conditions, of forged or pressed steel, complete with ASTM A325 bolts, reversible fillers, and self-locking nut or nut and lock washer.
   8. Steel forgings: ASTM A668.

C. Iron:
   1. Ductile iron: ASTM A536.
   2. Gray cast iron: ASTM A48 (minimum 30,000 PSI tensile strength).
   3. Malleable iron: ASTM A47, ASTM A197.

D. Stainless Steel:
   1. Stainless steel in welded applications: Low carbon 'L' type.
   2. Minimum yield strength of 30,000 PSI and minimum tensile strength of 75,000 PSI.
      a. Bars, shapes: ASTM A276, Type 304.
      b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
      c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
      d. Bolts and nuts: ASTM F593, Type 304 or 316.
   3. Minimum yield strength of 25,000 PSI and minimum tensile strength of 70,000 PSI.
      a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
   4. Welding electrodes: In accordance with AWS for metal alloy being welded.

E. Aluminum:
   1. Alloy 6061-T6, 32,000 PSI tensile yield strength minimum.
      a. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, tees and zees.
   2. Alloy 6063-T5 or T6, 15,000 PSI tensile yield strength minimum.

a. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
3. ASTM B26 for castings.
4. ASTM F468, alloy 2024 T4 for bolts.
5. ASTM F467, alloy 2024 T4 for nuts.
6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.

F. Washers: Same material and alloy as found in accompanying bolts and nuts.

G. Embedded Anchor Bolts: See Specification Section 03 15 19.

H. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

I. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 PSI and a minimum tensile strength of 60,000 PSI.

J. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 PSI and a minimum tensile strength of 80,000 PSI.

K. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

L. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.3 MANUFACTURED UNITS

A. Ladders: See Section 06 82 00 for main ladder specifications.
1. Ladder safety extension post:
a. Telescoping tubular aluminum or stainless steel section that automatically locks into place when fully extended.
b. Non-ferrous corrosion-resistant spring and hardware.
c. Factory assembled with all hardware necessary for mounting to ladder.
d. Bilco "LadderUp" safety post.

B. Bollards:
1. 8 IN DIA extra strength steel pipe, ASTM A53.
a. Galvanized.
b. See Specification Section 09 96 00 for painting requirements.

C. Steel Checkered Plate:
1. Provide galvanized checkered plate and edge supports.
2. Conform to ASTM A786.
a. Diamond pattern: No.3 (large) or No.4 (medium).
b. Use one (1) pattern throughout Project.
c. Material: 36 ksi minimum yield strength.
3. Provide joints at center of all openings unless shown otherwise.

D. Aluminum Checkered Plate:
1. Conform to ASTM B632.
a. Diamond pattern: Use one (1) pattern throughout Project.
b. Material: Type 6061-T6.
2. Design live load:
a. 100 PSF, uniform load.
b. 300 LBS concentrated load on 4 IN square area.

c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
d. Maximum deflection: 1/300 of span under a superimposed live load of 50 PSF.

3. Reinforce as necessary with aluminum angles.
4. Plate sections:
   a. Maximum 3 FT wide.
   b. Minimum 1/4 IN thick.
   c. Maximum 100 LBS per section if required to be removable.
5. Provide joints at center of all openings unless shown otherwise.
   a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
6. Unless shown otherwise, frame for openings with aluminum checkered plate cover:
   a. Aluminum support angles:
      1) 3 by 2 by 1/4 IN minimum size with long leg vertical.
      2) 5/8 IN DIA adhesive anchor bolts spaced at maximum of 24 IN OC along each side with not less than two (2) anchor bolts per side.
   b. Aluminum concrete insert seats:
      1) 2 by 2 by 1/4 IN minimum size.
      2) Auto-welded studs or strap anchors at 18 IN OC with not less than two (2) studs or anchored per side.
   c. Drill and tap frame to receive 3/8 IN DIA fasteners at not more than 24 IN OC with not less than two (2) fasteners per side.
      1) Fasteners: Stainless steel flat countersunk cap screws: ASTM F879.

E. Aluminum Grating:
1. NAAMM MBG 531.
2. Minimum depth: 1-1/2 IN.
3. Minimum rectangular bearing bar size:
   a. 3/16 IN thick.
   b. Maximum 1-3/16 IN OC spacing.
4. Minimum I-bar flange width: 1/4 IN.
5. Design live load:
   a. 100 psf, uniform load.
   b. 300 LBS concentrated load on 4 IN square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.
6. Cross bars:
   a. Welded, swaged or pressure locked to bearing bars.
   b. Maximum 4 IN OC spacing.
7. Top edges of bars: Grooved or serrated.
8. Removable grating sections: Not wider than 3 FT and not more than 100 LBS.
9. Standard mill finish.
10. Ends and perimeter edges: Banded.
11. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
12. Provide openings at joints between individual grating sections.
13. Clips and bolts: Stainless steel.
14. Seat angles: Aluminum.

15. At Contractor's option, aluminum plank type grating with skid-resistant surface may be used.
    a. Grating to have a minimum 35 percent up to a maximum of 45 percent open area and meet the design loads and deflection specified in this Specification Section.

F. Heavy-Duty Castings, Trench Covers, and Accessories:
1. Prefabricated, cast iron ASTM A48 or ductile iron ASTM A536.
2. Design load: AASHTO HS-20 wheel loading for indicated span.
3. Machine horizontal mating surfaces.

G. Access Cover:
1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
3. Equip lid with four (4) stainless steel screws to secure lid to frame.

H. Modular Framing System:
1. Materials:
    a. As indicated on Drawings.
    b. Steel: ASTM A1011, Grade 33.
        1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
    c. Aluminum: ASTM B221 or ASTM B209.
    d. Stainless steel: ASTM A666.
2. Channels and inserts:
    a. Steel or stainless steel: Minimum 12 GA.
    b. Aluminum: Minimum 0.080 IN.
    c. Channels to have one (1) side with a continuous slot with in-turned lips.
        1) Width: 1-5/8 IN.
        2) Depth and configuration as necessary for loading conditions.
3. Fittings: Same material as system major components.
4. Fasteners:
    a. Nuts: Toothed groves in top of nuts to engage the in-turned lips of channel.
    b. Bolts: Hex-head cap screws.
    c. Same material as system major components.
5. End caps:
    a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 FT or less above the floor or platform.
        a) Plastic for all exposed ends 7 FT or more above floor or platform.
        b) Plastic or metallic for all other exposed ends.
6. Schedule:
    a. Provide materials as scheduled below unless otherwise specifically noted on the Drawings.
    b. Interior areas: Aluminum.
    c. Exterior areas: Aluminum.
7. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.
8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Shop Connections:
   1. Welds to be continuous fillet type unless indicated otherwise.
   2. Full penetration butt weld at bends in stair stringers and ladder side rails.
   3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
   4. Weld aluminum in accordance with AWS D1.2.
   5. Weld stainless steel in accordance with AWS D1.6.
      a. Treat all welded areas in accordance with ASTM A380.
   6. All headed studs to be welded using automatically timed stud welding equipment.
   7. Grind smooth welds that will be exposed.

E. Passivate stainless steel items and stainless steel welds after they have been ground smooth, where indicated on Drawings.
   1. ASTM A380.

F. Conceal fastenings where practicable.

G. Fabricate work in shop in as large assemblies as is practicable.

H. Tolerances:
   1. Rolling:
      a. ASTM A6.
      b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members:
            a) 30 FT or less: 1/16 IN.
            b) Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6 tolerance for wide flange shapes.
      c. Specified member camber (except compression members):
         1) 50 FT or less: Minus 0/plus 1/2 IN.
         2) Over 50 FT: Minus 0/plus 1/2 IN (plus 1/8 IN per 10 FT over 50 FT).
         3) Members received from mill with 75 PCT of specified camber require no further cambering.

4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
5) Camber shall be measured in fabrication shop in unstressed condition.

d. At bolted splices, depth deviation shall be taken up by filler plates.
1) At welded joints, adjust weld profile to conform to variation in depth.
2) Slope weld surface per AWS requirements.

e. Finished members shall be free from twists, bends and open joints.
1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

I. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum/ galvanized steel unless shown otherwise on Drawings.
1. Finish:
a. Mill, unless noted otherwise.
b. Coat surfaces in contact with dissimilar materials.
1) See Specification Section 09 96 00.

J. Fabricate grating in accordance with NAAMM MBG 531.
1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 IN.
2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 IN.
a. Tolerance: NAAMM MBG 531.
3. Removable sections: Not wider than 3 FT and not heavier than 100 LBS.
4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
a. Provide full depth banding unless noted otherwise.
b. Banding at trenches and sumps to be 1/4 IN less than grating depth to allow for drainage.
5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
6. Provide joints at openings between individual grating sections.
7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

K. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
1. Workmanship: Class 2 unless noted otherwise.

L. See Specification Section 09 96 00 for preparation and painting of ferrous metals and other surfaces.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
1. Refer to Specification Section 09 96 00 for surface preparation requirements.
2. All miscellaneous metal fabrication item surfaces shall be inspected and approved by NACE certified coatings inspector prior to application of shop-applied paint coating.
a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.

b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Paint Coating Application:
1. Refer to Specification Section 09 96 00 for painting requirements.
2. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of paint coatings.
3. Application of paint coatings shall be observed and certified by NACE certified coatings inspector.

C. Shop Inspection and Testing:
1. Items requiring shop inspection and testing:
a. Steel checker plate covers over pumps.
b. Stairs.
c. See Section 05 12 00 for Source Quality Control requirements for these items.

D. Responsibilities of Testing Agency:
1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
a. Visually inspect all welds.
b. In addition to visual inspection, test 50 PCT of full penetration welds and 20 PCT of fillet welds with liquid dye penetrant or mag particle.
c. Test 20 PCT of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
a. Verify direct tension indicator gaps, if applicable.
3. Inspect structural steel which has been erected.
4. Inspect stud welding in accordance with AWS Code.
5. Prepare and submit inspection and test reports to Engineer.
a. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
1. Shim and grout as necessary.

B. Contractor is solely responsible for safety.
1. Construction means and methods and sequencing of work is the prerogative of the

Contractor.

2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
   1. Plumb, align, and set structural steel members to specified tolerances.
   2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
      a. If not obvious from experience or from the Drawings, the Contractor shall confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
   5. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
   1. Report defects in work-in-place which may influence satisfactory completion of the work.
   2. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement:
   1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
   2. Contractor responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
   1. Use surveyor's level.
   2. Notify Engineer of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together.
   1. Drifting to match unfair holes is not allowed.

J. Welding:
   1. Conform to AWS D1.1 and requirements of the FABRICATION Article in PART 2 of this Specification Section.
   2. When joining two (2) sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

K. Shore existing members when unbolting of common connections is required.
   1. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated prior to the completion of erection.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Field Welding:
   1. Follow AWS procedures.
   2. Grind welds smooth where field welding is required.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
   1. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:
   1. Connect steel members to steel members with 3/4 IN DIA ASTM A325 high strength bolts.
   2. Connect aluminum to aluminum with 3/4 IN DIA stainless bolts.
   3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts.
      a. Provide dissimilar metals protection.
   4. Connect aluminum and steel members to concrete using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
      a. Provide dissimilar materials protection.
   5. Provide washers for all bolted connections.
   6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top of installed nut.
      a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
   1. Provide hardened washers for all ASTM A325 bolts.
      a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

S. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
   1. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or

required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
   1. See Division 03 Specification Sections for non-shrink grout and anchorage.
   2. Set and anchor each base plate to proper line and elevation.
      a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
         1) Wedges, shims and setting nuts to be of same metal as base plate they support.
         2) Tighten nuts on anchor bolts.
      b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
         1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
      c. Do not remove wedges or shims.
         1) Where they protrude, cut off flush with edge of base plate.
      d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
   1. Tack welding prohibited.
      a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
   2. Anchor bolt location tolerance:
      a. Per Section 03 15 19.

Z. Crane Runways:
   1. Erect crane runways complete with columns, beams, girders, bracing, crane rails, crane stops, and other required components as indicated.
   2. Stagger crane rail joints with respect to each other on opposite sides of the runway and do not coincide with crane girder joints.
   3. Center crane rails on top of crane girders and secure to girders with tight clamps and/or floating clamps as appropriate; provide clamps in pairs spaced not over 3 FT OC along rail length, with each clamp secured with two (2) high-strength bolts and self-locking nuts (or nuts and lock washers), with reversible fillers used at each clamp to allow for alignment.
      a. Do not use hook bolt type clamps.
   4. Tolerances:
      a. Center-to-center of crane rails: Not exceed plus or minus 1/4 IN from indicated dimension.
      b. Crane rail horizontal misalignment: Not exceed 1/4 IN per 50 FT of runway with a maximum of 1/2 IN total deviation.
      c. Vertical misalignment between crane rails and along a crane rail measured at centerlines of columns: Not to exceed 1/4 IN per 50 FT of runway with a maximum of 1/2 IN total deviation.
   5. Tight-fitting joints between rail sections and install so top of crane rails are flush at all joints.
   6. Secure the joints with joint bars on each side of rail, bolted together through rail

with high-strength bolts, nuts and spring washers.

AA. Install bollards in concrete as detailed.
1. 48 IN projection above ground.
2. 48 IN embedment in concrete, unless detailed otherwise on Drawings.
3. Fill pipe with concrete and round off at top.

BB. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
1. Center stair nosings in stair width.
2. Coordinate nosings with railing vertical posts.
   a. Maintain 2 IN clear between end of nosing and edge of railing base plate.

CC. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
1. Keep screw holes clean and ready to receive screws.

DD. Attach grating to end and intermediate supports with grating saddle clips and bolts.
1. Maximum spacing: 2 FT OC with minimum of two (2) per side.
2. Attach individual units of aluminum grating together with clips at 2 FT OC maximum with a minimum of two (2) clips per side.

EE. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

FF. Repair damaged galvanized surfaces in accordance with ASTM A780.
1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

GG. Anchor ladder to concrete structure with minimum 3/4 IN stainless steel anchor bolts with minimum 6 IN embedment.

HH. Install ladder safety extension post in accordance with manufacturer's instructions.
1. Mount device opposite the climbing side.
2. Provide ladder safety extension device for all ladders unless noted otherwise.

II. Install ladder security door where indicated on the Drawings.
1. Install in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Tolerances shall meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature.

3.4 CLEANING

A. After fabrication, erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. All stainless steel products in addition to Paragraph A. above:
1. Remove all heat tint, rusting, discoloration by passivation, ASTM A380, or other acceptable means as listed in NiDI 11 007 as approved by the Engineer.

C. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09 96 00.

END OF SECTION

DIVISION 06
WOOD, PLASTICS, AND COMPOSITES

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SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Rough carpentry.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.
   3. Section 07 54 19 - PVC Membrane Roofing - Fully Adhered.
   4. Section 07 62 00 - Flashing and Sheet Metal.
   5. Section 07 92 00 - Joint Sealants.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Engineered Wood Association (APA):
      a. PRP-108, Performance Standards and Qualification Policy for Structural Use Panels.
      b. U450E, Storage and Handling of APA Trademarked Panels.
      c. Y510T, Plywood Design Specification.
   2. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
      c. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
      d. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
      e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. American Wood Protection Association (AWPA):
      a. M2, Standard for Inspection of Wood Products Treated with Preservatives.
      b. M3, Standard Quality Control Procedures for Wood Preserving Plants.
      c. M4, Standard for the Care of Preservative-Treated Wood Products.
      d. P5, Standard for Waterborne Preservatives.
      e. U1, Use Category System: User Specification for Treated Wood.
   4. American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI):
      a. ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roof Systems.
   5. Environmental Protection Agency (EPA).

6. FM Global (FM):
   a. 1-49, Property Loss Prevention Data Sheets - Perimeter Flashing.
7. National Institute of Standards and Technology (NIST):
   a. PS-1, Construction and Industrial Plywood.
   b. PS-20, American Softwood Lumber Standard.
8. Underwriters Laboratories, Inc. (UL):
   a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
9. Building Code:
   a. International Code Council (ICC):
      1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Wood Treatment Plant: AWPA M3.
   2. Treated Wood Inspection: AWPA M2.

C. Miscellaneous:
   1. Factory marking:
      a. Lumber:
         1) Identify type, grade, moisture content, inspection service, producing mill, and other qualities specified.
         2) Marking may be omitted, as allowed by Building Code, if certificate of inspection is provided for each shipment.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY AND STORAGE

A. Delivery, storage and handling of untreated wood products: Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. General:
   1. Lumber for framing, blocking, nailers, furring, grounds and similar members:
      a. NIST PS-20.
      b. Species:
         1) Treated material: As indicated in the appropriate AWPA standard.
            a) Provide species of FRTM as necessary to achieve UL rating listed.
      c. Grade:
         1) For nominal sizes up to and including 2 x 4: Standard and better.
         2) For nominal sizes up to 2 IN thick and wider than 4 IN: #2 and better.
   2. Non-structural plywood:
      a. NIST PS-1.

B. Preservative Treated Material:
   1. Moisture content:
      a. Prior to treatment: 25 PCT.
      b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
         1) Lumber: 19 PCT maximum.
         2) Plywood: 18 PCT maximum.
   2. Preservative:
      a. Waterborne: AWPA P5.
      b. As indicated in the appropriate AWPA standard.
   3. Pressure-treat material in accordance with AWPA U1.
   4. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

C. Fire-Retardant Treated Material (FRTM):
   1. Acceptable manufacturer:
      a. Hoover Treated Wood Products, Inc.:
         1) Interior: "Pyro-Guard".
         2) Exterior: "Exterior Fire-X".
   2. Maximum moisture content:
      a. Prior to treatment: 25 PCT.
      b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
         1) Lumber: 19 PCT (KDAT).
         2) Plywood: 15 PCT (KD-15).
   3. Fire-retardant preservative:
      a. Provide protection against decay:
         1) EPA registered for use as a wood preservative.

b. Shall not bleed-through or adversely affect bond of any finish.

4. Pressure-treat material in accordance with AWPA U1.
5. UL Classified:
   a. FR-S, UL 723.
   b. Exterior: No increase in classification when subjected to the Standard Rain Test, ASTM D2898.
   c. Provide UL mark on each piece of FRTM.
6. Maximum flame spread rating: 25, ASTM E84.
7. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

D. Fasteners and Anchors:
   1. Nails and screws:
      a. Dry, non-corrosive exposure: Type 304 stainless steel.
      b. Wet, corrosive, marine, and/or below grade: Type 316 stainless steel.
   2. Adhesive anchors, expansion anchors, self-tapping concrete anchors, bolts, nuts, and washers: See Specification Section 05 50 00.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify measurements, dimensions, and shop drawing details before proceeding.

B. Coordinate location of studs, nailers, blocking, grounds and similar supports for attached work.

C. Eliminate sharp projections which would puncture roofing, flashing or underlayment material.

3.2 ERECTION AND INSTALLATION

A. General:
   1. Provide preservative treated material for all wood used:
      a. Outside building.
      b. Below grade.
   2. Provide fire-retardant treated material for all wood used:
      a. Inside building.
      b. Exterior building walls.
      c. Roof construction.
      d. Parapet walls.
      e. Roofing nailers.

B. Attach work securely by anchoring and fastening as indicated or required to support applied loading.
   1. Anchor wood to concrete using adhesive or expansion anchors as specified in Specification Section 05 50 00.
   2. Anchor wood to metal using bolts and nuts as specified in Specification Section 05 50 00.
   3. Provide flat washers under all bolt heads and nuts.
   4. Fasten plywood in accordance with APA recommendations.

5. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
6. Install fasteners without splitting of wood; predrill as required.
7. Do not drive threaded friction type fasteners.
8. Tighten bolts and lag screws at installation and retighten as required.

C. Set work to required levels and lines, plumb, true.
   1. Shim as required.
   2. Cut and fit accurately.

D. Provide wood grounds, nailers, or blocking where required for attachment of other work and surface applied items.
   1. Form to shapes indicated or required.
      a. FRTM lumber:
         1) Do not rip or mill.
         2) Cross-cutting and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
         3) Resurfacing, planing or fabrication of special shapes or profiles shall be done prior to treatment.
      b. FRTM plywood:
         1) Cross-cutting, ripping and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
      c. Light sanding of FRTM as permitted by UL to remove raised grain or prepare for finishing is allowable.
      d. Field treat cuts and holes in preservative treated material in accordance with AWPA M4 and manufacturer's published recommendations.
   2. Grounds:
      a. Dressed, key beveled lumber minimum 1-1/2 IN wide of thickness required to bring face of ground even with finish material.
      b. Remove temporary grounds when no longer required.
   3. Install roofing nailers as necessary for attachment of flashing, curbs, fascia, coping, and related accessories:
      a. Match height of nailers to insulation.
      b. Anchor nailers to resist force of 300 PLF unless required otherwise by FM Global or roofing manufacturer.
         1) Metal decking attachment:
            a) Attach base nailer to metal roof deck using self-tapping stainless steel sheet metal screws (STSMS) with plate washers or with minimum 3/8 IN Type 304 stainless steel hex head bolts with nuts and washers.
            b) Countersink heads of bolts flush with top of nailer.
         2) Concrete decking attachment:
            a) Attach base nailer to concrete roof deck using minimum 3/8 IN stainless steel adhesive anchors with minimum 3 IN embedment.
            b) Countersink heads of bolts flush with top of nailer.
         3) Provide size and spacing of anchorage as required to meet loading criteria specified.
            a) Fasten blocking for perimeter flashing in accordance with ANSI/SPRI ES-1 and FM Global 1-49.
      c. Provide 1/2 IN vent spaces between lengths of nailers.

d. Install nailers over vapor retarder.

E. When wood has been exposed to moisture allow to completely dry out prior to covering with additional wood or another material.

F. Correct or replace wood which shows bowing, warping or twisting to provide a straight, plumb and level substrate for applications of other materials.

END OF SECTION

SECTION 06 82 00 - FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fiberglass reinforced plastic (FRP) fabrications including but not limited to:
      a. Ladders.
      b. Railings.
      c. Stairs.
      d. Backup float stilling wells.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 15 19 – Anchorage to Concrete
   3. Section 05 50 00 - Metal Fabrications.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. A14.3, Ladders - Fixed - Safety Requirements.
   2. ASTM International (ASTM):
      a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   3. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   4. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

1.4 DEFINITIONS

A. Skid-resistant:
   1. Manufacturer's standard applied abrasive grit coating.
   2. Abrasive coated tape is not acceptable.

B. FRP: Fiberglass Reinforced Plastic.

C. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

D. Handrail: A railing provided for grasping with the hand for support.
E. Railing: A generic term referring to guardrail, handrail and/or stair rails.
F. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.5 SYSTEM DESCRIPTION

A. All fiberglass reinforced plastic systems shall be designed by a registered Professional Structural Engineer licensed in the State of Illinois.

1.6 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
B. Samples:
   1. Ladder section 12 IN long.
   2. Rail section 12 IN long.
   3. Each component of system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle each item to preclude damage.
B. Store all items on skids above ground.
   1. Keep free of dirt and other foreign matter which will damage items or finish and protect from corrosion and UV exposure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ladders:
      a. American Grating.
      b. Enduro Composite Systems.
      c. Fibergrate Composite Structures, Inc.
      d. IKG Industries.
      e. Mona Composites.
      f. Seasafe, Inc.
      g. Strongwell.
   2. Railings:
      a. AICKIN.
      b. American Grating.
      c. Enduro Composite Systems.
      d. Fibergrate Composite Structures, Inc.
      e. IKG Industries.
      f. International Grating Inc.

g. Mona Composites.
h. Seasafe, Inc.
i. Strongwell.

3. Stairs:
   a. Enduro Composite Systems.
   b. Fibergrate Composite Structures, Inc.
   c. Mona Composites.
   d. Seasafe, Inc.
   e. Strongwell.
4. Backup float stilling wells:
   a. Fibergrate.
   b. Strongwell.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Fiberglass Reinforced Plastic (FRP):
   1. All structural materials, stair treads, risers, and rails to be non-combustible to meet IBC 703.5, 703.5.1, and 703.5.2.
   2. Vinyl ester with fiberglass reinforcing.
   3. Polyester resin with fiberglass reinforcing.
   4. Type I.
   5. Fire retardant.
      a. Flame spread: ASTM E84, 25 or less.
   6. Color: To be selected by Engineer when more than one (1) color is available for any one (1) component.

B. Fasteners, Clips, Saddles, and Miscellaneous Components:
   1. Fiberglass where possible.
   2. Stainless steel may be used if fiberglass component is not available.

C. Adhesive: Recommended by manufacturer.

D. Skid-resistant Surfacing: Manufacturer-applied abrasive grit coating.

2.3 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. Chemical resistance.
      a. System shall be capable of withstanding continual full immersion in storm water:
   3. Preassemble items in shop to greatest extent possible.
   4. All components shall be treated with UV inhibitor.
   5. Drill or punch holes with smooth edges.

B. Ladders:
   1. Design in accordance with ANSI A14.3, OSHA Standards and Building Code requirements unless noted otherwise below.
   2. Ladders shall be designed to support a minimum 300 LB concentrated vertical load with 150 LB concentrated horizontal load without failure or permanent set.
      a. Maximum lateral deflection: Side rail span/300.
   3. Rungs:
      a. 1 IN square or diameter solid bar with skid-resistant surface on all sides.
      b. Uniform maximum spacing of 12 IN.
      c. Top rung level with top of platform.
      d. Rungs shall not extend beyond the outside face of the ladder side rail.
   4. Rails:
      a. 2 IN SQ tube, minimum 0.156 IN thick.
      b. Provide minimum 1/2 x 2-1/2 IN x length required standoff brackets on each side rail with punched holes for 3/4 IN anchors.
         1) Maximum vertical spacing: 5 FT OC.
      c. The side rails of through ladder extensions shall extend 42 IN above the top rung or landing and shall flare out on each side to provide a clearance of 24 IN between the rails.
   5. Minimum distance from centerline of rungs to wall or obstruction shall be 7 IN.
   6. Ladder fall protection systems: Provided by Department.
   7. Ladder safety extension post: See Specification Section 05 50 00.

C. Railings:
   1. Custom fabricate handrail and guardrail to profiles and dimensions indicated on Drawings.
   2. Where not indicated on Drawings, set intermediate horizontal rails to requirements of Building Code.
   3. Minimum 2 IN SQ x 0.25 IN tube.
   4. Toeboard:
      a. 4 x 1/2 IN (corrugated) x 0.125 IN thick.
      b. Provide at all elevated platforms and where required by OSHA Standards.
   5. Provide handrail supports at 4 FT maximum spacing for wall brackets and 4 FT maximum spacing for posts.
      a. Provide vertical supports at 4 FT maximum spacing on all inclined rail sections.
      b. Provide brackets which provide a 1-1/2 IN projection from finish wall surface or guardrail to wall or guardrail side of rail.
      c. Handrails shall not project more than 4-1/2 IN into required stairway width.

6. Fit exposed ends of guardrails and handrails with solid terminations.
   a. Return ends of handrail to wall but do not attach end to wall.
   b. Where guardrail terminates at a wall or other obstruction, provide a vertical support post located 4 IN off wall or obstruction to center of post.
7. Design railings to resist loading as required by the Building Code, no less than force applied at any point in any direction without failure or permanent set
8. Form connections with flush, smooth, hairline joints.
   a. Provide concealed splice fitting at all connections.
   b. Top rail splices and expansion joints shall be located within 8 IN of support.
9. Fabricate items free of blemishes, seam marks, roller marks, rolled trade names and roughness.
10. Provide removable railing where indicated.
11. Provide weeps to drain moisture from hollow railing sections at exterior and in high humidity areas.
    a. 1/4 IN weep hole in railing 1 IN above walkway surface at bottom of posts set in concrete or otherwise closed at bottom, and at other low points where moisture can collect.

D. Stairs and Landings:
   1. Fabricate and design stair and landing assembly to support a 1000 LB concentrated, moving load or 100 PSF whichever requires stronger component.
   2. Design, fabricate, and install in compliance with applicable codes.
   3. Stair treads shall have 1 IN nosing with skid proof nosing surface.
   4. On stair treads over 36 IN wide, provide center riser reinforcement to limit deflection to 1/4 IN 6 MM maximum.

E. Backup Float Stilling Wells:
   1. Custom fabricate stilling wells to the dimensions indicated on Drawings.
   2. Where not indicated on Drawings, set intermediate horizontal rails to add structural rigidity such that the stilling well does not bow or flex more than 1/2 IN any direction. Stilling well sections shall have members that resist racking.
   3. Minimum 4 IN x 4 IN x 3/8 IN L angles and plate framing members.
   4. Minimum 3/8 IN side plate thickness.
   5. Design stilling wells to be self-supporting in the vertical direction. Intermediate supports shall not be designed to carry any vertical load.
   6. Design stilling wells to resist a lateral force of 60 LBS at the base of the structure in the direction of the flow of water to simulate the force of water imparted on the structure due to drag.
   7. Fabricate items free of blemishes, seam marks, roller marks, rolled trade names and roughness.
   8. Drill holes in flanges of adequate size to receive assembly hardware and to align stilling well sections for stacking.
   9. Provide a means of attaching intermediate lateral supports to the stilling well.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Set work accurately in location, alignment and elevation, plumb, level, and true.
   1. Measure from established lines and levels.
   2. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.
   3. Tolerances:
      a. Maximum variation from plumb in vertical line: 1/8 IN in 3 FT.
      b. Maximum variation from level of horizontal line: 1/4 IN in 20 FT.
      c. Maximum variation from plan location: 1/4 IN in 20 FT.

C. Railings:
   1. Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length.
      a. Plumb posts in each direction.
   2. Provide posts with floor flange, attached to post and with predrilled holes for bolting to stringer, floor or beam.
   3. Anchor handrails to walls or guardrails with brackets designed for condition.
      a. For concrete and solid masonry anchorage, use stainless steel anchors with stainless steel
      b. Anchor size and embedment to be designed by component fabricator.
         1) Provide minimum of 1/2 IN anchor bolts.

D. Fasten railings to beams and stair stringers with fiberglass bolts, nuts and washers. Stainless steel as alternate if allowed.
   1. Provide two (2) washers for each bolt.

E. Coat all exposed surfaces of stainless steel fasteners with minimum 15 MIL gel coating to match component being anchored.

F. File cut ends of all fiberglass to a 1/32 IN radius.

G. Seal cut ends of all items with catalyzed resin as recommended by manufacturer.
   1. Provide same resin used in fabrication of item as a minimum.

H. Provide all modular framing components as required to suit condition.
   1. Install in accordance with manufacturer's recommendations.

I. Stilling wells:
   1. Provide lateral support brackets at interval required to meet maximum deflection limits above. Intermediate support spacing shall not exceed 15-FT.
   2. Intermediate support brackets shall be of stainless steel or FRP construction.
   3. Anchor bolts into the concrete walls shall be stainless steel of a minimum diameter of 1/2 IN or as required to resist the forces on the stilling well.
   4. Stilling wells shall be installed plumb and shall bear on grout as indicated on the Drawings.

END OF SECTION

DIVISION 07
THERMAL AND MOISTURE PROTECTION

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SECTION 07 17 00 - BENTONITE COMPOSITE SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bentonite composite sheet waterproofing system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D751, Standard Test Methods for Coated Fabrics.
      b. D903, Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
      c. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      d. D5887, Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
      e. D5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
      f. D5993, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
      g. D6768, Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

B. Qualifications:
   1. Installer(s) to have completed a minimum of three (3) other projects of similar scope within last three (3) years.
   2. Contractor and all installers working on the project must be approved in writing by manufacturer.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.5 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Carlisle Coatings & Waterproofing.
   2. Tremco Inc.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MANUFACTURED UNITS

A. Bentonite Composite Sheet Waterproofing:
   1. Sodium bentonite clay evenly distributed and bonded to composite geotextile fabric and HDPE film.
   2. Carlisle "CCW MiraCLAY GM".

B. Accessory Items:
   1. Flashing, sealant, termination bars, fasteners, and ancillary items as required by manufacturer for a complete, waterproof system.

C. Protection Board: Extruded Polystyrene.
   1. Thickness: Minimum 1/4 IN.
   2. Fan-fold, 4 FT by 50 FT.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Bentonite Composite Sheet Waterproofing:
   1. Bentonite mass/unit area: ASTM D5993, minimum 1 LB/SF.
   2. Swell index: ASTM D5890, minimum 24 ml.

3. Tensile strength: ASTM D6768, 30 LB/IN MARV.
4. Permeability: ASTM D5887, $5x10^{-11}$ m/s maximum.
5. Elongation: ASTM D4632, 150 PCT.
   a. Measure at maximum peak in the weakest principle direction.
6. Hydrostatic head pressure: ASTM D751, 228 FT.
7. Adhesion to concrete: ASTM D903, 17.7 LB/IN.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ensure that concrete has been cured in accordance with manufacturer's recommendations.

B. Remove free standing water, debris, and loose material.

C. Fill all voids, seal all penetrations, and remove all sharp fins and ridges.

D. Seal all penetrations in accordance with Specification Section 01800.

E. Repair concrete surfaces in accordance with Specification Section 03348.
   1. Fill voids and remove all sharp fins and ridges.

3.2 INSTALLATION

A. Install continuous waterproofing membrane to all below grade surfaces where indicated on Drawings.
   1. Terminate top of membrane within 4 IN of finished grade.
   2. Extend membrane over footings and seal to bottom edge of footing.
   3. See drawings for unique conditions and terminations.

B. Install products in accordance with manufacturer's instructions.
   1. Provide granular bentonite cants at horizontal-to-vertical junctions.
   2. Overlap upper courses over lower courses with minimum 4 IN lap.
   3. Stagger seams minimum 12 IN.
   4. Seal around all penetrations in accordance with manufacturer's recommendations.

C. Provide all waterstops, sealant, termination bars, fasteners and other accessories required for a watertight installation.

D. Avoid panel damage during pouring and vibrating of concrete for slab work and during backfilling operations for wall work.

E. Install protection board immediately prior to backfilling.
   1. Temporarily secure protection board using manufacturer's recommended tape or adhesive.
      a. Do not mechanically fasten or penetrate waterproofing in any way.

3.3 FIELD QUALITY CONTROL

A. Field Testing: Testing to conform with the provisions of IDOT standard specifications

B. Manufacturer authorized representative shall inspect substrate for acceptability prior to application of waterproofing membrane.
   1. Provide written documentation of inspection, including identification of

deficiencies and remedies provided.

C. Manufacturer authorized representative shall inspect completed installation prior to installation of protection board or backfilling.
   1. Perform flood testing of installed membrane to demonstrate water-tightness.

3.4 PROTECTION

A. Protect panels as required from pre-hydration caused by precipitation or other construction activities.

B. Protect system from physical damage until backfilling is completed.

C. Repair or replace damaged materials in accordance with manufacturer's recommendations as necessary to ensure a waterproof installation.

END OF SECTION

SECTION 07 19 00 - LIQUID WATER REPELLENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Liquid water repellent.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 04 21 13 - Brick Masonry.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Material must not inhibit the adhesion of future paint coatings.

B. Mock-Ups:
   1. Product shall be applied to mock-up erected under Division 03.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 WARRANTY

A. Provide manufacturer's standard five (5) year performance warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Liquid water repellent:
      a. L&M Construction Chemicals, Inc.
      b. Chemprobe Technologies, Inc.
      c. Hydrozo, Inc.
      d. Degussa.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the

equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Liquid Water Repellent Type 2:
   1. Clear, deep penetrating sealer formulated for sealing vertical concrete and brick surfaces.
      a. Water based, VOC compliant, odorless.
         1) VOC: Less than 195 g/L.
      b. Non-yellowing, non-staining.
      c. Provides both surface barrier and penetrating chemical action barrier.
   2. Surface barrier shall protect against water intrusion, mildew, dirt and airborne contaminants.
   3. L&M Construction Chemicals, Inc. "HYROPEL WB."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect adjacent surfaces not intended to be covered.

B. Clean surfaces to be covered in accordance with manufacturer's recommendations.

C. Make all mortar repairs at least 48 HRS prior to application.

D. Allow masonry surfaces to cure minimum of 10 days prior to application.

3.2 INSTALLATION AND APPLICATION

A. Install products in accordance with manufacturer's instructions.
   1. At a minimum apply material in accordance with manufacturer's recommended application rates using procedures and equipment recommended by manufacturer.
      a. Apply two (2) coats of material.
   2. Using manufacturer's recommended application rates, apply as many coats of material as necessary to obtain results required by the FIELD QUALITY CONTROL Article.

B. Apply liquid water repellent "Type 2 IN to exterior concrete precast concrete surfaces where indicated and to exterior brick surfaces.

3.3 FIELD QUALITY CONTROL

A. Field Testing: Testing to conform with the provisions of IDOT standard specifications

B. Manufacturer or manufacturer's designated representative shall conduct a water spray test to an area of the mock-up wall for a period of 5 HRS.
   1. Water from the spray shall impact the wall at a 45-degree angle to the vertical and shall cover an area of not less than 9 SQFT.
   2. Water flow shall be minimum 5 GPM at 60 PSI pressure.
   3. If, within 5 HRS, moisture appears on the inside face of the wall within the test area, the wall shall be recoated.

C. Retest as required.

D. Recoat as required until wall area remains dry within limits of testing procedure.

E. Results of this test shall be used to determine material quantity in excess of manufacturer's minimum recommended amounts to be applied per square foot to the building surface.

F. Protect adjacent materials not required to be coated.

3.4 SCHEDULE

A. Apply liquid water repellent to the following surfaces:

STRUCTURE	SURFACE
Pump station	Interior face at precast concrete panels

END OF SECTION

SECTION 07 54 19 - PVC MEMBRANE ROOFING - FULLY ADHERED

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Roof insulation.
2. Membrane roofing, cover board, and base flashings.
3. Vapor retarder.
4. Insulated curbs for roof penetrations of ductwork or piping.

B. Related Specification Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
2. Section 06 10 00 - Rough Carpentry.
3. Section 07 62 00 - Flashing and Sheet Metal.
4. Section 26 05 03 - Electrical: Basic Requirements.
5. Section 40 05 07 - Pipe Support Systems.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
1. ASTM International (ASTM):
a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
b. C642, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.
c. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
d. D395, Standard Test Methods for Rubber Property - Compression Set.
e. D573, Standard Test Method for Rubber - Deterioration in an Air Oven.
f. D638, Standard Test Method for Tensile Properties of Plastics.
g. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
h. D4434, Standard Specification for Poly (Vinyl Chloride) Sheet Roofing.
i. D5147, Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
j. D6294, Standard Test Method for Corrosion Resistance of Ferrous Metal Fastener Assemblies Used in Roofing and Waterproofing.
k. E96, Standard Test Methods for Water Vapor Transmission of Materials.
2. FM Global (FM):
a. Approval Standard 4470, Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.

b. 4470, Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built- Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.

3. Underwriters Laboratories, Inc. (UL):
   a. 790, Standard for Standard Test Methods for Fire Tests of Roof Coverings.

B. Qualifications:
   1. Manufacturer shall have a minimum of 10 years continuous recent experience in the manufacture of membrane roofing systems similar to system specified.
      a. Manufacturer to have similar systems in place that meet or exceed warranty length as specified.
   2. Applicator factory trained and approved in writing by roofing manufacturer.
   3. Applicator shall have a minimum of 10 years of experience installing membrane roofing systems similar to system specified.
      a. Minimum of five (5) years of the 10 years of experience shall have been spent installing roof systems manufactured by company proposed for use.
      b. Applicator shall have minimum of five (5) years installation experience using heat welded seaming equipment and testing of heat welded seams for seam integrity.
   4. Manufacturer's Technical Field Representative shall have minimum 10 years of experience in field installation and applicator training and approval process.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.5 SYSTEM DESCRIPTION

A. Fully adhered single-ply roofing system over concrete deck, including but not limited to:
   1. Vapor retarder.
   2. Roof insulation.
   3. Cover board.
   4. Single-ply reinforced PVC membrane.
   5. Flashings, expansion joints, penetrations and/or other materials necessary for a complete installation.
   6. Walkway protection.

1.6 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

B. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

C. Store membrane rolls lying down on pallets and fully protected from the weather with clean canvas tarpaulins.
   1. Unvented polyethylene tarpaulins are not acceptable.

D. Store adhesives at temperatures recommended by manufacturer.

E. Replace all materials that become damaged during storage prior to installation.
   1. Remove damaged material from the Site.

F. Protect insulation from direct exposure to sunlight.

1.8 WARRANTY

A. Manufacturer's 10 year system warranty.
   1. Warranty to cover roofing membrane, insulation, and roofing manufacturer provided accessories.
   2. Warranty to cover manufacturer's authorized applicator workmanship applied to the roof membrane identified in the preceding paragraph.
   3. Warranty period to commence on date of Engineer's final acceptance of the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. PVC roofing membrane:
      a. Sika Sarnafil, Inc.
      b. I.B. Systems.
   2. Insulation:
      a. Sika Sarnafil, Inc.
      b. Atlas Building Products.
      c. Hunter Panels.
      d. I.B. Systems.
   3. Vapor retarder:
      a. Sika Sarnafil, Inc.
      b. I.B. Systems.
   4. Other materials:
      a. Manufacturers as noted.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility

to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 DESIGN CRITERIA

A. Roof Assembly:
   1. Fire resistance: UL 790, Class A.
   2. Hail and wind uplift resistance: FM Approval Standard 4470, Class 1-60 minimum.

2.3 SYSTEM COMPONENTS

A. Membrane:
   1. Reinforced PVC (polyvinyl chloride) sheet with lacquer coating.
      a. Meet requirements of ASTM D4434, Type II, Grade 1.
      b. Thickness:
         1) 0.060 IN.
         2) Sheet width to be determined by manufacturer.
         3) Provide widest sheet possible.
         4) ASTM plus or minus tolerance for membrane thickness is not acceptable.
            a) Provide certification of specified mil thickness.
      c. Color:
         1) White.
         2) Reflectivity: 0.83.
         3) Emissivity: 0.92.
         4) Solar reflective index (SRI): Greater than 104.
   2. Physical properties:
      a. Tensile strength, minimum psi: ASTM D638, 1600.
      b. Elongation at break, minimum: ASTM D638, 270 PCT machine by 250 PCT transverse.
      c. Seam strength, minimum (percent of tensile strength): ASTM D638, 80.

B. Insulation:
   1. Rigid, HCFC free, isocyanurate foam insulation boards with approved faces for adhered membrane application.
      a. Size:
         1) 4 FT x 4 FT with 2 IN thick base layer at roof drain locations and scupper openings unless noted otherwise on the Drawings.

2) 4 FT x 8 IN boards acceptable on mechanically attached applications.

b. Total thickness as indicated on the Drawings.
c. ASTM C1289, Class 1, Type II, faced rigid cellular polyisocyanurate.
d. Density: 2 PCF.
e. Compressive strength: 25 PSI.
f. Board edges: Square.
g. Thermal value: R value (long term thermal resistance) minimum 6.2.
h. Moisture vapor transmission: Less than 1.0 perm.
i. Tapered insulation: Same material as base layer of insulation tapered to provide 1/4 IN per foot of slope.

C. Vapor Retarder:
1. Self-adhered multi-ply reinforced sheet.
a. SBS modified bitumen with high-density polyethylene grid laminated between two (2) layers of polyethylene film.
b. Thickness: 32 MIL minimum.
c. Water vapor permeance: ASTM E96, maximum 0.10 perms.
d. Breaking strength, MD/XD: ASTM D5147, 64/88 LB/IN.

D. Cover Board:
1. Thickness:
a. 1/4 IN.
b. Size: 4 x 4 FT or 4 x 8 FT.
2. Non-structural glass mat faced, water resistant, non-combustible silicone treated gypsum core panel approved for use as a substrate under fully adhered PVC roofing membranes.
a. Top surface shall be pre-primed to enhance adhesion.
3. Georgia Pacific Corp. "Dens-Deck Prime."

E. Adhesives:
1. Proper type as required for substrate and service being adhered.
2. Only solvent base adhesives are acceptable.
3. Provide primers as required for all adhesives.

F. Vent Pipe Flashing, Sealants, Prefabricated Inside and Outside Flashing Corners, Termination Bars and Batten Strips:
1. Provide manufacturer's standard premolded, prefabricated PVC product that best suits the condition encountered.
2. Provide aluminum termination bars.
a. Size: 2-1/4 IN deep by 0.10 IN thick extruded bar with predrilled holes at 8 IN OC.
3. Batten strips:
a. Minimum 14 GA channel shaped steel bar, galvanized, ASTM A653.
b. Fastener holes predrilled prior to galvanizing process.

G. Miscellaneous Fasteners and Anchors: Provide all miscellaneous fasteners and anchors as required for a free draining, water and air tight roofing system.

H. Wood Blocking and Nailers: See Specification Section 06 10 00.

I. Fasteners:

1. Ferrous components:
   a. Test in accordance with ASTM D6294.
   b. Meet or exceed FM 4470.
2. Provide stainless steel for all exposed fasteners.

2.4 ACCESSORIES

A. Sheet metal fabrications, including but not limited to coping, and counterflashing.
   1. See Specification Section 07 62 00.
B. Walkway Protection:
   1. Weldable, polyester reinforced PVC membrane.
      a. Minimum thickness: 96 mils.
      b. Color: Light gray.
   2. Minimum 39 IN wide.
   3. Embossed surface.
C. Pipe, Duct and Conduit Supports:
   1. 100 PCT recycled rubber.
      a. Density: ASTM C642, minimum 0.50 OZ/cubic IN.
      b. Compressive deformation:
         1) ASTM D395.
         2) 5 PCT at 70 PSI and 72 DEGF.
      c. Brittleness at low temperature: ASTM D746, -50 DEGF.
      d. Weathering: ASTM D573, 70 HRS at 120 DEGF.
   2. Uniform load capacity: 500 LBS per lineal FT.
   3. Size:
      a. Width: 6 IN.
      b. Length and height as necessary for item being supported.
   4. Compatible with modular framing.
   5. Provide modular framing, pipe supports, pipe clamps or other accessories as necessary for items being supported.
      a. See Specification Section 40 05 07 and Specification Section 26 05 00 as applicable.
   6. Similar to Cooper B-Line "DURA-BLOK."

PART 3 - EXECUTION

3.1 PREPARATION

A. Pre-Installation Conference:
   1. The applicator, roofing manufacturer's Technical Installation Representative, Engineer and Contractor shall attend a pre-installation conference.
   2. The meeting shall discuss all aspects of the Project including but not limited to:
      a. Safety.
      b. Setup.
      c. Schedule.
      d. Material storage and handling.
      e. Replacement of unacceptable materials prior to and during

installation and disposal of unacceptable materials.

B. Applicator to verify that area to be roofed is free of ice/snow, water, dirt, incompatible materials, sharp objects, and miscellaneous debris that may damage the membrane or the vapor retarder.

3.2 INSTALLATION

A. Install all materials in accordance with manufacturer's written instructions.

B. Manufacturer's installation procedures take precedence over this Specification Section.

C. Provide wood nailers and blocking as necessary for a complete installation.

D. Vapor Retarder:
   1. Install over concrete decking as applicable using adhesive recommended by the manufacturer.
   2. Cut around roof penetrations and seal vapor tight.
   3. Extend vapor retarder up face of parapet wall to top of roof insulation.
   4. Lap side joints minimum 4 IN, lap end joints minimum of 6 IN and seal all laps with adhesive then tape raw edge of lap.
   5. Repair all damage, tears, holes, and nicks in accordance with vapor retarder manufacturer's recommendations.
      a. Verify compatibility of adhesive with vapor retarder patching method and materials.
   6. Do not piece vapor retarder together using scraps.

E. Installation of Insulation:
   1. Cut insulation neatly to fit around all roof penetrations, projections, and changes in thickness of concrete topping.
   2. Before installation is started, remove trash, debris, grease, oil, water, moisture and contaminants from substrate to receive insulation.
      a. Prepare all surfaces according to applicable Specification Sections.
   3. Bottom layer of insulation shall be installed with all joints tightly butted and end joints staggered 12 IN minimum.
      a. Additional layers shall be installed over preceding layers with all joints tightly butted and end joints staggered 12 IN minimum.
   4. Attach insulation using adhesive in accordance with manufacturer's recommendations for uplift rating specified.
   5. Provide tapered insulation where shown on the Drawings or where required.
   6. Provide crickets behind all roof penetrations larger than 12 IN.
   7. Do not install boards that have been damaged and/or broken into pieces unless the area to be insulated requires a smaller piece.
      a. Trim damaged boards prior to use to provide straight edges and square corners.

F. Provide roofing manufacturer’s recommended sleeper at all duct support structures, condensing units or similar equipment.
   1. Fasten sleeper to deck as necessary to resist uplift.
   2. Flash sleeper to roof membrane as recommended by roofing manufacturer.

G. Installation of Cover Board:
   1. Lay cover board over top of insulation tightly butted and cut to fit around all penetrations.
      a. Stagger end joints 12 IN minimum.
   2. Attach cover board using adhesive in accordance with manufacturer's recommendations for uplift rating required.
   3. Seal around all penetrations with sealant acceptable to insulation and roof membrane manufacturer.
   4. Do not install boards that have been broken into pieces smaller than 4 FT x 4 FT unless the area to be covered requires a smaller piece.
      a. Trim damaged boards prior to use to provide straight edges and square corners.

H. Installation of Roofing:
   1. Install roof membrane and flashing using adhesives recommended by roofing manufacturer. Mechanical fasteners shall not penetrate through the supporting roof structure, adjust length as required.
   2. Extend roofing to face of parapet wall and secure.
   3. Extend flashing up parapet wall.
      a. Install flashing up parapet wall over top of wood blocking on top of parapet wall and down opposite face to bottom of wood blocking unless noted otherwise.
      b. Provide in one (1) piece with no horizontal joints.
      c. Extend flashing onto roof surface as required by manufacturer.
   4. Install flashing at all vertical surfaces, roof interruptions and penetrations.
      a. Flash all roof penetrations in accordance with roofing manufacturer's standard details unless indicated otherwise on the Drawings.
   5. Heat weld and test all seams the same day they are laid.
   6. Install walkway protection where indicated.
      a. Heat weld into place.
      b. Use only full width pieces of walkway protection cut to fit.
         1) Torn or otherwise damaged sections of walkway protection will not be accepted.
      c. Provide breaks in walkway protection to avoid ponding of water on sloped portions of roofing.

3.3 FIELD QUALITY CONTROL

A. Provide for manufacturer's Technical Field Representative time during Pre-Installation Conference, job start-up, and every two (2) weeks, with a minimum of two (2) site visits during roofing application.
   1. Manufacturer's Technical Field Representative shall inspect all roofing, flashing, and spot test welded seams at completion, generate punch list and provide copy of punch list to Engineer.
   2. Include all applicable costs.

B. Protect installed insulation from water using water cut-offs in bad weather and at end of work period.

C. Remove and replace wet and/or damaged insulation and cover board.

D. On-site quality reviews of all welded seams shall be performed by Applicator prior to stopping work each day:
   1. Provide subsequent report identifying the location(s) of all seam failures and repairs made to that seam.
      a. Manufacturer's guidelines shall be followed and all protocol shall be maintained if a seam fails the quality review.

END OF SECTION

SECTION 07 62 00 - FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Architectural flashing and sheet metal work.
   2. Factory formed copingsystem
   3. Prefinished scuppers, conductor heads and downspouts.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 07 54 19 - PVC Membrane Roofing - Full Adhered.
   3. Section 07 72 33 - Roof Hatches.
   4. Section 07 92 00 - Joint Sealants.
   5. Section 08 62 00 - Skylight.
   6. Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   2. American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI):
      a. ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roof Systems.
   3. ASTM International (ASTM):
      a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
      b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      c. B32, Standard Specification for Solder Metal.
      d. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   4. FM Global (FM).
   5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Architectural Sheet Metal Manual, Seventh Edition, 2012.

B. Qualifications:
   1. Sheet metal fabricator shall have minimum 10 years of experience in fabrication of sheet metal items similar to items specified.

2. Sheet metal installer shall have minimum five (5) years of experience installing sheet metal items specified.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. PVDF: Polyvinylidene fluoride.

1.5 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pre-finished sheet metal:
      a. Carlisle.
      b. Firestone Building Products.
      c. Petersen Aluminum Corp.
   2. Factory-formed coping system.
      a. W.P. Hickman Co.
      b. Metal Era, Inc.
   3. Butyl sealant:
      a. Pecora.
      b. Sika.
      c. Tremco.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in

Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Sheet Metal:
   1. Stainless Steel: ASTM A666.
      a. Type 304.

B. Fasteners: Non-ferrous compatible with sheet metal.

C. Sealants:
   1. Non-curing Butyl Sealant:
      a. Pecora “BA-98”.
      b. Sika “SikaLastomer 511”.
      c. Tremco “TremPro JS-773”.
   2. Building sealants:
      a. See Specification Section 07 92 00.

D. Fasteners: Stainless steel, compatible with sheet metal.

E. Retainer Clips and Continuous Cleats: Stainless steel.

F. Solder: ASTM B32.

G. Dissimilar Metal Protection: Comply with Specification Section 09 96 00.

H. Reglets: See Specification Section 04 05 23.

2.3 MANUFACTURED ITEMS

A. Factory Formed Coping System:
   1. Formed coping piece which locks to anchor plate fastened to top of wall.
   2. ANSI/SPRI ES-1 tested.
   3. FM approved.
   4. Coping cover:
      a. Stainless steel, 304-2B
         1) Thickness: 22 GA.
   5. Anchor plate: Continuous cleat, galvanized steel minimum 20 GA.
   6. Splice plates: Aluminum, minimum 0.032 IN.
      a. Continuous, minimum 6 IN long.
      b. Front and back legs with extruded butyl seal.
      c. Finish: Match coping.
   7. Factory fabricated accessories, including but not limited to:
      a. Corners, end caps, end terminations.
      b. All accessories to be factory mitered and welded.
   8. Profile:
      a. Metal-Era "Perma-Tite Tapered."
      b. Front leg: 6 IN.
      c. Back leg: 5 IN.

B. Finish:
   1. Architectural Class 1 coating per AA DAF 45, 304-2B stainless steel.
      a. SS - ASTM A480, No. 4 finish.

2.4 FABRICATED ITEMS

A. General:
   1. Shop fabricate items to maximum extent possible.
      a. Fabricate true and sharp to profiles and sizes indicated on Drawings.
         1) Shop fabricate and weld or solder all corners.
   2. Stainless steel:
      a. Thickness: Minimum 0.050 IN.
      b. Texture: Smooth.
      c. ASTM A480, No. 4 finish.

B. Scupper and Conductor Head:
   1. Roofing manufacturer's recommended through-wall scupper design.
      a. Size and location(s) as shown on Drawings.
   2. Conductor head profile per SMACNA Figure 1-25F.
      a. Provide 1 IN x 4 IN overflow opening with drip edge on front face of conductor.
   3. 4 IN long outlet tube.
      a. Size and shape to match downspout.
   4. Debris screen:
      a. Installed in top of conductor head.
      b. 1/4 x 1/4 IN aluminum mesh screen.
      c. Screen shall be removable without damage to screen or conductor head.

C. Downspouts:
   1. Rectangular open-face style similar to SMACNA Figure 1-32E 5 IN min width.
      a. Horizontal cross brace at 5 FT maximum spacing w/ 20Ga min SS straps anchored to panel in drilled exp anchors.
   2. Fabricated in longest practical lengths.

D. Splash Block:
   1. Rectangluar concrete splash block, as defined in architectural standard details.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction to Contractor in time to allow their installation.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions, SMACNA, and as indicated on Drawings.

B. Weld materials to achieve weathertight joints and required details.
   1. Do not weld slip joints.
   2. Touch-up damaged prefinished items.

C. Solder steel to achieve weathertight joints and required details.
   1. Do not solder slip joints.

2. Touch-up damaged prefinished items.

D. Set top edges of membrane flashing and sheet metal flashing into reglets wherever practicable.
   1. Surface applied terminations will be allowed only where specifically detailed or otherwise approved in writing by the Engineer.
   2. Provide counterflashing at all reglets.
   3. Seal reglets and counterflashings in accordance with Specification Section 07 92 00.

E. Fasten materials at intervals recommended by SMACNA.

F. Install slip joints to allow for thermal movement as recommended by SMACNA and manufacturer.
   1. Maximum spacing: 10 FT OC.
   2. Provide slip joint 24 IN from corners.
   3. Provide slip joint at each vertical expansion joint location in wall.
      a. Provide break in continuous cleat at each vertical expansion joint.
      b. The above expansion joints do not include brick veneer expansion joints.

G. Seal slip joints with two (2) beads of non-curing butyl sealant on each side of slip joint overlap.

H. Form flashings to provide spring action with exposed edges hemmed or folded to create tight junctures.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact or where sheet metal contacts mortar, concrete masonry or concrete.

J. Provide all miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weathertight installation.
   1. Provide all components necessary to create weather-tight junctures between roofing and sheet metal work.

K. Provide sheet metal liner at exposed-to-view openings through roof deck, including but not limited to:
   1. Roof hatches: See Specification Section 07 72 33.
   2. Insulated Skylights: See Specification Section 08 68 00.

L. Design Criteria:
   1. Install per manufacturer's requirements to meet the following minimum design wind loads as required by IBC and per FM 4435/ES-1 Standard.
      a. Basic wind speed: 105 mph.
      b. Horizontal design pressure: 30 psf.
      c. Vertical design pressure: 50 psf.

END OF SECTION

SECTION 07 72 33 - ROOF HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof hatches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.
   3. Section 07 54 19 - PVC Membrane Roofing - Fully Adhered.
   4. Section 07 62 00 - Flashing and Sheet Metal.
   5. Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. Occupational Safety and Health Organization (OSHA).

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 WARRANTY

A. Roof Hatches: Manufacturer's standard five (5) year warranty.

B. Hatch Rail System: Manufacturer's standard 25 year warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products specified are manufactured by "The Bilco Company."

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Roof hatches:
      a. Bilco.
      b. Dur-Red Products.

c. Milcor Inc.

C. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Sheet Metal:
   1. Stainless steel: Type 304.

B. Insulation:
   1. Curb: R-18 min.
   2. Cover: R-25 min.

C. Gaskets: Thermoplastic or extruded EPDM Rubber.

D. Hardware: Type 316 stainless steel, unless noted otherwise.

E. Anchors:
   1. Stai
   nless
   steel. 2.

F. Hatch Rail System: FRP safety rail system.
   1. Posts and rails:
      a. Pultruded fiberglass.
      b. UV resistant.
      c. Fire retardant.
      d. Color: Hazard yellow.
   2. Mounting brackets: Type 316 stainless steel.
   3. Hinges and post guides: Type 316 stainless steel.
   4. Fasteners: Type 316 stainless steel.

2.3 MANUFACTURED UNITS

A. General:
   1. 12 IN high.
   2. Fully welded corners.

3. Hardware:
   a. Lifting mechanism and automatic hold-open device.
      1) Vinyl-covered grip handle.
   b. Hinges.
   c. Latch: Operating handles for inside and outside operation.
4. Finish: Satin.

B. Roof Hatches:
1. Curb:
   a. 11 GA.
   b. Integral cap flashing.
   c. Mounting flange:
      1) Minimum 3-1/2 IN wide x 12 IN above finished roof Punched holes for fastening to roof deck.
   d. Insulated, R-25 min.
2. Cover:
   a. Exterior: 11 GA.
   b. Interior: 18 GA liner.
   c. Internally reinforced.
      1) Minimum 40 PSF live loading.
   d. Insulated; R-12 min.
   e. Completely weather sealed and gasketed.
3. Finish: Satin.

C. High Security Roof Hatches:
1. Hardware:
   a. Hinges: Heavy duty w/ lift assist mechanism, and stainless steel welded pins.
   b. Type 316 stainless steel for all other hardware components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units in accordance with manufacturer's installation instructions.

B. Securely anchor units as appropriate.
1. Anchor to concrete with 1/2 IN adhesive anchors.
2. Maximum anchor spacing: 12 IN.
3. Manufacturer's predrilled fastener locations take precedent over this specification.
4. Provide attachment at each corner as a minimum.

C. Flash and counterflash to provide weathertight installation.
1. See Specification Section 07 54 19 for roofing.

D. For units mounted directly to concrete curbs (such as on site vault structures), flash down the sides of the units with single ply roofing membrane flashing material.
1. Extend flashing material horizontally over the unit base mounting flange and out onto the concrete surface a minimum of 3 IN beyond the unit mounting flange.
2. Adhere the membrane to the concrete using recommended adhesive

and seal all membrane edges with sealant recommended by membrane manufacturer.
a. See Specification Section 07 54 19 for membrane flashing.

E. Head Deflector Plate: See Specification Section 05 50 00.
F. Fasten hatch rail system to roof hatch cap flashing in accordance with manufacturer's instructions.
1. Fasten without penetration of roofing membrane or flashing.

G. Adjust all components to provide smooth easy operation.

H. Provide dissimilar metals protection as required.
1. Refer to Specification Section 09 96 00.

3.2 SCHEDULE

A. Model numbers refer to "Bilco" products.

B. Units:
1. Equipment access units:
a. 48 IN x 48 IN: Model "F."

C. Schedule:

ROOF HATCH NO.	DRAW ING NO.	LOCATION	MODEL NO.	REMARKS
RH101	A105	MAIN ROOF	MODEL “F”	Note 1.

Remarks:
1. Provide head deflector.

END OF SECTION

SECTION 07 84 00 - FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Firestopping of joints, through-wall penetrations, and membrane penetrations of fire-resistance rated construction.
   2. Selection of firestopping assemblies.
   3. Engineering Judgments.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

C. Firestopping: Material or combination of materials used to retain integrity of fire rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. E814, Standard Method of Fire Tests of Through Penetration Fire Stops.
      b. E1966, Standard Test Method for Fire Resistive Joint Systems.
      c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      d. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
      e. E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.
      f. E2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
      g. E2837, Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall.
   2. International Firestop Council (IFC).
      a. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments (EJs), referred to herein as IFC Recommended Guidelines.
   3. National Fire Protection Association (NFPA).
      a. 101, Life Safety Code.
      b. 220, Standard on Types of Building Construction.
      c. 221, Standard for High Challenge Fire Walls, Fire Walls, and Fire Barriers.
      d. 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.

e. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

4. Underwriters Laboratories, Inc. (UL):
   a. 1479, Fire Tests of Through Penetration Fire Stops.
   b. 2079, Standard for Tests for Fire Resistance of Building Joint Systems.
   c. 263, Fire Tests of Building Construction and Materials.
   d. 723, Surface Burning Characteristics of Building Materials.
5. Building Code:
   a. International Code Council (ICC):
      1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.
      2) International Fire Code and associated standards, 2015 Edition including all amendments, referred to herein as the Fire Code.

B. Qualifications:
   1. Firestop system installations must meet the requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of the construction being penetrated.
   2. Proposed firestop systems shall conform to applicable governing codes having local jurisdiction.
   3. For those fire stop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents shall follow the requirements set forth by the International Firestop Council.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials undamaged in manufacturers clearly labeled original, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with the manufacturer's requirements, including temperature.

D. Do not use damaged or expired materials.

1.6 PROJECT CONDITIONS

A. Schedule installation of firestopping after completion of penetrating item

installation but prior to covering or concealing of openings.

B. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

C. Do not proceed with the installation of firestop materials when the ambient temperature is outside the manufacturer's recommended limitations for installation and curing times as printed on the product label and product data sheet.

D. During installation provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Expanding silicone elastomer:
      a. Any manufacturer UL listed for system used.
   2. Firestop sealant:
      a. Dow Corning.
      b. 3M Company.
      c. Specified Technologies Inc.
      d. Hilti.
   3. Moldable putty:
      a. 3M Company.
      b. Specified Technologies Inc.
      c. Hilti.
      d. Rector Seal.
   4. Collars:
      a. 3 M Company.
      b. Specified technologies Inc.
      c. Hilti.
   5. Expanding Foams:
      a. 3 M Company.
      b. Hilti.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional

information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. General:
   1. Use only materials that have been UL 1479 or ASTM E 814 tested for specific fire- rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate item.

B. Expanding Silicone Elastomer: UL listed.
   1. Fill, Void or Cavity Materials: Product category XHHW.
   2. Through Penetration Firestop Systems: Product category XHEZ.

C. Firestop Sealant: UL listed one part silicone installed as required by the listed design.

D. Moldable Putty: UL listed, product category QCSN or CLIV, Wall Opening Protective Materials.

E. Firestop collars: UL Listed.

F. Backer rod and/or compressible filler: UL listed, product category XHHW, Fill, Void or Cavity Materials.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Selection and installation of firestopping assemblies is entirely the responsibility of the Contractor.
   2. All firestopping shall be provided in accordance with the Building Code and UL listing requirements as necessary to provide the required fire-resistance rating.
   3. When UL listing is not available, install in accordance with approved written Engineering Judgment.
   4. All firestopping products shall be installed in accordance with the manufacturer's instructions.
   5. Where firestopping will be exposed to view, provide colors matching adjacent construction or paint, if approved by manufacturer, only after inspection and approval by AHJ.
   6. Where firestopping is not exposed to view, provide manufacturer's standard color.

B. Openings and Penetrations:
   1. Provide firestopping assembly tested in accordance with ASTM E814 or UL1479 for all openings, through-penetrations, and membrane penetrations in fire-rated construction.
      a. Provide Flame (F), Thermal(T), Smoke (L), and Water (W) rated assemblies as necessary to meet Building Code requirements.

C. Building Joint Systems:
   1. Provide firestopping assembly tested in accordance with ASTM E1966 and ASTM E1399, or UL 2079 for all joint assemblies in or between fire-resistance-rated walls, floors or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
D. Refer to Specification Section 01 73 20 for Openings and Penetrations requiring fire stopping.

3.2 IDENTIFICATION AND DOCUMENTATION

A. Prior to acceptance, Contractor shall, provide written statement to Engineer that all fire- rated penetrations have been sealed using products specified in accordance with UL requirements for required rating.

B. Provide documents to the Engineer of all listed systems installed and all engineering judgments.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sealing all joints which will permit penetration of dust, air or moisture.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 73 20 - Openings and Penetrations in Construction.
   3. Section 07 84 00 - Firestopping.
   4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
      a. C834, Standard Specification for Latex Sealants.
      b. C920, Standard Specification for Elastomeric Joint Sealants.
      c. C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   3. Underwriters Laboratories, Inc. (UL).

B. Qualifications: Sealant applicator shall have minimum five (5) years of experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Engineer.
      a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.
      b. Each sample shall cure for a minimum of seven (7) days at which time the sealant manufacturer's authorized factory representative shall perform adhesion tests on each sample joint.
         1) Perform adhesion tests per ASTM C1521.
         2) If mock-up is not acceptable or if adhesion test fails, provide additional mock-up and adhesion testing as required until acceptable to Engineer.

1.4 DEFINITIONS

A. Corrosive Areas Include: Entire project is considered corrosive.
B. Defect(ive): Failure of watertightness or airtightness.
C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.
D. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.
E. "Interior wet areas": Entire area is considered wet.
F. "Seal," "sealing" and "sealant": Joint sealant work.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Compressible sealant:
      a. Polytite Manufacturing Corporation.
      b. Emseal.
      c. Norton.
      d. Sandell.
   2. Expanding foam sealant:
      a. Macklanburg Duncan.
      b. Convenience Products.
      c. FAI International, Inc.
   3. Fire-resistant sealant: See Specification Section 07 84 00.
   4. Polyether sealants:
      a. BASF.
      b. ChemLink, Inc.
      c. Tremco.
   5. Polysulfide rubber sealant:
      a. Pecora.

b. BASF.
c. PolySpec.

6. Polyurea joint filler:
   a. Dayton Superior Specialty Chemical Corporation.
   b. Euclid Chemical Co.
   c. L&M Construction Chemicals, Inc.
   d. BASF.
7. Polyurethane sealants:
   a. Pecora.
   b. Sika Chemical Corp.
   c. BASF.
   d. Tremco.
8. Backer rod, compressible filler, primer, joint cleaners, bond breaker:
   As recommended by sealant manufacturer.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler:
      a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
         1) Control joint depth.
         2) Break bond of sealant at bottom of joint.
         3) Provide proper shape of sealant bead.

4) Serve as expansion joint filler.

B. Fire-Resistant Sealant: See Specification Section 07 84 00.

C. Polyether Sealant:
1. Silyl-terminated polyether polymer.
2. ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
a. BASF MasterSeal 150.
b. ChemLink DuraLink.
c. Tremco Dymonic FC.

D. Polysulfide Rubber Sealant:
1. One (1) or two (2) component.
2. Meet ASTM C920.
a. Pecora Synthacalk GC2+.
b. PolySpec THIOKOL 2235.

E. Polyurea Joint Filler:
1. Two (2) component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.
a. Dayton Superior Specialty Chemical Corp. "Joint Fill, Joint Seal, Joint Saver II" as required for condition and recommended by manufacturer.
b. Euclid Chemical Co. "EUCO QWIK" joint.
c. L&M Construction Chemicals, Inc. "Joint Tite 750 IN.
d. BASF MasterSeal “CR100 IN control joint filler.
2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.
3. Color: Gray.

F. Polyurethane Sealant:
1. One (1) or two (2) components.
2. Paintable.
3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A, and O.
a. Pecora Dynatrol-IXL, Dynatrol II, Urexpan NR-200, NR-201.
b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
c. BASF MasterSeal NP-1, NP-II, SL-1 SL-2.
d. Tremco Dymonic or Dymeric, Vulkem 116, 227 ,45 ,245.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.
1. Limit application to surfaces to receive sealant.
2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions and UL requirements.

B. Clean all joints.

C. Make all joints water and airtight.

D. At changes in direction of joints, joint intersections and where sealant joints interface with other construction, install continuous sealant as necessary to ensure a weather- tight seal.

E. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 IN nor more than 1/2 IN unless recommended otherwise by the manufacturer.

F. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
   1. Take care to not puncture backer rod and compressible filler.
   2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

G. Apply bond breaker where required.

H. Tool sealants using sufficient pressure to fill all voids.

I. Upon completion, leave sealant with smooth, even, neat finish.

J. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

K. Install compressible sealant to position at indicated depth.
   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

L. Install expanding foam sealant to minimum 4 IN depth or thickness of wall being penetrated if less than 4 IN or as indicated on Drawings.
   1. Provide adequate fire rated backing material as required.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.

3.3 SEALANT WORK

A. General:
   1. Work includes but is not limited to: Sealing all joints which will permit

penetration of dust, air, or moisture.
2. Refer to SCHEDULE for materials to be used.
3. See Specification Section 07 84 00 for Firestopping.

B. Concrete joints:
1. Flooring joints.
2. Isolation joints.
3. Joints between paving or sidewalks and building.
4. Construction, control and expansion joints.
5. Joints between precast roof units and between precast roof units and walls.
6. Joints between precast wall panels.
7. Precast panel bearing joints:
a. At panels bearing at or above grade, seal both sides of panel base joint.
b. At panels bearing below grade:
1) Seal exterior panel base joint prior to backfilling and/or placement of site paving.
2) Provide compressible filler and sealant or backer rod and sealant as appropriate for interior slab condition.

C. Masonry:
1. Masonry control joints.
2. Brick expansion joints.
3. Cast stone coping and sill head joints.
4. Glass masonry joints.
5. Between masonry and other materials.

D. Openings:
1. Perimeters of door and window frames, louvers, grilles, etc.
2. Door thresholds shall be set in a full bed of sealant.

E. Pipe penetrations.

F. Penetrations of walls, floors and decks.

G. Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

3.4 FIELD QUALITY CONTROL

A. Field Testing: Testing to conform with the provisions of IDOT standard specifications.

B. Adhesion Testing:
1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
a. Water bearing structures: One (1) test per every 1000 LF of joint sealed.
b. Exterior precast concrete wall panels: One (1) test per every 2000 LF of joint sealed.
c. Chemical containment areas: One (1) test per every 1000 LF of joint sealed.
d. Building expansion joints: One (1) test per every 500 LF of joint sealed.
e. All other type of joints except butt glazing joints: One (1) test per every 3000 LF of joint sealed.
f. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

3.5 SCHEDULE

A. Furnish sealant as indicated for the following areas:
   1. Exterior areas: Polyether.
   2. Interior areas:
      a. Corrosive areas: Polysulfide.
      b. Fire-rated construction: See Specification Section 07 84 00.
   3. Immersion:
      a. Prolonged contact with or immersion in:
         1) Nonpotable water, wastewater or sewage: Polysulfide.
   4. Exterior wall penetrations: Expanding urethane foam, with finish sealant.
      a. Finish sealant:
         1) Exterior side: Polyether.
         2) Interior side: Polysulfide.
   5. Interior concrete slab formed or saw-cut control joints: Polyurea joint filler.

END OF SECTION

DIVISION 08
OPENINGS

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SECTION 08 11 19 - STAINLESS STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stainless steel doors and frames.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 08 70 00 - Finish Hardware.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Door and Hardware Institute/American National Standards Institute (DHI/ANSI):
      a. A115.1, Preparation of Mortise Locks in 1-3/8 IN and 1-3/4 IN Standard Steel Doors and Frames.
   2. National Association of Architectural Metal Manufacturers (NAAMM):
      a. Hollow Metal Manufacturers Association (HMMA).
   3. National Fire Protection Association (NFPA):
      a. 80, Standard for Fire Doors and Other Opening Protectives.
   4. Steel Door Institute (SDI):
      a. 117, Manufacturing Tolerances for Standard Steel Doors and Frames.
      b. All SDI Publications.
   5. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.7, Nomenclature for Standard Steel Doors and Steel Frames.
   6. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

B. Qualifications: Manufacturer must be current member of SDI, and NAAMM (HMMA).

1.4 DEFINITIONS

A. As identified in SDI/ANSI A250.7.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of IDOT standard specifications, Section 106.

B. Store doors and frames including borrowed lite frames under protective covering.
   1. Place units on wood skids providing a minimum 4 IN air space above the ground.
   2. Do not store units flat.
   3. Set frames and doors on edge providing a minimum 1/2 IN air circulation space between each unit.
   4. Provide covering which will ensure air flow around each unit to prevent trapping moisture.
   5. If door wrapper becomes wet, remove immediately and provide dry protection equivalent to wrapper removed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Stainless steel doors and frames:
      a. Next Door Company.
      b. Curries Company.
      c. Pioneer Industries.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Steel Sheet and Frames: Type 304 stainless steel.

B. Hinge Edge Channel: Type 304 stainless steel.

C. Lock Edge, Top and Bottom Channel: Type 304 stainless steel.

D. Lock Reinforcement: Type 304 stainless steel plate.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard stainless steel units.

F. Insulation: Urethane or polystyrene.

2.3 ACCESSORIES

A. Frame Anchors:
   1. Jamb Anchors:
      a. 16 GA, stainless steel.
   2. Floor Anchors:
      a. Minimum 14 GA, stainless steel.

2.4 FABRICATION

A. General:
   1. Fabricate rigid, neat in appearance and free from defects.
   2. Form to sizes and profiles indicated on Drawings.
   3. Fit and assemble in shop wherever practical.
   4. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
   5. Weld all joints continuously, dress exposed joints smooth and flush.
   6. Fabricate doors and frames to tolerance requirements of SDI-117.
   7. Fit doors to SDI and NFPA 80 clearances.
   8. Provide doors which are approved and labeled by FM/UL.
   9. Provide all exposed stainless steel surfaces with #4 finish.

B. Hollow Metal Doors:
   1. General:
      a. 1-3/4 IN thick.
      b. 16 GA minimum face sheets.
      c. Fabricate with flush top closures.
      d. Weld, fill and grind smooth all joints.
   2. Exterior:
      a. SDI Grade III, Model 4, seamless, insulated minimum R10.
   3. Fire rated:
      a. SDI Grade II, Model 4, seamless.
      b. Sound insulated.
      c. UL fire labeled.
      d. Maximum transmitted temperature:
         1) Fire doors shall have a maximum transmitted temperature end point of not more than 250 DEGF above ambient at the end of 30 minutes of standard fire test exposure.
      e. Pairs UL fire labeled without astragal.
   4. Interior (except fire rated):
      a. SDI Grade II, Model 4, seamless.

C. Hollow Metal Frames:
   1. Door frames:
      a. 26 GA stainless steel boxes welded to frame at back of all hardware cutouts.
      b. 8 GA stainless steel plate reinforcement welded to frame for hinge reinforcing.

c. 12 GA stainless steel plate reinforcement welded to frame for strikes, closers and surface-mounted hardware.
d. Split-type frames not acceptable.
e. Conceal all fasteners.
f. Frames shall be set up, all joints welded and ground smooth.
   1) Finish of welds to match balance of frame finish.
g. Exterior (up to 4 FT wide): 16 GA.
h. Exterior (over 4 FT wide): 14 GA.
i. Fire rated:
   1) UL/FM labeled.
   2) Comply with NFPA 80.
j. Interior: 16 GA.
k. Provide removable spreaders at bottom of frame.

D. Supports, Reinforcing and Anchors:
   1. Minimum 16 GA.

E. Prepare for finish hardware in accordance with hardware schedule, templates provided by hardware supplier, and DHI/ANSI A115.1.
   1. Locate finish hardware in accordance with SDI.
   2. See Specification Section 08 70 00 for hardware.

F. Clean off mill scale and foreign materials, repair damaged surfaces.

G. After fabrication thoroughly clean.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install doors and frames in accordance with SDI and manufacturer's instructions.

B. Place frames prior to construction of enclosing walls and ceilings.

C. Plumb, align, and brace securely until permanently anchored.

D. After completion of walls, remove temporary braces and spreaders.

E. Install fire-rated frames in accordance with NFPA 80 and manufacturer's instructions.

F. Use plastic plugs to keep silencer holes clear during construction.

G. Immediately after erection, repair damaged areas.

H. Install three (3) silencers on strike jamb of single door frame and two (2) on head of double door frame.
   1. See Specification Section 08 70 00.

I. Number and location of anchors shall be in accordance with frame manufacturer's recommendation with minimum of three (3) anchors per jamb.

J. For floor anchors, provide two (2) adjustable 3 IN wide flanged floor clips punched for anchoring.

K. Protect frames during construction.

END OF SECTION

SECTION 08 31 00 - ACCESS DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Floor access doors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Specification Section 09 96 00 - High Performance Industrial Coatings.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      d. A480, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      e. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      g. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      h. B221,Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. Occupational Safety and Health Administration (OSHA).
   4. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

1.4 DEFINITIONS

A. Standard Duty: Will support live load of 150 PSF.

B. Heavy Duty: Will support live load of 300 PSF.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Floor access doors:
      a. Bilco Company.
      b. Babcock Davis Associates.
      c. Dur-Red Products.
      d. Halliday Products.
      e. USF Fabrication Inc.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Aluminum:
   1. Sheet and Plate: ASTM B209.
   2. Extruded shapes: ASTM B221.

B. Stainless Steel: ASTM A240 or A666.

2.3 MANUFACTURED UNITS

A. General:
   1. All access doors shall be provided by the same manufacturer when possible.
   2. Coat all aluminum components in contact with concrete or masonry with manufacturer's standard bituminous coating.

B. Heavy Duty Floor Access Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
      a. 1-1/2 IN DIA drain coupling.
   2. Cover:
      a. 1/4 IN mill finished diamond plate aluminum.
      b. Reinforce cover with aluminum stiffeners.
         1) Live load: 300 PSF.
         2) Deflection: Maximum 1/150 of span.
   3. Hardware:
      a. All hardware to be stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
      c. Slam lock and removable key handle.
   4. Bilco Company, Type "J-AL".
      a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

C. H-20 Loading Doors:
   1. Frame: 1/4 IN mill finish aluminum channel with anchor tabs.
      a. 1-1/2 IN DIA drain coupling.
   2. Cover:
      a. 1/4 IN mill finished diamond plate aluminum.
      b. Reinforce cover with aluminum stiffeners.
         1) Reinforced for AASHTO H-20 wheel loading for use in off street applications.
         2) Deflection: Maximum 1/150 of span.
   3. Hardware:
      a. All hardware to be stainless steel.
      b. Positive hold open arm that engages automatically when door reaches full 90 degree open position.
      c. Slam lock and removable key handle.
   4. Bilco Company, Type "J H-20".
      a. Size(s): Refer to the SCHEDULES Article in PART 3 of this Specification Section.

2.4 ACCESSORIES

A. Load Rating Plates:
   1. Minimum 18 GA Type 316 stainless steel, ASTM A666.
   2. Engraved with maximum design live load allowed for unit on which it will be mounted.
   3. Display load in English units as well as metric units.
   4. Size as required for text as needed.
   5. Text:
      a. Font: Helvetica Narrow, all caps.
      b. Size: 1/4 IN height.
      c. Depth of engraving: 3 mils.
   6. Finish:
      a. Text:

1) Black epoxy baked on paint.
2) Plate to have finish conductive to paint application.

b. Coat entire plate with baked on clear coat on front and back side.

7. Attach to top of all floor access doors using stainless steel screws in location determined by manufacturer.
   a. Provide a neoprene gasket under the plate to separate the stainless steel from the aluminum cover or frame.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 SCHEDULES

A. Access Hatch Schedule:

HATCH TYPE	SCHED	LOCATION	CLEAR OPENING SIZE (a)	TYPE	REMARKS
A	A601	VARIES	2 FT-0 IN x 2 FT-0 IN	J-1AL	a,b
B	A601	VARIES	3 FT-0 IN x 3 FT-0 IN	J-4AL	a,b
C	A601	VARIES	2 FT-0 IN x 2 FT-0 IN	J-1ALH20	a,c
D	A601	624.83 PLAN	1 FT-10 IN x 2 FT-0 IN	J-1AL	a,b

1. Notes:
   a. See definition of Clear Opening Size in the DEFINITIONS Article in PART 2 of this Specification Section.
   b. Heavy Duty – 300psf.
   c. H-20 loading capacity.

END OF SECTION

SECTION 08 33 23 - STEEL ROLLING OVERHEAD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Steel rolling overhead doors.
      a. Motor operated.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 61 03 - Equipment: Basic Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      e. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

B. Qualifications:
   1. Installer to be licensed or approved in writing by door manufacturer.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Steel rolling overhead doors:
      a. The Cookson Company.
      b. Cornell Iron Works.
      c. Wayne Dalton.
      d. Overhead Door Corp.
      e. Raynor.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Door Curtain and Hood: Stainless steel, ASTM A240, Type 304.

B. Weatherproofing: Neoprene or vinyl.

C. Guides, Head Plates and Pipe Barrel: Stainless steel, ASTM A276, Type 304.

D. Fasteners: Same material as door construction.

2.3 ACCESSORIES

A. Motor Operator:
   1. Minimum 1/2 HP, See electrical for voltage/ amperage.
      a. Motor shall be sized by door manufacturer for door size indicated on Drawings.
      b. Provide manufacturer's standard reversing controller with motor thermal protection if motor is not internally protected.
      c. Class I, Div II classified motor and control casement.
   2. Instant reversing with electric reversing safety edge and weather seal on bottom of door.
      a. Provide complete wiring connections for instant reversing safety edge to motor operator including all intermediate junction boxes, conduit,

disconnects, wiring and low voltage wiring.
3. Opening and closing rate: Between 2/3 and 1 FPS.
4. Standard oiltight three (3) pushbutton control(s).
   a. NEMA 4X.

2.4 FABRICATION

A. Door Curtain:
   1. Insulated flat profile with interlocking face sheets:
      a. 2-5/8 IN high.
      b. Exterior face: Minimum 22 GA.
      c. Interior face: Minimum 24 GA.
      d. Galvanized steel endlocks.
      e. Core: Insulated. R-10 min.
   2. Weather stripping:
      a. Guide sealing adjustable weatherstripping at jambs and lintel exterior doors only.
   3. Bottom bar: Reversing electric safety edge with weatherseal.
   4. Finish:
      a. Architectural Class 1 coating per AA DAF 45, 304-2B stainless steel.
         1) SS - ASTM A480, No. 4 finish.

B. Hood:
   1. Minimum 24 GA.
   2. Provide full length air baffle weatherstripping at all exterior doors.
   3. Finish: Match door curtain.

C. Guides:
   1. Mounting:
      a. Interior face of wall.
   2. Manufacturer's standard structural angle guide system for size of door specified.
      a. Cold-rolled guides are not acceptable.
      b. Furnish wind locks.
   3. Finish: Match door curtain.

D. Head Plates:
   1. Galvanized Stainless steel plate mounted to guides.
   2. Sized to support counter balance assembly, curtain, motor operator and hood.
   3. Finish: Match door curtain.

E. Counterbalance Assembly:
   1. Pipe barrel:
      a. Stainless steel pipe shaft.
      b. Maximum deflection: 0.03 IN/FT.
   2. Torsion springs:
      a. Oil-tempered helical torsion springs on cast anchors.
      b. 100,000 cycle.
   3. Adjustable tension wheel.

F. Trim Pieces: Material and finish to match curtain.

G. Wind Load: 20 PSF minimum.

H. Operation:
   1. Motor operated with chain operator backup.

a. Locking: Slide bolts.

I. Insulated door system: Overhead Door Corp. "625 IN Series.

2.5 SOURCE QUALITY CONTROL

A. Air Infiltration: 1.98 CFM/SQFT of door when tested on a 10 FT x 10 FT door in accordance with ASTM E283 with 25 MPH wind load.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Installation shall be done by manufacturer's authorized representative.

C. Provide all required trim, weatherstripping, closures etc., for complete weather tight installation.

D. Adjust for proper counter balance.

E. Seal along bottom of vertical track (guides), seal the vertical joint between the two (2) separate track angles (if not filled by welding) and seal all holes in vertical track (not being used for fasteners) to provide a completely weather tight track and door system.
   1. At fastener locations provide steel washers under bolt head to completely cover the slotted holes in the vertical track.
      a. Finish of steel washer shall match finish of track (guides).

F. Electrical disconnect and conduit and wiring from standard three (3) pushbutton control to motor operator is provided in the Electrical Design.

G. Provide bracing for motor operator to eliminate vibration.

3.2 ADJUSTMENT

A. Prior to occupancy, adjust door for smooth operation.

END OF SECTION

SECTION 08 68 00 - INSULATED STRUCTURAL SKYLIGHT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Insulated structural skylights.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Architectural Manufacturers Association (AAMA):
      a. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   2. Underwriter's Laboratories, Inc. (UL):
      a. 972, Standard for Burglary Resisting Glazing Material.
   3. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
   1. Installer shall have minimum five (5) years of experience installing similar products.
   2. Installer shall have completed minimum three (3) successful projects of similar size and complexity in last five (5) years.
   3. All structural system design and calculations shall be prepared and stamped by a Professional Engineer registered in the State of Illinois.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the project site.
   2. Installer and applicator are synonymous.

B. PVDF: Polyvinylidene fluoride.

1.5 SYSTEM DESCRIPTION

A. System shall be comprised of a 2-3/4 IN thick double-faced, insulated,

translucent fiberglass structural sandwich panel.

B. The panel system shall be permanently secured to an aluminum or stainless steel superstructure designed and provided by the panel manufacturer.

C. System shall be removable as a completed unit.

D. The manufacturer shall be responsible for the configuration and fabrication of the skylight system including the super structure.

1.6 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Insulated Structural Skylight System:
      a. Kalwall Corporation.
      b. Structures Unlimited, Inc.
   2. PVDF coating:
      a. PPG - DURANAR.
      b. Valspar - FLUROPON.
      c. Atofina Chemicals - KYNAR 500.
      d. Solvay Solexis - HYLAR 5000.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Curb: Aluminum.

B. Glazing: Fiberglass.

C. Insulation: Fiberglass.

D. Fasteners: Stainless steel, 300 series.

E. Framework: Aluminum.

2.3 FABRICATION

A. General:
   1. Size: Clear opening defined on Drawings.
   2. Aluminum box beam size: As required by manufacturer.
   3. Eave height:
      a. Manufacturer's standard for pitch and size of unit.
   4. Roof pitch: 4/12 max slope.
   5. Sandwich panels:
      a. Minimum 2-3/4 IN thick double faced fiberglass structural sandwich panels with minimum 12 x 24 IN mechanically interlocking grid:
         1) Insulated.
         2) Translucent.
   6. Fasteners: Stainless steel Type 304 or 316.

B. Load Criteria.
   1. Roof live load: 26 PSF minimum.
   2. Wind load (negative uplift load): 40 PSF minimum.
   3. Skylight system shall meet requirements of the Building Code.

C. Curb: By Others.

D. Glazing:
   1. System – Performance Design Criteria: Based on R-10 (0.10U), 2-3/4 IN panel thickness.
      a. Light transmission (VLT): Minimum 35 PCT.
      b. Thermal Rating: 0.53U.
      c. Solar Heat Gain Coefficient: 0.52.
   2. Exterior:
      a. Minimum 0.070 IN thick fiberglass.
      b. Color: Crystal.
   3. Interior:
      a. Minimum 0.045 IN thick fiberglass.
      b. Color: White.
   4. Impact resistance: The exterior face sheet shall be capable of withstanding 70 FT LBS of force without fracture or tear from impact of a 3-1/4 IN DIA, 5 LB free-falling ball per UL 972.
   5. Allow no direct fiberglass to aluminum contact.

E. Finish:
   1. Meet requirements of AAMA 2605.
      a. PVDF based coating with minimum 70 PCT resin content.
      b. Color: To be selected by Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.
   1. Attach to roof structure with fasteners at spacing required to meet loading criteria indicated.

B. Provide all periphery items as required for complete weathertight installation.

END OF SECTION

SECTION 08 70 00 - FINISH HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish hardware.
   1. Inspection and testing of door operation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 08 11 19 - Stainless Steel Doors and Frames.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. All door hardware shall be provided by a single hardware supplier.
   1. Hardware is to be provided under this Specification Section, unless noted otherwise, for doors specified in:
      a. Specification Section 08 11 00.

B. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
      a. A156.1, Butts and Hinges.
      b. A156.3, Exit Devices.
      c. A156.4, Door Controls -Closers.
      d. A156.6, Architectural Door Trim.
      e. A156.8, Door Controls - Overhead Stops and Holders.
      f. A156.13, Mortise Locks and Latches Series 1000.
      g. A156.16, Auxiliary Hardware.
      h. A156.18, Materials and Finishes.
      i. A156.21, Thresholds.
   3. Door and Hardware Institute (DHI).
   4. National Fire Protection Association (NFPA):
      a. 101, Life Safety Code.
   5. Steel Door Institute (SDI).
   6. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

C. Qualifications:

1. Installation shall be inspected by a certified Architectural Hardware Consultant (AHC).

1.4 DEFINITIONS

A. AHC: Architectural Hardware Consultant, certified by DHI.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. All weather: Capable of operation from -50 to +120 DEGF.

D. Active Leaf: Right-hand leaf when facing door from keyed side unless noted otherwise on Drawings.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Certification from AHC stating:
      a. All door hardware has been reviewed by AHC and verified to be compatible with doors and frames.
      b. All electrified door hardware has been reviewed by AHC and has been coordinated with power supply and access control system.
      c. No submittals will be reviewed until Engineer has received AHC certification.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

1.6 WARRANTY

A. Provide all individual manufacturers' extended warranties as advertised.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Locksets and latchsets:
      a. Corbin/Russwin.
      b. Schlage.
      c. Yale.
   2. Closers:
      a. LCN.
      b. Norton.
      c. Corbin/Russwin.
   3. Hinges:

a. Stanley Works.
b. Hager Hinge Co.
c. Lawrence.

4. Door stops and holders:
   a. Rockwood.
   b. Ives.
5. Overhead stops:
   a. Corbin Russwin.
   b. Rockwood.
   c. Trimco.
   d. Rixson.
6. Weatherstripping and thresholds:
   a. Pemko Manufacturing Co.
   b. Reese Enterprises, Inc.
   c. Hager.
   d. National Guard Products, Inc.
7. Exit devices:
   a. Von Duprin, Inc.
   b. Corbin/Russwin.
   c. Adams Rite.
8. Door bolts, coordinators and strikes:
   a. Ives.
   b. Corbin Russwin.
   c. Trimco.
   d. Hager.
   e. Rockwood.
   f. Baldwin.
9. Magnetic door position switches:
   a. GE Security/Sentrol.
   b. George Risk Industries (GRI).

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. General: As indicated in the FABRICATION Article in PART 2 of this Specification Section.

B. Fasteners: Stainless steel

C. Closers:
   1. Corrosion resistant closer:
      a. Body: Aluminum.
      b. All other components and fasteners: Stainless steel.
      c. Closer arm bushing: Bronze.

D. Kickplates: Stainless steel.

E. Thresholds: Aluminum.

F. Overhead Stops and Wall Stops: Stainless steel.

G. Keys: Brass or bronze.

H. Weatherstripping and Smoke Seals: Polypropylene, neoprene, or EPDM.

I. Silencers: Rubber.

2.3 ACCESSORIES

A. Strikes:
   1. Curved lips.
      a. Extended lips when required.
   2. Furnish strike boxes.
   3. Appropriate for function and hardware listed.

2.4 FABRICATION

A. Hardware - General:
   1. Generally prepare for Phillips head machine screw installation.
   2. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
   3. Provide concealed fasteners unless thru bolted.
   4. Through bolt closers on all doors.
   5. Furnish items of hardware for proper door swing.
   6. Furnish lock devices which allow door to be opened from inside room without a key or any special knowledge.

B. Hardware:
   1. Fabricate hardware for fire rated openings in compliance with UL and NFPA 80.
      a. This requirement takes precedence over other requirements for such hardware.
      b. Provide only hardware which has been tested and listed by UL for types and sizes of doors.
   2. Provide following ANSI/BHMA A156.18 finishes:
      a. Locksets, latchsets and strikes: 630.
      b. Door pulls, push bars, push plates: 630.
      c. Kickplates:

1) Stainless steel: 630.

d. Exit devices: 630 where available; 626 if 630 not available.
   1) Provide 630 finish on trim.
e. Butt hinges: 630.
f. Door stops, dead locks, mortise bolts, and miscellaneous hardware: 630 where available, 626 if 630 not available.
g. Door overhead stops: 630.
h. Corrosion resistant closers: 630.

C. Mortise Locks and Latches:
1. ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 1.
   a. Meet requirements of ADA.
2. Antifriction two-piece mechanical latchbolt with stainless steel anti-friction insert.
   a. One-piece stainless steel deadbolt, minimum 1-1/4 IN x 9/ 16 IN thick with 1 IN throw.
   b. 2-3/4 IN backset.
   c. Cylinder: Brass, 6 pin, with interchangeable core.
   d. ADA compliant thumb turn lever.
3. Locking, latching and retracting mechanism and lock case:
   a. Corrosion resistant: Non-ferrous lock case.
      1) Provide non-ferrous lock case on doors scheduled to receive corrosion resistant closers.
4. Trim design: Corbin/Russwin "NSP".
   a. Functions as indicated in following table in accordance with ANSI/BHMA A156.13.
      1) All electric lock hardware to be 24 VDC.

MORTISE LOCK NUMBERS		
ANSI	FUNCTION	CORBIN/RUSSW IN
F01	Passage	ML2010
F19	Privacy	ML2030
F05	Classroom	ML2055
F07	Storeroom	ML2057
F13	Entrance or Office	ML2065
	Electronic Lockset	ML20905 x M92

D. Door Closers:
1. ANSI/BHMA A156.4, Grade 1.
2. Size door closers to comply with ANSI recommendations for door size and location.
3. Fabricate all closers with integral back check.
4. Provide integral stop unless noted otherwise.
   a. Do not provide integral stop at closers indicated to be installed on pull side of door.
5. Arms, brackets, and plates: As required for complete installation.
6. Closers:

a. Corrosion resistant: Norton 7500 SS Series.

7. Provide manufacturer's standard 10 year warranty.

E. Hinges:
1. Butt hinges:
a. ANSI/BHMA A156.1.
1) A5111: Stainless steel, full-mortise, anti-friction bearing, Grade 1.
b. Ball bearing.
c. Flat button tips.
d. Butt hinges:
1) Hager BB1199.
2) Stanley Model FBB 191.
3) Lawrence Model BB4101.
e. Hinge size:
1) Doors up to and including 46 IN wide: 4.5 IN x 4.5 IN.
2) Doors over 46 IN up to and including 60 IN wide: 5 IN high x 4.5 IN.

F. Door Stops:
1. ANSI/BHMA A156.16.
a. Wall stops: Ives WS406-CVX or WS406-CCV.

G. Overhead Door Holders/Stop:
1. ANSI/BHMA A156.8.
2. Provide 'hold-open' function on all stops unless noted otherwise.
a. Do not provide ‘hold-open’ function at fire rated doors.
3. Surface mounted stops: Rockwood N14400 Series or Glynn Johnson 90 Series.
4. Concealed stops: Rockwood N11000 Series or Glynn Johnson 100 Series.

H. Kickplates:
1. ANSI/BHMA A156.6.
2. 8 IN high x 2 IN less than door width.
3. Beveled on all edges.
4. Thickness:
a. Stainless steel: 0.050 IN.

I. Thresholds:
1. ANSI/BHMA A156.21.
2. Thermally broken unit.
3. Height: 1/2 IN high maximum.
4. Width: 4 IN.
5. Provide required bolt cutouts.

J. Exit Devices:
1. ANSI/BHMA A156.3, Grade 1.
2. Single doors: Mortise.
3. Pairs of doors: Concealed vertical rods.
4. Trim: Sargent “ET”.
a. Lever operation.
b. Lever style: Sargent "L".
5. Sargent "80 Series".
a. Function as indicated on Hardware Schedule.

6. Coordinate power supply and electric option requirements with access control system and electric door assisting device.

K. Keyed Mullion:
   1. Nonrated:
      a. Aluminum.
      b. Designed for 8 FT x 8 FT opening.
      c. Complete with top and bottom retainers.
      d. Lockable with cylinder keyed to building master keying system.
      e. Sargent L-980 lockable mullion.

L. Weatherstripping:
   1. Weather seal at jambs and head:
      a. Self-adhesive strip: Reese #797W.
      b. Color: Black.
   2. Sweep at bottom of doors:
      a. Reese 701.
      b. Color: Clear anodized.
   3. Weather seal astragal at meeting edges of pairs of doors:
      a. Reese 92 each leaf.
      b. Color: Clear anodized.

M. Silencers:
   1. Stainless steel frames: Trimco 1229A or Rockwood 608.
   2. Self-adhesive silencers are not acceptable.

N. Keying:
   1. Establish keying with Engineer.
      a. Provide and set up complete visible card indexed system with key tags and control slips.
      b. Tag and identify keys.
      c. Provide two (2) keys for each lock or cylinder.
      d. Master key and key in groups as directed.
      e. Provide construction master keys for all exterior doors.

O. Bolts:
   1. ANSI/BHMAA 156.16.
   2. Surface bolts: Rockwood 580 Series with top and bottom strikes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's installation instructions.
   1. Perform installation by or under the direct supervision of an AHC.

B. Provide all hardware in accordance with Building Code.

C. Fit hardware before final door finishing.

D. Permanently install hardware after door finishing operations are complete.

E. Use SDI mounting heights for hardware.

F. Butt Hinges:
   1. Provide non-removable pin (NRP) at:
      a. Exterior doors.
      b. Reverse handed doors equipped with locks.
   2. Quantities:
      a. Door height 61 - 90 IN: Three (3).
      b. Door height 91 - 114 IN: Four (4).
      c. Door height 115 - 144 IN: Five (5).
      d. Doors over 48 IN wide and over 96 IN high:
         1) Provide top butt hinge within 6 IN of the top of the door to top of hinge.
         2) Provide one (1) additional butt hinge approximately 6 IN below the bottom of the top butt hinge.
   3. Provide transfer hinge as necessary where electrified lockset or exit device is specified or as otherwise indicated in Hardware Schedule.

G. Closers:
   1. Mount closers on push side of doors unless noted otherwise.

H. Provide coordinator when required by hardware specified.

I. Overhead Stops:
   1. Provide overhead stop when corrosion resistant closer is specified.
   2. Provide concealed overhead stop on doors scheduled to receive closer mounted on pull side of door.
   3. Provide at interior doors not scheduled to receive a closer as follows:
      a. Doors that swing more than 105 DEG without encountering a wall or obstruction.
         1) Stop shall limit swing of door from impacting wall or obstruction.
      b. Inactive leafs of pairs of doors.

J. Wall Mount Door Stops:
   1. Provide where specifically indicated on Hardware Schedule and at doors not otherwise indicated to receive:
      a. Overhead stop.
      b. Closer with integral stop.

K. Floor mounted stops are not acceptable unless noted otherwise in this Specification Section.

L. Provide silencers for door frames.
   1. Stainless steel frames: See Specification Section 08 11 19.

M. Provide weather seal, door sweep and threshold at all exterior doors and where scheduled on interior doors.
   1. Set thresholds in a full bed of sealant.
   2. Mount door sweeps on exterior face of door.
   3. Mount weather seal astragal at meeting edges of pairs of doors on the exterior face of the doors.

N. Provide smoke seals on all fire rated doors.

O. Mount kickplates on push side of doors.

3.2 FIELD QUALITY CONTROL

A. Adjust and check each operating item of hardware to assure proper operation or function.
   1. Lubricate moving parts with lubricant recommended by manufacturer.

B. During week prior to startup, make a final check and adjustment of all hardware items.
   1. Clean and lubricate as necessary to assure proper function and operation.
   2. Adjust door control devices to compensate for operation of heating and ventilating equipment.

C. Inspection and Testing:
   1. AHC shall inspect and test all door assemblies and provide written certification that door assemblies are in proper working order.
      a. Door assemblies required to swing in the direction of egress shall be inspected and tested in accordance with NFPA 101.

3.3 SCHEDULES

A. Hardware Schedule:

Hardware Set	Quantity	Unit	Description
HW -1 Exterior Door, 001B, 002B, 101C, 102A, 102C	1 1/2	PR	Butts
	1	EA	Exit Device w/ Storeroom Function latchset
	1	EA	Door position switch.
	1	EA	Closer w/Stop – Push Side Mounted
	1	EA	Weather gasket set
	1	EA	Threshold
HW -2 Interior Fire Rated Door 001C, 002C, 001A, 002A	1-1/2	PR	Butts
	1	EA	Latchset – Passage Function Closer
	1	EA	w/Stop – Push Side Mounted
	1	EA	Smoke Seals
HW -4 (Exterior double doors)	3	PR	Butts
	1	EA	Exit Device at active leaf w/ deadbolt
	1	EA	Dummy trim at inactive leaf
	1	EA	Surface Bolts – Top and Bottom
	1	EA	Astragal at active leaf
	1	EA	Overhead Stop – Hold-open
	1	EA	Weatherstripping
	1	EA	Threshold

	2	EA	Closer
	1	EA	Sweep each door

END OF SECTION

SECTION 08 90 00 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Louvers and vents.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 07 62 00 - Flashing and Sheet Metal.
   3. Section 07 92 00 - Joint Sealants.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. Air Movement and Control Association (AMCA).
   3. ASTM International (ASTM):
      a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Louvers:
      a. Airolite Co.
      b. Construction Specialties, Inc.
      c. Ruskin Manufacturing.
      d. Industrial Louvers, Inc.
      e. American Warming.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility

to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MANUFACTURED UNITS

A. Louvers:
   1. 4 IN deep.
   2. Drainable with blades at 37-1/2 DEG.
   3. Continuous blade appearance.
   4. Continuous stainless steel retainer collar.
   5. Stainless steel sill flashing with sealed end brake. 0.040 IN.
   6. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 IN thick.
   7. Minimum free area: 8.58 SQFT for 4 x 4 FT louver.
   8. Maximum pressure drop: 0.10 IN of water at 700 FPM.
   9. Water penetration: 0.01 OZ/SQFT at 873 FPM.
   10. AMCA certified.
   11. Insect screen:
      a. 18-16 mesh aluminum.
      b. Install in standard aluminum frame.

B. Anchors, Fasteners, Reinforcing: Stainless steel.

C. Continuous 4 sided stainless steel anchoring collar, mount to opening and louver, see detail drawings.

D. Finish:
   1. Architectural Class 1 coating per AA DAF 45, 304-2B stainless steel.
      a. SS - ASTM A480, No. 4 finish.

E. Size: Refer to Mechanical Drawings for louver size, and refer to Architectural Drawings for louver shapes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions with continuous retaining collar.

B. Install anchoring and bracing accessories as required.

C. Seal around perimeter on exterior and interior.
   1. See Section 07 92 00.

D. Install 0.040 IN stainless steel flashing at sill.

END OF SECTION

DIVISION 09

FINISHES

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SECTION 09 30 13 - CERAMIC TILE (CT)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. See the DEFINITIONS Article, Ceramic Tile paragraph for types of tile included in this Specification Section.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. A108.1, Specification for the Installation of Ceramic Tile.
      b. A137.1, Standard Specifications for Ceramic Tile.
   2. Tile Council of North America (TCNA):
      a. TCA Handbook for Ceramic Tile Installation.

B. Qualifications:
   1. Installer must have minimum five (5) years of experience installing similar products with similar substrates.

1.4 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Ceramic Tile: For purposes of this Specification Section, the term "ceramic tile" is intended to include ceramic, porcelain, granite, and terrazzo tiles.

1.5 SYSTEM DESCRIPTION

A. Unless noted otherwise on the Drawings, floor tile selection shall be made from complete range of available sizes within Class [3] or Class [4] durability rating.
   1. Tile colors, styles and profiles and associated trim pieces to be selected from manufacturer's complete line including premium and custom offerings.

B. Unless noted otherwise on the Drawings, wall tile selection shall be made

from a complete range of available sizes.

1. Tile colors, styles and profiles and associated trim pieces to be selected from manufacturer's complete line including premium and custom offerings.

1.6 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

B. Samples:
   1. Provide minimum 16 x 16 IN sample palette or two (2) full tiles if 12 x 12 IN (or larger) tile are specified, in color, pattern, blend and type for Engineer's final approval.
      a. Include selected grout color as part of sample.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ceramic tile:
      a. American Olean Tile Co. (AOT).
      b. Dal-Tile Corp. (DTC).
      c. Esquire (ESQ).
      d. Florida Tile (FT).
      e. Metropolitan Ceramics (MC).
      f. Richetti (RICH).
      g. Summitville (SUM).
      h. United States Ceramic Tile Co. (USCT).
   2. Adhesives, mortars, grouts and leveling compounds:
      a. Bonsal Co.
      b. Bostik Construction Products.
      c. H.B. Fuller (TEC).

d. Laticrete International Inc.
e. Mapei Canada, Inc.

B. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Adhesives for Setting Tile:
1. Dry-set Portland cement mortars: ANSI A108.1.
2. Latex-Portland cement mortars: ANSI A108.1.
3. Assure adhesives are compatible with cement backer board.

B. Grout: Portland cement-based material, containing quartz aggregate, colorfast pigments and Portland cement.
1. Epoxy Grout: Two-part acid alkali resistant epoxy grout.

2.3 MANUFACTURED UNITS

A. Wall Tile:
1. Ceramic units conforming to ANSI A137.1.
2. 5/16 IN thick.
3. Size(s): 3x6 Subway Tile set in brick joint pattern.
4. Color: Pure White.
a. High gloss smooth glaze.

B. Grout:
1. Epoxy grout mix:
a. Mapei: Kerapoxy, 113 Cement Grey.

C. Tile Base and Associated Trim:
1. Factory made trim shapes for all curbs, caps, corners, bullnose, bases, coves, beads, depressions, moldings, chair rails, etc.
a. Base: Round top 6 x 6 IN.

2.4 MAINTENANCE MATERIALS

A. Extra Material:
   1. Furnish Engineer with the following extra materials:
      a. 2 PCT of each different size, pattern, style and/or color of tile used including trim shapes with minimum of one (1) full size tile of each for maintenance purposes.
      b. Enough extra grout mix of each different color and/or type to allow for full 2 PCT of tile to be replaced.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate expansion joints prior to product installation.

B. Verify that substrate is ready to accept tile installation.
   1. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.2 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions and ANSI A108.1.
   2. Place tile in offset brick pattern.
   3. Align tile joints on adjoining walls/floors.
   4. Lay out and center tile in both directions in each space or on each wall area.
   5. Avoid use of tile less than 1/2 size.
   6. Adjust tile to minimize cutting.
   7. Provide uniform joint widths insofar as practicable.
      a. Provide joint widths as recommended by tile manufacturer.
   8. Provide leveling beds as required.
   9. Provide edging at exposed edges where there is a change of level.

3.3 CLEANING

A. After installation, clean in accordance with manufacturer's instructions.

3.4 PROTECTION

A. Permit no traffic on floors for 72 HRS after grouting and protect installed tile work with minimum 0.125 IN thick non-staining covering during construction to prevent damage.

END OF SECTION

SECTION 09 96 00 - HIGH PERFORMANCE INDUSTRIAL COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High performance industrial coatings (HPIC).
   2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC).
   3. Division 26 - Electrical.
   4. Division 40 - Process Interconnections.
   5. Section 40 05 00 - Pipe and Pipe Fittings: Basic Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
      b. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      c. D4259, Standard Practice for Abrading Concrete.
      d. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      e. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      f. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      h. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      i. D6677, Standard Test Method for Evaluating Adhesion by Knife.
      j. D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
      k. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

l. F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

2. International Concrete Repair Institute (ICRI):
   a. 310.2, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
3. National Association of Pipe Fabricators (NAPF):
   a. 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings:
      1) 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
      2) 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
4. NSF International (NSF).
   a. 61, Drinking Water System Components - Health Effects.
5. Steel Door Institute/American National Standards Institute (SDI/ANSI):
   a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors and Frames.
6. The Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   b. SP 1, Solvent Cleaning.
   c. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
7. The Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 5/NACE No. 1, White Metal Blast Cleaning.
   b. SP 6/NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/NACE No. 2, Near-White Blast Cleaning.
   e. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's authorized representative shall provide written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
   2. Applicators shall have minimum of 10 years of experience in application of similar products on similar project.
      a. Provide references for minimum of three (3) different projects completed in last five (5) years with similar scope of work.
      b. Include name and address of project, size of project in value (painting) and contact person.

C. Miscellaneous:
   1. Furnish coating through one (1) manufacturer unless noted otherwise.

D. Deviation from specified mil thickness or product type is not allowed without written authorization of Engineer.

E. Material shall not be thinned unless approved, in writing, by coating manufacturer's authorized representative.

1.4 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified.

C. Corrosive Environment:
1. Immersion in or subject to:
a. Condensation, spillage or splash of a corrosive material such as water, wastewater or chemical solution.

D. Holiday:
1. A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating.
2. May also be identified as a discontinuity or pinhole.

E. Exposed Exterior Surface:
1. Exterior surface which is exposed to view.
2. Exterior surface which is exposed to weather but not necessarily exposed to view.

F. Finished Area: An area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be coated.

G. Immersion Service:
1. Any surface immersed in water or some other liquid.
2. Surface of any pipe, valve, or any other component of the piping system subject to frequent wetting.
3. Surfaces within two feet above high water level in water bearing structures.

H. Surface Hidden from View:
1. Within pipe chases.
2. Between top side of ceilings and underside of floor or roof structures above.

I. HPIC: High performance industrial coatings.
1. Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

J. Water level for purposes of coating: See Drawings.

1.5 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by Senior Corrosion Specification Specialist employed by the coating manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials as defined under provisions of

IDOT standard specifications, Section 106.

B. Store materials in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 DEGF.

1.7 PROJECT CONDITIONS

A. Verify that atmosphere in area where coating is to take place is within coating manufacturer's acceptable temperature, humidity and sun exposure limits.
   1. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
      a. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by coating manufacturer.
      b. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 HR basis.
         1) Vent exhaust gases to exterior environment.
         2) No exhaust gases shall be allowed to vent into the space being coated or any adjacent space.
   2. Do not apply coatings in snow, rain, fog or mist.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. High Performance Industrial Coatings:
      a. Carboline Protective Coatings.
      b. PPG Industries.
      c. Sherwin Williams.
      d. Tnemec.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Coatings used for interior finishes shall meet the requirements of the Building Code.

B. General:
   1. High Performance Industrial Coatings: Products listed are manufactured by Tnemec.
   2. Products of other manufacturers will be considered for use provided that the product:
      a. Is of the same generic resin.
      b. Requires comparable surface preparation.
      c. Has comparable application requirements.
      d. Meets the same VOC levels or better.
      e. Provides the same finish and color options.
      f. Will withstand the atmospheric or immersion conditions of the location where it is to be applied.
   3. Where manufacturer's product data sheet indicates a minimum mil thickness per coat that is greater than specified herein, mil thickness for entire coating system shall be increased proportionately.

C. Coatings shall comply with the VOC limits of EPA.

D. For unspecified materials such as thinner, provide manufacturer's recommended products.

E. High Performance Industrial Coatings:

GENERIC DESCRIPTION	PRODUCT
Modified Aromatic Polyurethane Primer	Series 1 Omnithane
Modified Polyamine Epoxy (NSF 61)	Series 22 Pota-Pox 100
Polyamidoamine Epoxy	Series L69 Hi-Build Epoxoline II
Zinc-Rich Urethane	Series 94-H20 Hydro-Zinc
Modified Polyamidoamine Epoxy	Series 135 Chembuild
Acrylic Emulsion	Series 180 WB Tneme-Crete
Polyamidoamine Epoxy (NSF 61)	Series L140 Pota-Pox Plus
Modified Polyamine Epoxy	Series 201 Epoxoprime
Modified Flexible Polyamine Epoxy	Series 206SC Chembloc
Modified Polyamine Epoxy Surfacer/Filler	Series 215 Surfacing Epoxy
Epoxy Modified Cementitious Mortar	Series 218 MortarClad
Modified Polyamine Epoxy	Series 237 Power-Tread
Modified Polyamine Epoxy (Secondary Containment)	Series 237SC Chembloc
Novolac Vinyl Ester (Primer)	Series 251SC Chembloc
Novolac Vinyl Ester (Secondary Containment)	Series 252SC Chembloc
Polyamine Novolac Epoxy	Series 282 Tneme-Glaze

GENERIC DESCRIPTION	PRODUCT
Aliphatic Polyester Polyurethane	Series 290 CRU
Polyfunctional Hybrid Urethane (Gloss)	Series 740 UVX
Polyfunctional Hybrid Urethane (Semi-Gloss)	Series 750 UVX
Inorganic Hybrid Water-Based Epoxy	Series 1254 Epoxoblock WB

2.3 COATING SYSTEMS

Environment	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Ferrous Metals (Structural & Miscellaneous Metals)				
Interior atmospheric	SSPC SP-6/ NACE No. 3	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Interior atmospheric (corrosive environment)	SSPC SP-10/ NACE No. 2 min. 2 MIL anchor profile	2.5 to 3.5 mil Series 94-H2O	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Immersion – non NSF	SSPC SP-10/ NACE No. 2	mil Series3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Exterior atmospheric	SSPC SP-6/ NACE No. 3	2.5 to 3.5 mil Series 94-H2O	3.0 to 5.0 mil Series L69	2.5 to 3.5 mil Series 740
Hollow Metal Doors	SSPC SP-3	2.5 to 3.5 mil Series 135		2.5 to 3.5 mil Series 750
Bar Joists	SSPC SP-3	2.5 to 3.5 mil Series 1		3.0 to 4.0 mil Series L69
Galvanized Steel				
Interior atmospheric	SSPC SP-16	4.0 to 6.0 mil Series 135		2.0 to 3.0 mil Series L69
Immersion – non NSF	SSPC SP-16	4.0 to 6.0 mil Series 135	2.0 to 3.0 mil Series L69	2.0 to 3.0 mil Series L69
Exterior atmospheric	SSPC SP-16	4.0 to 6.0 mil Series 135		2.5 to 3.5 mil Series 740
Field cut pipe threads	SSPC SP-3	4.0 to 6.0 mil Series 135	Coat per exposure above	Coat per exposure above
Non Ferrous Metals, including piping				
Dissimilar Materials Protection	SSPC SP-2	4.5 to 5.5 mil Series L69		
Interior atmospheric	SSPC SP-2	3.0 to 4.0 mil Series L69		3.0 to 4.0 mil Series L69

Environment	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Immersion – non NSF	SSPC SP-16	3.0 to 4.0 mil Series L69		5.0 to 6.0 mil Series L69
Exterior atmospheric	SSPC SP-2	4.0 to 6.0 mil Series L69		2.5 to 3.5 mil Series 750
Ferrous Piping				
Interior atmospheric	SSPC SP-6/ NACE No. 3	2.5 to 3.5 mil Series 94-H2O	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Immersion – non NSF	SSPC SP-5/ NACE No.1	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Exterior atmospheric	SSPC SP-10/ NACE No. 2	2.5 to 3.5 mil Series 94-H2O	3.0 to 4.0 mil Series L69	2.5 to 3.5 mil Series 750
Ductile Iron Piping				
Interior atmospheric	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Immersion – non NSF	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69
Exterior atmospheric	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil Series L69	3.0 to 4.0 mil Series L69	2.5 to 3.5 mil Series 750
Cast Iron Piping				
Interior atmospheric	SSPC SP-1	4.0 to 6.0 mil Series 135	2.0 to 3.0 mil Series L69	2.0 to 3.0 mil Series L69
Exterior atmospheric	SSPC SP-1	4.0 to 6.0 mil Series 135	2.0 to 3.0 mil Series L69	2.5 to 3.5 mil Series 750
PVC Piping				
Interior atmospheric	Hand Sanding/ SSPC SP-1	3.0 to 4.0 mil Series L69		3.0 to 4.0 mil Series L69
Exterior atmospheric	Hand Sanding/ SSPC SP-1	3.0 to 4.0 mil Series L69		2.5 to 3.5 mil Series 750

Environment	Surface Preparation	Filler/ Surfacer	Prime Coat	Intermediate Coat	Finish Coat
Concrete					
Interior walls, ceilings, etc. atmospheric	SSPC SP-13/ NACE No. 6 ICRI CSP 5	Series 218 and/or 215 as necessary to fill holes and	250 to 300 SQFT/GAL Series L69		250 to 300 SQFT/GAL Series L69

Environment	Surface Preparation	Filler/ Surfacer	Prime Coat	Intermediate Coat	Finish Coat
		depressions			
Interior floors	SSPC SP-13/ NACE No. 6 ICRI CSP 5	Series 215 as necessary to fill holes and depressions	175 to 225 SQFT/GAL Series 237 clear	200 to 250 SQFT/GAL Series 237 pigmented	200 to 250 SQFT/GAL Series 237 pigmented
Immersion – non NSF	SSPC SP-13/ NACE No. 6 ICRI CSP 5	1/16 to 1/4 IN Series 218			16 to 20 MIL Series 22
Exterior atmospheric Corrosive Environment	SSPC SP-13/ NACE No. 6 ICRI CSP 5	Series 218 and/or 215 as necessary to fill holes and depressions	150 to 175 SQFT/GAL Series 180		150 to 175 SQFT/GAL Series 180
CMU*					
Interior atmospheric	Refer to PART 3	100 to 150 SQFT/Gal Series 1254	175 to 200 SQFT/Gal Series L69		175 to 200 SQFT/Gal Series L69
Exterior atmospheric Corrosive Environment	Refer to PART 3	100 to 150 SQFT/Gal Series 1254	175 to 200 SQFT/Gal Series L69		275 to 300 SQFT/Gal Series 750
Exterior atmospheric Non-Corrosive Environment	Refer to Specification Section 09 01 92 Architectural Coatings				

* Coverage rates indicated are based on smooth-face normal weight CMU. Provide increased coverage rates in accordance with manufacturer's recommendations for more porous surfaces.

PART 3 - EXECUTION

3.1 ITEMS TO BE COATED

A. Exterior Surfaces, including but not limited to:
   1. Structural steel:
      a. Columns, beams and bracing.
      b. Field welded connections of factory painted structural steel.
   2. Miscellaneous ferrous metal surfaces:
      a. Items specifically noted on Drawings to be painted.
   3. Miscellaneous galvanized steel surfaces:
      a. Pipe Bollards.
      b. Embed Plates.
      c. Loose lintels.
      d. Steel components of concrete lintels.
      e. Items specifically noted on Drawings to be painted.
   4. Appurtenant surfaces attached to or adjacent to a surface indicated to be painted:
      a. Conduit, boxes, covers and supports.

B. Interior Areas:
   1. Piping, fittings, and supports:

a. As scheduled in Specification Sections 40 05 00 and 40 05 07.
b. Do not paint piping scheduled to be insulated.

2. Structural steel:
   a. Columns, beams and bracing.
3. Ferrous metal process equipment.
   a. Bridge Crane Structural Runway Steel and Top Rails, excluding trolley and end cart wheel contact wear surfaces.
   b. Embed Plates.
4. Miscellaneous galvanized steel surfaces:
   a. Pipe Bollards.
   b. Embed Plates.
   c. Stilling well support brackets.
   d. Items specifically noted on Drawings to be painted.

3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article, unless noted otherwise.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical Equipment.

D. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless Steel Surfaces, except:
   1. Piping where specifically noted to be painted.
   2. Banding as required to identify piping.

H. Aluminum Surfaces, except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.
   4. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

I. Fiberglass Surfaces, except:
   1. Fiberglass piping where specifically noted to be painted.
   2. Piping supports where specifically noted to be painted.
   3. Appurtenant surfaces as described in the ITEMS TO BE PAINTED article.

J. Mechanical piping scheduled to be insulated.

K. Interior of Pipe, Ductwork, and Conduits.
   1. See Division 23 for ductwork.
   2. See Division 40 for pipe linings.

L. Galvanized Steel Items, unless specifically noted to be painted.

M. Architectural Finishes:

1. Exterior concrete indicated to receive another finish.
2. Precast concrete surfaces, unless specifically indicated to be painted.
3. Prefinished masonry surfaces:
   a. Pre-colored masonry (exterior face).
      1) Interior face shall be painted where scheduled.
   b. Burnished (ground face) concrete masonry.
   c. Prefaced masonry.
   d. Face brick.
   e. Glass masonry.
4. Plastic laminate.
5. Solid surface material.
6. Standing and running trim.
7. Fiberglass fabrications.
8. Anodized aluminum.
9. PVDF coated metals.
10. Factory finished doors and frames.
11. Aluminum windows, curtainwall and storefront framing systems.
12. Finish hardware.
13. Glass and glazing.
14. Ceramic, porcelain, quarry tile or natural stone.
15. Acoustical materials.
16. Building specialties.
17. Louvers.
18. Casework and countertops.
19. Pipe insulation and jacketing.
20. Standing seam metal roof, fascia, trim, soffit and accessories.

3.3 EXAMINATION

A. Concrete:
   1. Test pH of surface to be painted in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.
      b. Retest pH until acceptable results are obtained.
   2. Verify that moisture content of surface to be painted is within coating manufacturer's recommended acceptable limits.
      a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
         1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869 or ASTM F2170.
         2) Provide remedial measures as necessary to bring moisture content within coating manufacturer’s recommended acceptable limits.
         3) Retest surface until acceptable results are obtained.

3.4 PREPARATION

A. General:

1. Prepare surfaces to be painted in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
    a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Engineer.
2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
3. Adhere to manufacturer's recoat time surface preparation requirements.
    a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
        1) Minimum SSPC SP 7/NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
    1. Protect surrounding surfaces not to be coated.
    2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
    3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
    1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
        a. All piping, pumps, valves, fittings and any other component used in the water piping system that requires preparation for painting shall be prepared in accordance with requirements for immersion service.
        b. Prepare all areas requiring patch painting in accordance with recommendations of manufacturer and NAPF.
        c. Remove bituminous coating per piping manufacturer, paint manufacturer and NAPF recommendations.
            1) The most stringent recommendations shall apply.
    2. Complete fabrication, welding or burning before beginning surface preparation.
        a. Chip or grind off flux, spatter, slag or other laminations left from welding.
        b. Remove mill scale.
        c. Grind smooth rough welds and other sharp projections.
    3. Solvent clean in accordance with SSPC SP 1.
    4. Restore surface of field welds and adjacent areas to original surface preparation.

E. Galvanized Steel and Non-ferrous Metals:
    1. Solvent clean in accordance with SSPC SP 1 followed by brush-off blast clean in accordance with SSPC SP 16 to remove zinc oxide and other foreign contaminants.
        a. Provide uniform 1 MIL profile surface.

F. Hollow Metal Doors and Frames:

1. Verify factory-applied prime coat is in accordance with SDI/ANSI A250.10.
2. Prepare as indicated in COATING SYSTEMS Article.

G. Concrete:
1. Cure for minimum of 28 days.
2. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
3. Abrasive blast concrete surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6.
   a. Provide profile per ICRI 301.2 as listed in MATERIALS article of this Specification Section.
4. Test pH and moisture content in accordance with EXAMINATION article in this Specification Section.

H. Preparation by Abrasive Blasting:
1. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before painting.
2. Provide compressed air for blasting that is free of water and oil.
   a. Provide accessible separators and traps.
3. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
4. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of paint coatings.
   a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.
5. Perform additional blasting and cleaning as required to achieve surface preparation required.
   a. Re-blast surfaces not meeting requirements of these Specifications.
   b. Prior to painting, re-blast surfaces allowed to set overnight and surfaces that show rust bloom.
   c. Surfaces allowed to set overnight or surfaces which show rust bloom prior to painting shall be re-inspected prior to paint application.
6. Profile depth of blasted surface: Not less than 1 MIL or greater than 2 mils unless required otherwise by coating manufacturer.
7. Ensure abrasive blasting operation does not result in embedment of abrasive particles in paint film.
8. Confine blast abrasives to area being blasted.
   a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
   b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation.

I. All Plastic Surfaces:
1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.5 APPLICATION

A. General:
   1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
      a. Application equipment must be inspected and approved in writing by coating manufacturer.
      b. Hollow metal shall be spray applied only.
   2. Temperature and weather conditions:
      a. Do not paint surfaces when surface temperature is below 50 DEGF unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and paint manufacturer's authorized representative.
      b. Avoid painting surfaces exposed to hot sun.
      c. Do not paint on damp surfaces.
   3. Apply materials under adequate illumination.
   4. Provide complete coverage to mil thickness specified.
      a. Thickness specified is dry mil thickness.
   5. Evenly spread to provide full, smooth coverage.
      a. All paint systems are "to cover."
         1) In situations of discrepancy between manufacturer's square footage coverage rates and mil thickness, mil thickness requirements govern.
      b. When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
      c. Finished paint system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.
   6. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.
   7. Work each application of material into corners, crevices, joints, and other difficult to work areas.
   8. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contamination.
      a. Clean contaminated surfaces before applying next coat.
   9. Smooth out runs or sags immediately, or remove and recoat entire surface.
   10. Allow preceding coats to dry before recoating.
      a. Recoat within time limits specified by coating manufacturer.
      b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
   11. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
   12. Coat all aluminum in contact with dissimilar materials.
   13. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses.
   14. Backroll surfaces if paint coatings are spray applied.
B. Employ services of coating manufacturer's qualified technical representative to ensure that field-applied coatings are compatible with factory-applied or existing coatings.

1. Certify through material data sheets.
2. Perform test patch.
   a. Prepare existing coating surface to receive specified coating system.
   b. Apply coating to a minimum 1 SQFT area and allow to cure in accordance with manufacturer's recommendations.
   c. Evaluate adhesion to existing coating:
      1) Concrete or Masonry substrates: ASTM D4541.
      2) All other substrates: ASTM D6677 and ASTM D3359 (X-cut method).
3. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
   a. Perform test patch as described above.
4. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system listed in the MATERIALS Article, Paint Systems paragraph of this Specification Section.
   a. All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to the Contract.

C. Prime Coat Application:
   1. Apply structural steel and miscellaneous steel prime coat in the factory.
      a. Finish coats shall be applied in the factory.
      b. Prime coat referred to here is prime coat as indicated in this Specification.
         1) Prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
   2. Prime all surfaces indicated to be painted.
      a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
   3. Prime ferrous metals embedded in concrete to minimum of 1 IN below exposed surfaces.
   4. Apply zinc-rich primers while under continuous agitation.
   5. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
   6. Touch up damaged primer coats prior to applying finish coats.
      a. Restore primed surface equal to surface before damage.
   7. All surfaces of steel lintels and steel components of concrete lintels used in wall construction shall be completely painted with both prime and finish coats prior to placing in wall.

D. Finish Coat Application:
   1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
      a. Prepare damaged area in accordance with the PREPARATION

Article of this Specification Section.

3.6 COLOR CODING

A. Color code piping in accordance with the SCHEDULE Article of this Specification Section.

3.7 FIELD QUALITY CONTROL

A. Application Deficiencies:
   1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
   2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.
      a. Epoxy surfaces showing evidence of chalking or amine blush shall be prepared and recoated as follows:
         1) Solvent clean surfaces in accordance with SSPC SP1 and abrasive blast in accordance with SSPC SP7/NACE No. 4.
         2) Recoat with intermediate and finish coats in accordance with coating system specified herein.

B. Provide protection for painted surfaces.
   1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Contractor Performed Testing:
   1. The Contractor shall provide ongoing testing and inspection, including but not limited to the following:
      a. Measurement and recording of environmental conditions as specified herein.
      b. Measurement and recording of substrate conditions as specified herein.
      c. Thickness Testing:
         1) Wet film thickness during application in accordance with ASTM D4414.
         2) Dry Film Thickness (DFT) in accordance with SSPC PA 2 and ASTM D7091.

D. Instrumentation:
   1. Provide instrumentation as necessary to measure and record atmospheric and substrate conditions, including but not limited to:
      a. Dry Film Thickness Gauge.
      b. Wet Film Thickness Gauge.
      c. Sling Psychrometer.
      d. Surface Temperature Gauge.
      e. Anemometer.
      f. Moisture Meter.

E. Maintain Daily Records:
   1. Record the following information during application:
      a. Date, starting time, end time, and all breaks taken by painters.
      b. Air temperature.
      c. Relative humidity.

d. Dew point.
e. Moisture content and pH level of concrete or masonry substrates prior to coating.
f. Surface temperature of substrate.
g. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind blown dust and debris from contaminating the wet paint film.
h. For exterior painting:
    1) Sky condition.
    2) Wind speed and direction.
i. Record environmental conditions, substrate moisture content and surface temperature information not less than once every 4 HRS during application.
    1) Record hourly when temperatures are below 50 DEGF or above 100 DEGF.

2. Record the following information daily for the paint manufacturer's recommended curing period:
    a. Date and start time of cure period for each item or area.
    b. For exterior painting:
        1) Sky conditions.
        2) Wind speed and direction.
        3) Air temperature.
            a) Dry Bulb.
            b) Wet Bulb.
        4) Relative humidity.
        5) Dew point.
        6) Surface temperatures.
    c. Record environmental conditions not less than once every 4 HRS.
        1) Record hourly when temperatures are below 50 DEGF or above 100 DEGF.
    d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
3. Format for daily record to be computer generated.

F. Measure wet coating with wet film thickness gages in accordance with ASTM D4414.

G. Measure coating dry film thickness in accordance with SSPC PA 2.
1. Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.

H. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

I. Measure substrate humidity with humidity gage specifically designed for such.

J. Provide “wet paint” signs.

3.8 COLOR SCHEDULE

A. Pipe Bollards: 02SF Safety Yellow.

B. Pump Storage Floor Hatching: 02SF Safety Yellow.

C. Final paint color selections shall be made by the Engineer.

END OF SECTION

DIVISION 10

SPECIALTIES

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SECTION 10 14 00 - IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1, Scheme for the Identification of Piping Systems.
   2. The International Society of Automation (ISA).
   3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. Z535.1, Safety Color Code.
      b. Z535.2, Environmental and Facility Safety Signs.
      c. Z535.3, Criteria for Safety Symbols.
      d. Z535.4, Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. W.H. Brady Co.
   2. Panduit.
   3. Seton.

4. National Band and Tag Co.
5. Carlton Industries, Inc.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 IN minimum.
      b. Thickness: 0.035 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 IN x 1-1/2 IN minimum.
      b. Thickness: 0.036 IN (20 GA) minimum.
   3. Fabrication:
      a. 3/16 IN minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 IN minimum.
      b. Length as required by text.
   3. Fabrication:

a. 3/16 IN minimum mounting hole.
b. Legend: Embossed.

4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:
1. Materials: Fiberglass reinforced plastic.
2. Size:
a. Surface: 2 x 2 IN minimum.
b. Thickness: 100 mils.
3. Fabrication:
a. 3/16 IN mounting hole with metal eyelet.
b. Legend: Preprinted and permanently embedded and fade resistant.
4. Color:
a. Background: Manufacturer standard or as specified.
b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:
1. Materials: Fiberglass reinforced or durable plastic.
2. Size:
a. Surface: As required by text.
b. Thickness: 60 mils minimum.
3. Fabrication:
a. Rounded corners.
b. Drilled holes in corners with grommets.
c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
4. Color:
a. Background: Manufacturer standard or as specified.
b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:
1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
a. Surface: As required by text.
b. Thickness: 1/16 IN.
3. Fabrication:
a. Outdoor rated and UV resistant when installed outdoors.
b. Two (2) layers laminated.
c. Legend: Engraved through top lamination into bottom lamination.
d. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:
1. Materials: Vinyl tape or vinyl cloth.
2. Size:
a. Surface: As required by text.
b. Thickness: 5 mils minimum.
3. Fabrication:

a. Indoor/Outdoor grade.
b. Weather and UV resistant inks.
c. Permanent adhesive.
d. Legend: Preprinted.
e. Wire markers to be self-laminating.

4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
a. Legend: Preprinted.
4. Color: White background, black printing.

I. Type F - Underground Warning Tape:
1. Materials: Polyethylene.
2. Size:
a. 6 IN wide (minimum).
b. Thickness: 3.5 mils.
3. Fabrication:
a. Legend: Preprinted and permanently imbedded.
b. Message continuous printed.
c. Tensile strength: 1750 PSI.
4. Color: As specified.

J. Type G - Stenciling System:
1. Materials:
a. Exterior type stenciling enamel.
b. Either brushing grade or pressurized spray can form and grade.
2. Size: As required.
3. Fabrication:
a. Legend: As required.
4. Color: Black or white for best contrast.

K. Underground Tracer Wire:
1. Materials:
a. Wire:
1) 12 GA AWG.
2) Solid.
b. Wire nuts: Waterproof type.
c. Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:
1. Bead chain: #6 brass, aluminum or stainless steel.
2. Plastic strap: Nylon, urethane or polypropylene.
3. Screws: Self-tapping, stainless steel.

4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
   1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
   1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:
   1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
   2. Continuous pass from each valve box and above grade at each structure.
   3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
   4. 1,000 FT maximum spacing between valve boxes.
   5. If split bolts are used for splicing, wrap with electrical tape.
   6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
   7. Use continuous strand of wire between valve box where possible.
      a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

A. Process Systems:
   1. General:
      a. Provide arrows and markers on piping.
         1) At 20 FT maximum centers along continuous lines.
         2) At changes in direction (route) or obstructions.
         3) At valves, risers, "T" joints, machinery or equipment.
         4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
   1) If flow is in both directions use double headed arrow markers.
c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:
   a. Tag type: Type F - Underground Warning Tape.
   b. Location: Halfway between top of piping and finished grade.
   c. Letter height: 1-1/4 IN minimum.
   d. Potable water:
      1) Color: Blue with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED WATER LINE BELOW"
   e. Storm and sanitary sewer lines:
      1) Color: Green with black letters.
      2) Legend:
         a) First line: "CAUTION CAUTION CAUTION"
         b) Second line: "BURIED SEWER LINE BELOW"
3. Yard valves, buried, with valve box and concrete pad:
   a. Tag type: Type A2 - Rectangle Metal Tags.
   b. Fastener: 3/16 IN x 7/8 IN plastic screw anchor with 1 IN #6 stainless steel pan head screw.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
4. Valves and slide gates:
   a. Tag type:
      1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
      2) Indoor noncorrosive:
         a) Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
      3) Indoor corrosive:
         a) Stainless steel Type A1 - Round Metal Tags.
         b) Type B1 - Square Nonmetallic Tags.
   b. Fastener:
      1) Type A1: Chain of the same material.
      2) Type B1: Stainless steel chain.
   c. Color: Per ASME A13.1 corresponding to the piping system.
   d. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
   a. Tag type:
      1) Type B2 - Nonmetallic Signs.
      2) Type D - Self-Adhesive Tape Tags and Signs.
      3) Type G - Stenciling System.
   b. Fastener:

1) Self.
2) Screws.
3) Adhesive.

c. Legend:
1) Letter height: 1/2 IN minimum.
2) Equipment designation as indicated on the Drawings (e.g., "Primary Sludge Pump P-xxx").

6. Piping systems:
a. Tag type:
1) Outdoor locations: Type G - Stenciling System.
2) Indoor locations:
a) Type D - Self-Adhesive Tape Tags and Signs.
b) Type G - Stenciling System.

b. Fastener: Self.
c. Color: Per ASME A13.1.
d. Legend:
1) Letter height: Manufacturers standard for the pipe diameter.
2) Mark piping in accordance with ASME A13.1.
3) Use piping designation as indicated on the Drawings.
4) Arrow: Single arrow.

7. Equipment that starts automatically:
a. Tag type:
1) Type B2 - Nonmetallic Signs.
2) Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener:
1) Type B2 - Screw or adhesive.
2) Type D - Self.

c. Size: 5 IN x 7 IN
d. Legend:
1) OSHA Warning Sign.
2) Description of Warning: "THIS MACHINE STARTS AUTOMATICALLY".

B. Instrumentation Systems:
1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
a. Tag type:
1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
2) Indoor noncorrosive:
a) Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.
3) Indoor corrosive:
a) Stainless steel Type A1 - Round Metal Tags.
b) Type B1 - Square Nonmetallic Tags.

b. Fastener:
1) Type A1: Chain of the same material.
2) Type B1: Stainless steel chain.

c. Legend:
1) Letter height: 1/4 IN minimum.
2) Equipment ISA designation as indicated on the Drawings (e.g., "FIT-xxx").

2. Enclosure for instrumentation and control equipment, (e.g., PLC control

panels, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/2 IN minimum.
2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").

3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers):
a. Tag type: Type D - Self-Adhesive Tape Tags.
b. Fastener: Self.
c. Legend:
1) Letter height: 3/16 IN minimum.
2) Description or function of component (e.g., "PLC-xxx" or "CR-xxx").

4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/4 IN minimum.
2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").

C. HVAC Systems:
1. General:
a. Provide arrows and markers on ducts.
1) At 20 FT maximum centers along continuous lines.
2) At changes in direction (route) or obstructions.
3) At dampers, risers, branches, machinery or equipment.
4) Where ducts pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
b. Position markers on both sides of duct with arrow markers pointing in flow direction.
1) If flow is in both directions use double headed arrow markers.
c. Apply tapes and stenciling in uniform manner parallel to ducts.

2. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):
a. Tag type:
1) Type B2 - Nonmetallic Signs.
2) Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1 IN minimum.
2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").

3. Ductwork:
a. Tag type:
1) Type D - Self-Adhesive Tape Tags and Signs.
2) Type G - Stenciling System.
b. Fastener: Self.
c. Legend:
1) Letter height: 1 IN minimum.
2) Description of ductwork, (e.g., "AIR SUPPLY").

3) Arrows: Single arrow.

4. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").
5. Wall mounted thermostats:
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").
6. Components inside equipment enclosure, (e.g., controller's, control relays, contactors, and timers):
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "CR-xxx").
7. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Component tag number as indicated on the Drawings or as defined by Contractor (e.g., "HS-xxx").

D. Electrical Systems:
   1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
      a. Tag type: Type F - Underground Warning Tape.
      b. Letter height: 1-1/4 IN minimum.
      c. Location:
         1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
         2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
      d. Electrical power (e.g., low and medium voltage):
         1) Color: Red with black letters.
         2) Legend:
            a) First line: "CAUTION CAUTION CAUTION".
            b) Second line: "BURIED ELECTRIC LINE BELOW".
      e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
         1) Color: Orange with black letters.
         2) Legend:
            a) First line: "CAUTION CAUTION CAUTION".

b) Second line: “BURIED COMMUNICATION LINE BELOW”.

2. Exterior pad mounted equipment (e.g., transformers, switchgear):
   a. Tag type: Type D - Self-Adhesive Tape Tags.
   b. Fastener: Self.
   c. General legend:
      1) Letter height:
         a) First line: 1-1/2 IN minimum.
         b) Subsequent lines: 1/2 IN minimum.
      2) First line: Equipment name (e.g., "TRANSFORMER Txxx").
      3) Second line: System voltage (e.g., "13,800 V: 480/277 V").
      4) Third line: Date installed (e.g., “INSTALLED JULY 20xx”).
   d. Each section/cubical legend:
      1) Letter height: 1-1/2 IN minimum.
      2) Description of source or load (e.g., "MAIN DISCONNECT" or "TO SWITCHGEAR SGxxx" or "TO TRANSFORMER Txxx").
3. Switchgear, switchboards and motor control centers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Main equipment legend:
      1) Letter height:
         a) First line: 1 IN minimum.
         b) Subsequent lines: 3/8 IN minimum.
      2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
      3) Second line:
         a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
         b) Include the building name or number if the source is in another building.
      4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).
      5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).
   d. Main and feeder device legend:
      1) Letter height: 3/8 IN minimum.
      2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").
4. Panelboards and transformers:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height:
         a) First line: 3/8 IN minimum.
         b) Subsequent lines: 3/16 IN minimum.
      2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
      3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).
      4) Third line:
         a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN

ROOM xxx").
b) Include the building name or number if the source is in another building.
5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).

5. Transfer switches:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height:
         a) First line: 3/8 IN minimum.
         b) Subsequent lines: 3/16 IN minimum.
      2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").
      3) Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCCxxx").
      4) Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGENxxx").
      5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).
6. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
7. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/2 IN minimum.
      2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
8. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
   a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 3/16 IN minimum.
      2) Description or function of component (e.g., "M-xxx”, “CR-xxx” or “TR-xxx").
9. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
   a. Tag type: Type C - Phenolic Name Plates.
   b. Fastener: Screws.
   c. Legend:
      1) Letter height: 1/4 IN minimum.
      2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

10. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
11. Conductors in handholes and manholes.
    a. Tag type: Type A3 - Metal Tape Tags.
    b. Fastener: Nylon strap.
    c. Tag conductor at both ends.
    d. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Circuit number or wire number as scheduled on the Drawings.
12. Grounding conductors associated with grounding electrode system in accordance with the following:
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 1/8 IN minimum.
        2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
13. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
    a. Tag type: Type D - Self-Adhesive Tape Signs.
    b. Fastener: Self.
    c. Legend: Per NFPA 70.
14. Entrances to electrical rooms:
    a. Tag type: Type B2 - Nonmetallic Signs.
    b. Fastener: Screw or adhesive.
    c. Size: 5 IN x 7 IN.
    d. Location: Each door to room.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: “HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY”.
15. Equipment where more than one (1) voltage source is present:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 1-3/4 IN x 2-1/2 IN.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:

1) OSHA Danger Sign.
2) Description of Danger: “MULTIPLE VOLTAGE SOURCES”.

END OF SECTION

SECTION 10 14 23 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Room identification signs.
   2. Other identification signs:
      a. Fire and/or smoke barrier identification signs.
      b. Stair identification signs.
   3. Post mount exterior dimensional aluminum letters.
   4. Plaque.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 10 14 00 - Identification Devices.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. ASTM International (ASTM):
      a. B26, Standard Specification for Aluminum-Alloy Sand Castings.
   3. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2015 Edition including all amendments, referred to herein as Building Code.

1.4 DEFINITIONS

A. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the entire facility is considered wet and/or corrosive.

1.5 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Color charts for Engineer's color selection.

1) Color selection shall be made from manufacturer's complete color line including all premium and special colors.

2. Schedule of all signs indicating text and graphics.
3. Layout Drawings of all signage showing size, letter style, text, border, finish, and installation detail.
   a. Provide Drawings for:
      1) Room, exit, and stair identification signs.
      2) Fire and/or smoke barrier identification signs.
      3) Aluminum letters.

B. Samples:
   1. Room, exit, and stair identification signs.
   2. Fire and/or smoke barrier identification signs.
   3. Aluminum letters.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Room, exit and stair identification signs:
      a. ASE - Architectural Signs and Engraving.
      b. ASI Signage Innovations.
      c. Best Sign Systems.
      d. Mohawk Sign Systems.
      e. Nelson-Harkins.
      f. Southwell Co.
      g. Stamprite Supersine Identification Specialists.
   2. Fire and/or smoke barrier identification signs:
      a. Brady.
      b. Panduit.
      c. Seton.
      d. Carlton Industries.
   3. Aluminum letters:
      a. A R K Ramos Manufacturing Co., Inc.
      b. ASI Signage Innovations.
      c. Leeds Architectural Letters.
      d. Metal Arts.
      e. Metallic Arts.
      f. The Southwell Co.
   4. Plaque:
      a. ARK-Ramos.
      b. Metal Arts.
      c. Metallic Arts.

B. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal

and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Room, Exit, and Stair Identification Signs:
   1. Interior:
      a. Wet and/or corrosive areas: Aluminum or fiberglass suitable for raised lettering and Braille.
   2. Exterior: Aluminum or fiberglass suitable for raised lettering and Braille.

B. Fire and/or Smoke Barrier Identification Signs:
   1. Self-adhesive vinyl tape or vinyl cloth.

C. Aluminum Letters:
   1. Post mount offset cast aluminum ASTM B26.
   2. For machine cut letters, provide aluminum of appropriate alloy and hardness.

D. Plaque: Cast bronze.

2.3 FABRICATION

A. Room and Exit Identification Signs:
   1. General:
      a. Raised text, border and graphics.
         1) Minimum 1/32 IN height.
         2) Provide international graphic symbology for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
         3) Provide handicap symbol on all signs for rooms meeting handicap requirements.
      b. Grade 2 Braille.
      c. Finish: Eggshell.
         1) Color: To be selected.
      d. Text:
         1) Typeface: Sans Serif.
         2) Size: Minimum 3/4 IN high.
      e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.
      f. Exterior signs shall be rated for exterior use.

g. All signs shall comply with requirements of ADA.

B. Stair Identification Signs:
   1. Minimum 18 IN by 12 IN sign:
      a. Raised text, border and graphics height: Minimum 1/32 IN.
      b. Indicate;
         1) Floor level.
         2) Terminus of top and bottom of exit enclosure.
         3) Identification of stair.
         4) Story of and direction to exit discharge.
         5) Availability of roof access from enclosure.
   2. Text and number height:
      a. Letters designating stair enclosure: Minimum 1.5 IN.
      b. Number designating floor level: Minimum 5 IN, in center of sign.
      c. Other letters and numbers: Minimum 1 IN.
   3. Finish:
      a. Eggshell.
      b. Color: To be selected.
   4. All signs shall comply with requirements of ADA.

C. Fire and/or Smoke Barrier Identification Signs:
   1. Self-adhesive tape tags and signs:
      a. Materials: Vinyl tape or vinyl cloth.
      b. Size:
         1) Surface: As required by text.
         2) Thickness: 5 mils minimum.
      c. Fabrication:
         1) Indoor/Outdoor grade.
         2) Weather and UV resistant inks.
         3) Permanent adhesive.
         4) Legend: Preprinted.
         5) Self-laminating.
      d. Color: White with black lettering or as specified.

D. Aluminum Letters:
   1. General:
      a. Cast aluminum, machine cut or laser cut aluminum.
      b. Finish: Anodized.
      c. Color: Silver.
      d. Mounting:
         1) 1/4 IN projected (Flush Mount).
         2) Provide stainless steel mounting studs.
      e. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.
   2. Letters:
      a. Style: As identified in IDOT Standard Specifications.
      b. Size:
         1) Main Id Sign: Upper case, 14 IN tall.
         2) Address Sign: Upper Case, 8 IN tall.
      c. Depth: 3/8 IN.

3. Provide true angles, crisp corners and straight edges with no burrs or pitting in the surface.

E. Plaque:
   1. Cast one-piece unit complete with mounting device.
   2. Text, border and text style as indicated on Drawings.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Room Identification Signs:
   1. Install signs using foam tape for interior signs and stainless steel screws (minimum of two (2)) for exterior signs.
      a. Stainless steel screws shall be painted to match sign color.
   2. Mounting Locations:
      a. Tactile characters on signs shall be located 48 IN minimum above the finished floor or ground surface, measured from the baseline of the lowest tactile character and 60 IN maximum above the finish floor or ground surface, measured from the baseline of the highest tactile character.
      b. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf. Where a tactile sign is provided at double doors with two active leafs, the sign shall be located to the right side of the right hand door. Where there is no wall space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.
      c. Signs containing tactile characters shall be located so that a clear floor space of
      18 IN minimum by 18 IN minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.

B. Stair Identification Signs:
   1. Install signs on walls adjacent to door leading from enclosure into corridor, in a position readily visible when doors are in open and closed positions.
   2. Mount 60 IN above finish floor to centerline of top row of text.
   3. Exit Signs:
      a. Doors at exit passageways, exit discharge and exit stairways shall be identified by tactile signs complying with requirements of ADA.
      b. Mounting Locations: Refer to paragraph for Room Identification Signs above.

C. Fire and/or Smoke Barrier Identification Signs:
   1. Provide marking and identification in compliance with Building Code.
   2. Locate in accessible concealed floor, floor-ceiling, or attic spaces.
   3. Repeat at intervals not exceeding 15 FT measured horizontally.
   4. Lettering: Not less than 1/2 IN high.

D. Aluminum Letters:
   1. Install letters where indicated on Drawings.
   2. Mount to walls with 1/4 IN projection in accordance with manufacturer's instructions.

3.2 SCHEDULES

A. Room and Exit Identification Signs:

BUILDING LOCATION	MOUNTING	VERBIAGE	REMARKS
PUMP BUILDING			
DOOR 001A	INTERIOR	STAIR	1
DOOR 001A	INTERIOR	STAIR	1
DOOR 102A	EXTERIOR	ELECTRICAL	
DOOR 102A	EXTERIOR	ELECTRICAL	
NORTH ELEVATION	EXTERIOR	PUMP STATION No. 4	
REMARKS: 1. Provide Universal Graphic Symbology.			

B. Stair Identification Signs:
   1. Refer to Stair Identification Signs in the FABRICATION Article in PART 2 of this Specification Section for specific information requirements.

C. Fire and/or Smoke Barrier Identification Signs:
   1. FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS

END OF SECTION

SECTION 10 41 00 - EMERGENCY ACCESS CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Emergency Key Cabinets.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Division 03 - Concrete.
   3. Division 04 - Masonry.
   4. Section 07 92 00 - Joint Sealants.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. Society of Automotive Engineers (SAE).
   3. Underwriters Laboratories Inc. (UL):
      a. 1037, Standard for Antitheft Alarms and Devices.
   4. Fire Code:
      a. International Code Council (ICC):
         1) International Fire Code and associated standards, 2015 Edition including all amendments, referred to herein as Fire Code.

B. Qualifications:
   1. Manufacturer shall be acceptable to the local Authority Having Jurisdiction (AHJ).

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.5 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

B. Galvanize, Galvanized or Galvanizing:

1. Sheet metal: Hot-dip zinc coated in accordance with ASTM A653, G60 minimum.
2. Steel fabrications and hardware: Hot-dip zinc coated in accordance with ASTM A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Emergency Key Cabinets:
      a. Knox Company.
   2. Locks:
      a. Medeco.

2.2 MANUFACTURED UNITS

A. Emergency Key Cabinets: Coordinate mounting location with fire marshal or authority having jurisdiction.
   1. Knox 3200 Series.
   2. Listed: UL 1037.
   3. Surface mounted.
   4. High-security key box:
      a. Fully welded steel case.
      b. Minimum 1/4 IN thick steel.
      c. Size: Nominal 5 IN wide x 4 IN high x 3 IN deep.
      d. Integral flange.
   5. Hinged door:
      a. Stainless Steel, 5/8 IN thick.
      b. Weather resistant door gasket.
      c. Stainless steel hinge.
   6. Lock:
      a. UL listed.
      b. Double-action rotating tumblers.
      c. Hardened steel pins.
      d. Biased cut key.
      e. Hinged lock cover: Stainless steel, 1/8 IN thick.
   7. Finish:
      a. Manufacturer's proprietary finishing process.
      b. Corrosion resistant aluminized substrate.
      c. Color: Satin Mill Finish.

2.3 ACCESSORIES

A. Mounting Hardware:
   1. Bolts:
      a. SAE Grade 5 or 8.

b. Carriage head.
c. Stainless Steel.
d. Emergency Information Cabinets: 5/16 IN DIA by length required.
e. Emergency Key Cabinets: 3/8 IN DIA by length required.

2. Nuts and washers:
   a. Match bolts.
   b. Provide fender washer under bolt head and nut.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Prior to installation; verify locations and mounting heights shown on drawings with the AHJ.
      a. AHJ direction takes precedence over Drawings.
   2. Install units in accordance with manufacturer's instructions and Fire Code.

B. Emergency Information Cabinets: Surface-mount with through-bolted connection as recommended by manufacturer.

C. Emergency Key Cabinets:
   1. Surface-mount with through-bolted connection as recommended by manufacturer.

END OF SECTION

SECTION 10 44 33 - FIRE EXTINGUISHER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire extinguishers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 10, Standard for Portable Fire Extinguishers.
   2. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

1.4 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

1.5 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire extinguishers:
      a. J. L. Industries.
      b. Larsen's Manufacturing Co.
      c. Amerex Corporation.

d. Ansul Fire Protection.
e. Walter Kidde.
f. Potter - Roemer Inc.

2. Fire extinguisher signs:
   a. Seton.

B. Request for Substitution:
1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MANUFACTURED UNITS

A. Fire Extinguisher (FEXT):
1. Steel bodied, all metal top (head) and valves.
2. Multi-purpose dry chemical with hose and horn.
3. FM Approved.
4. Provide one (1) UL rated 10A-120BC extinguisher for each fire extinguisher location (FEXT) indicated on Drawings.
5. Finish: Red with epoxy finish coat.

B. Wall Brackets:
1. Bracket type to fit specified extinguisher.
2. Furnish bracket for each extinguisher not in cabinet.
3. Bracket to be finished in red or black enamel.

C. Fire Extinguisher Signage:
1. Single faced: SETON #21999.
2. Double faced: SETON #22001.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and NFPA 10.
1. Install units with extinguisher top not over 48 IN above floor.
2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.

a. See Specification Section 05 50 00.

B. Fire extinguisher locations shown on Drawings are approximate locations.
   1. Verify all extinguisher mounting locations with the AHJ.
C. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
   1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

END OF SECTION

DIVISION 11
EQUIPMENT

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DIVISION 12
FURNISHINGS

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SECTION 12 51 00 - OFFICE FURNITURE AND FURNISHINGS (OF)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Office furniture and furnishings.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. HFS100, Human Factors Engineering of Visual Display Terminal Workstations.
   2. Catalog and/or model numbers are provided to establish minimum quality and functional requirements.

1.4 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.5 WARRANTY

A. Manufacturer's standard five (5) year warranty for office furniture. Standard one (1) year warranty for equipment and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers, or approved equal, are acceptable:
   1. Desks, file cabinets, tables and chairs:
      a. Steelcase, Inc.
      b. All Steel Company.
      c. Haworth.
      d. Hon.
      e. Knoll.

B. Request for Substitution:

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.

2.2 FABRICATED UNITS

A. General:
   1. Baked enamel painted finish on all exposed steel surfaces.
   2. Steel panel leg design on all desks.
   3. All pedestals shall be suspended.
   4. Provide plastic laminate top with square edge design.
   5. Chair shall have fabric upholstery.
      a. All chairs shall meet ANSI HFS100.

B. Furniture and Equipment Units:
   1. OF-1 Desk: Hon – Metro Double pedestal.
      a. 60 x 30 IN top.
      b. 29.5 IN tall, 1-1/8 IN the top.
      c. (2) box, two (2) file drawer and center pencil drawer.
      d. Central center lock.
   2. OF-2 Chair: Hon – Basyx VL531, Black.
      a. Black mesh back, polyester seat.
      b. Lever height adjustment.
   3. OF-3 Waste Basket:
      a. Trash can shall be made of polyethylene and the capacity shall be approximately 40-50 gallon industrial type with wheels/casters.
   4. OF-4 Staff gauges:
      a. Two staff gauges (one in the wet pit and one in the discharge chamber), calibrated in feet and tenths of a foot, shall be provided to show the depth of the water.
      b. Each gauge shall be porcelain enameled iron rod. The rods shall be professional type, 2-1/2 IN wide minimum, with large bold markings of a height for the full height of the wet well.
      c. Each staff gauge shall be attached and supported using corrosion resistant hardware at locations to avoid conflict with level controls, etc.
   5. OF-5 Electronic clock:
      a. Clock shall be synchronous motor type, 12 IN face, 120 V. 60 Hz.
   6. OF -6 Metal shelf:
      a. Metal shelf shall be approximately 53 IN long, 12.5 IN wide by 15 IN deep to be wall mounted above the bulletin board.
   7. OF-7 Bulletin board:

a. Furnish and install one (1) two panel bulletin board with glass doors. Bulletin board panels shall be 1/4 IN cork mounted on hardboard. Doors shall have 1/4 IN glass and shall be continuously hinged with flat key tumbler locks. Overall dimensions shall be approximately 40 IN high, 60 IN long, 3 IN deep.
b. Provide wall anchors for install at concrete walls.

8. OF -8 First Aid Kit (1 at main pump room and 1 at electrical room by office area).
   a. Furnish and install a first aid kit with brackets for wall mounting as directed in the pump room and electrical room. The kit shall be Model No. 640135 as manufactured by Johnson and Johnson or equal.
9. OF -9 PS Identification Sign Plate
   a. Furnish and secure in position and location, one, 24 IN x 30 IN cast bronze tablet for each such required tablet. The tablet shall be made by a firm specializing in bronze tablet work and shall be of best grade of statuary bronze. Lettering shall be arranged as directed and of a style to be selected. All lettering and designs to be of embossed type, milled and polished. Background shall be pebble finish, left rough. A full-size rubbing shall be submitted for approval before casting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's printed instructions for installation.

B. Provide all trim, fillers, closures, supports, brackets, braces or other miscellaneous items required for complete installation.

C. Refer to Contract Documents for location of all office furniture and furnishings.

D. Repair all scratches or other damage as a result of shipping and installation.
   1. Use patching materials provided by manufacturer.

END OF SECTION

DIVISION 23
HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

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SECTION 23 00 00 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

B. Progress payments will be in accordance with Section 109 of the Standard Specifications.

C. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION

1.4 REFERENCES:

A. Standards:

1. ANSI B1.1: Unified Inch Screw Threads (UN and UNR Thread Form).
2. ANSI B18.2.1: Square and Hex Bolts and Screws, Inch Series)
3. ANSI B18.2.2: Square and Hex Nuts.
4. ASME: Boiler and Pressure Vessel Code.
5. ASTM A36: Specification for Structural Steel.
6. ASTM A48: Specification for Gray Iron Castings.

7. ASTM A53: Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.

8. ASTM A123: Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strips.

9. ASTM A240: Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

10. ASTM A307: Specification for Carbon Steel Externally Threaded Standard Fasteners.

11. ASTM A569: Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

12. ASTM B23: Specification for White Metal Bearing Alloys (known commercially as "Babbitt Metal").

13. ASTM B26: Specification for Aluminum Alloy Sand Castings.

14. ASTM B30: Specification for Copper-Base Alloys in Ingot Form.

15. ASTM B98: Specification for Copper-Silicon Alloy Rod, Bar and Shapes.

16. ASTM B138: Specification for Manganese Bronze Rod, Bar and Shapes.

17. ASTM D1785: Specification for Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

18. IEEE: all pertinent to standards.

19. NEMA: all pertinent to standards.

20. Occupational Safety and Health Administration (OSHA): all pertinent to rules and regulations.

B. Codes:

1. IEEE: all pertinent to standards.

1.5 SUBMITTALS:

A. Shop Drawings:

1. Detailed drawings of proposed departures due to actual field conditions or other causes shall be submitted to the Engineer for approval as part of shop drawings.

A. Quality Assurance/Control Submittals:

1. Certificates:

   a. Each set of V-belts shall be accompanied by the manufacturer's certificate stating the belts have been factory matched in regard to tension.

   O&M Instructions:

   b. The Contractor shall furnish the manufacturer's standard O&M manuals, lubrication charts or schedules for each piece of equipment or machinery in accordance with Section 01 33 04 “Operation and Maintenance Manuals”.

1.6 QUALITY ASSURANCE

A. General Design Criteria:

1. General:

   a. All equipment and machinery furnished under this contract shall be of the latest and most improved design and fully suitable for the service for which it is to be used. All products shall be in current production with no notice having been given that this product is to be drastically changed, modified or discontinued from production. The supplier, by submitting, certifies that equipment being proposed is proper for the application intended and that it has the capacity called for. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of labor, power, maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum noise, wear and vibration when properly installed and maintained.

   b. Whenever possible, fittings and fixtures of the same make and model shall be used for the several units and their connections. All equipment of identical size, type, and service shall be the product of the same manufacturer.

   c. The various parts of equipment and machinery shall be of plain shape and good lines, especially designed and constructed for strength and durability. Castings shall be designed and constructed to cool uniformly without shrinking strains and shall have adequately sized fillets

at all re-entrant corners. Sudden changes of section shall be avoided.

d. Whenever possible, parts of each unit shall be made to gauge and be a duplicate of, and inter-changeable with, the same parts of other machines of the same size and kind.

e. Workmanship shall be of the highest class throughout.

f. All assemblies shall be shop fabricated, and structural steel shall be shop erected. Assemblies and structural steel parts shall be match-marked before being disassembled for shipment. Parts shall be assembled in largest size units practicable prior to shipment to minimize field reassembly.

g. All parts shall be designed for all stresses, which may occur during operation, and any additional stresses, which may occur during fabrication and erection.

h. Unless otherwise specified, galvanizing shall be per ASTM A123 and shall be done after fabrication.

i. All exposed belts, gears and drives shall be protected with guards. Guards may be of the equipment manufacturer's standard design, but shall meet OSHA minimum standards.

j. Motor-driven equipment shall be mounted on structural steel bases. The bases shall be of adequate size to accommodate the equipment and motors, to form an integral, rigid mounting platform.

k. All products, materials and accessories shall be furnished and installed as required for complete system ready for Department's use.

2. Couplings, Journals, Bearings and Keys:

a. Except where otherwise specified, a standard self-aligning forged steel coupling, with seal lubrication, as manufactured by Waldron Coupling Division, Dodge Para-Flex, Koppers Company, Falk or other approved equivalent, shall be provided between each driver and its driven equipment. One hub of the coupling shall be firmly fixed and keyed to the equipment shaft with the other hub similarly secured to the abutting drive shaft. Couplings shall be placed as close to the driven equipment and the driver bearings as possible to provide

compact arrangement. Couplings shall be moisture and dust-proof.

b. Journal and bearing surfaces shall be of sufficient size and proportion for low wear and for overheat protection under all conditions, with provisions for easy removal and for proper adjustments. Journals shall be suitable boxes which, where necessary, shall be lined with babbitt metal hammered into grooves and bored in place. Bearings shall be of ample size to carry the maximum loads with a factor of safety to prevent flaking, spalling or crushing. Ball bearings shall be equally spaced and held in position by rugged races.

c. Pins and keys shall be properly proportioned. Keys, nuts and all other parts which might otherwise work loose shall be secured with approved locking devices.

3. Lubrication:

a. All bearings, except those specifically requiring oil or water lubrication, shall be designed for pressure grease lubrication. All lubrication points shall be readily accessible, away from locations dangerous to workmen. Pressure grease lubrication fittings shall be the "Zerk Hydraulic" type or the "Alemite" type as made by the Stewart Warner Corporation, or approved equivalent. Housings of grease lubricated bearings shall be automatically exhausted to the atmosphere to prevent excessive greasing. The Contractor shall furnish two Zerk Hydraulic guns, or approved equivalent.

4. Electric Motors:

a. General:

1) Unless otherwise specified, all electric motors furnished and installed shall conform to the requirements hereinafter set forth and comply with the requirements of Section 23 05 13 “Common Motor Requirements for HVAC Equipment”

2) When output requirements for a motor are specified in the detail specifications for the driven equipment, the motor furnished shall meet the requirements specified without exceeding its rated

nameplate current or specified temperature rise at rated voltage.

3) When output requirements are not specified, the motor shall have sufficient capacity to start and accelerate the driven equipment as given in the detail specifications under the given load and operating conditions, and to operate the driven equipment under the specified temperature limit at rated voltage.

4) Motors shall be of a type approved for starting characteristics and ruggedness as may be required under the actual conditions of operation and shall be suitable for full-voltage starting.

5) Motors shall meet requirements to NEMA and IEEE standards.

b. Special Purpose Motors:

1) Hermetically sealed air conditioning units, hoists, cranes and other equipment complying with special safety codes shall be furnished with motors, control equipment, accessories and safety devices for approved, safe, and efficient operation per manufacturer's standards, and shall be rated for the duty cycle as specified for the driven equipment. Minimum service factor for motors above 3 hp shall be 1.15.

c. Motor Controls:

1) Controls for each motor shall be manual or automatic as specified for each in pertinent to mechanical and electrical Sections.

d. Flanges and Bolts:

1) Flanges shall be cast solid, and boltholes shall be drilled and spot-faced on the back. Stud holes shall not be drilled through. Flanges shall be uniform in thickness and, where required, machined smooth.

2) Jacking screws shall be provided for covers, etc., where pertinent, and also suitable eye bolts for lifting. Bolts and nuts shall be of the best quality of open hearth, free machining steel. Bolts shall have good, sound well-fitting threads; nuts shall be cold pressed. All heads, nuts and threads shall be

regular size per ANSI B1.1, ANSI B18.2.1 and ANSI B18.2.2. All bolts and nuts (except those used for flanged pipe, fittings and valves) shall be corrosion resistant.

e. Belt Drives:

1) All multi-V drives shall be per Multiple V-Belt Drive Association. Drives shall be selected for 150 percent of required rating, and shall be Dodge Dyna-V-Drivers, T.B. Wood's Sons Company V-Belt Drives, or approved equivalent.

5. Labeling:

a. All electrical equipment and items consisting primarily of electrical components shall bear a label of an independent testing laboratory, such as Underwriter's Laboratories (UL).

b. Where such testing and labeling service is available for other products, such as fire dampers, boilers, etc. the equipment shall bear such a label.

6. Painting:

a. All fabricated or assembled surfaces normally painted shall be thoroughly dry and free from all rust, grease, dirt or scale. Unless otherwise specified, shop prime painting and field finish painting shall be per Section 09 96 00 “Protective Coatings”. Shop prime coats shall be compatible with field-applied painting.

7. Protection before Installation:

a. Finished parts shall be adequately protected in the shop, during transportation, and before and after erection to prevent damage of any kind. Damaged parts, which the Engineer determines cannot be repaired, shall be promptly replaced by the Contractor without expense to the Department. Otherwise, damaged paint shall be properly repaired at no additional cost to the Department.

b. All exposed finished parts of machinery shall be greased or oiled before shipment.

1.7 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair,

any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. MATERIALS SHALL BE PER FOLLOWING ASTM:

Material	Designation
Structural Steel	A36
Steel Pipe	A53
Iron Castings	A48
Babbitt	B23
Bronze Castings	B30
Bronze (Manganese)	B138
Bronze (Silicon)	B98
Steel Bolts	A307
Aluminum Castings	B26
316 Stainless Steel	A240
PVC Pipe and Fittings	D2466 and D1785

B. Materials shall fulfill all requirements specified. Engineer may make physical tests. The Contractor, at his expense, shall furnish test pieces and samples in the number, shape, size and finish required by the Engineer. Any failure of test specimens shall be sufficient cause for rejection of the entire melt or stock from which samples were obtained.

C. Iron castings shall be smooth, clean and free from scales, lumps, blisters, and other defects. Plugging, welding, or filling is prohibited.

D. All Ductwork and accessories hanger systems, etc. shall be 316 stainless steel.

PART 3 - EXECUTION

3.1 CONSTRUCTION:

A. General:

1. The general arrangement of pipe and equipment shall be as shown on the Drawings. The Contractor shall carefully examine the Drawings

and shall be responsible for the proper fitting of materials and equipment in each installation, as intended, without substantial alteration. Due to drawing scales it is not possible to indicate the exact location of piping and ductwork, offsets, fittings and accessories which may be required. The Contractor shall carefully investigate space requirements for proper clearances and the structural and finish conditions affecting his work, and shall arrange such work accordingly, furnishing such offsets, fittings, valves and accessories as required to meet such conditions.

2. All work shall be performed by competent mechanics using proper tools and equipment to produce first-quality work. All work shall be neatly installed, accessible for maintenance, and complete with all accessories required.

3. All equipment shall be installed in such a way that all components requiring access (such as drain pans, drains, fire dampers, control dampers, control operators, motors, drives, etc.) are so located and installed that they may be serviced, reset, replaced or recalibrated, etc., by service people with normal service tools and equipment. If any equipment or components are shown in such a position that it precludes compliance with the above, the Contractor shall attempt to resolve the problem of access in a manner acceptable to the Engineer. If not successful, Engineer shall be notified in writing and a decision requested.

4. The Contractor shall determine the location, size, etc. of all chases and openings required for proper installation of work. Where necessary to run pipes or duct work through walls or fittings, proper provisions shall be made for same. The Contractor shall furnish and correctly set all inserts, sleeves, hanger supports, etc., required.

5. All piping and duct work exposed to view shall be generally parallel with the lines of the building and as close to walls, columns and ceilings as practicable, consistent with proper grade and maintenance of proper clearances for access to all parts requiring servicing. No exposed ductwork or piping shall cross below the head of any window or door, unless it is impossible to avoid doing so.

6. The Contractor shall do no cutting of woodwork, masonry, concrete or other materials after same have been installed without written permission from the Engineer. No waterproofing shall be cut for any purpose except on written approval from the Engineer.

7. Unless otherwise detailed on the Drawings for specific items of equipment, all items of mechanical equipment mounted on masonry floors shall be provided with a concrete pad not less than six inches high, and of additional height as required to accommodate piping connections to equipment and/or to place centerline of small motors

and equipment about 30 inches above floor for ease of servicing. Pads for wet equipment (pumps, etc.) shall have a rimmed base and outlet piped to floor drain.

8. The Contractor shall align all coupled equipment using a Contractor furnished laser optical alignment test set. All alignments shall be performed by personnel trained and fully qualified in the use of the optical laser alignment test set.

B. Equipment Testing:

1. The Engineer shall be notified in 15 days in advance of all tests.

2. After erection, the Contractor shall adjust, align and balance all equipment and systems, and shall demonstrate that all equipment is operating in a satisfactory manner. All rotating equipment shall be lubricated according to recommendations of the manufacturers, and all adjustments shall be made to suit anticipated operating conditions. Each piece of machinery shall be tested to show that it operates quietly, without vibration, overheating, or sign of distress at full specified capacity. Adjustments shall be made as necessary. All defective parts on machinery shall be replaced. All required testing equipment, instruments and services of equipment manufacturers shall be provided by the Contractor. All test instruments shall be calibrated by a recognized independent testing laboratory.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with NFPA 820 Class I, Division II, Group D for Explosion Proof Motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Explosion Proof Motors: Comply with NFPA 820 Class I Division II, Group D, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Pipe stands.

6. Equipment supports.

B. Related Sections:

1. Section 230548 "Vibration and Siesmic Controls for HVAC piping and Equipment" for vibration isolation devices.

2. Section 233113 "Metal Ducts" for duct hangers and supports.

1.5 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.6 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.7 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their

preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.8 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.9 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.1 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.2 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit; a part of Atkore International.

   b. B-line, an Eaton business.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
7. Retain one of four subparagraphs below for coating.
8. Metallic Coating: Electroplated zinc
9. Paint Coating: Vinyl.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with

plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24 , requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control

piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.

    b. Vertical (MSS Type 55): Mounted vertically.

    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.

7. Housed-restrained-spring isolators.

8. Resilient pipe guides.

9. Elastomeric hangers.

10. Spring hangers.

11. Snubbers.

12. Seismic-restraint accessories.

13. Mechanical anchor bolts.

14. Vibration isolation equipment bases.

15. Restrained isolation roof-curb rails.

1.5 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic restraints and for designing vibration isolation bases.

   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

4. Seismic-Restraint Details:

   a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

   c. Coordinate seismic-restraint and vibration isolation details with windrestraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For restrained-air-spring mounts to include in operation and maintenance manuals.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICCES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: A.

2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.

   a. Component Importance Factor: 1.0.

   b. Component Response Modification Factor: 1.5

   c. Component Amplification Factor: 1.0

3. Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

   a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls, Inc.

2. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded.

   b. Retain "Baseplate" Subparagraph below if the elastomeric mount being specified has a baseplate.

   c. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.

   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.

7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment

bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

   a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).

   b. Top housing with threaded mounting holes and internal leveling device.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

   b. Vibration Eliminator Co., Inc.

   c. Vibration Mountings & Controls, Inc.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

b. Top plate with threaded mounting holes.

c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

5. Minimum Additional Travel: 50 percent of the required deflection at rated load.

6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls, Inc.

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.9 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.10 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.

b. Vibration Eliminator Co., Inc.

c. Vibration Mountings & Controls, Inc.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment

without binding or reducing isolation efficiency.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.11 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kinetics Noise Control, Inc.

2. Mason Industries, Inc.

3. Vibration Mountings & Controls, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

2.12 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kinetics Noise Control, Inc.

2. Mason Industries, Inc.

3. Vibration & Seismic Technologies, LLC.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.13 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line, an Eaton business.

2. Kinetics Noise Control, Inc.

3. Mason Industries, Inc.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.14 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Kinetics Noise Control, Inc.

2. Mason Industries, Inc.

3. Vibration Eliminator Co., Inc.

4. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less

than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.15 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic forces.

C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces.

D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 “Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Division 07 "Thermal and Moisture Protection" for installation of roof curbs, equipment supports, and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with the Engineer, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Engineer.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 3 "Concrete."

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Equipment labels.

2. Warning signs and labels.

3. Duct labels.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each

identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Craftmark Pipe Markers.

   b. LEM Products Inc.

   c. Marking Services, Inc.

2. Material and Thickness: **stainless steel, 0.025-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.

3. Letter Color: Black

4. Background Color: White

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Champion America.
2. Craftmark Pipe Markers.
3. LEM Products Inc.
4. Marking Sevices Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving,

1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color**:** Red.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 DUCT LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Champion America.
2. Craftmark Pipe Markers.
3. LEM Products Inc.
4. Marking Sevices Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: White.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

1. Progress payments will be in accordance with Section 109 of the Standard Specifications.

2. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

1. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Vibration tests.
   3. Duct leakage tests.

1.5 DEFINITIONS

1. AABC: Associated Air Balance Council.

2. BAS: Building automation systems.

3. NEBB: National Environmental Balancing Bureau.

4. TAB: Testing, adjusting, and balancing.

5. TABB: Testing, Adjusting, and Balancing Bureau.

6. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

7. TDH: Total dynamic head.

1.6 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Engineer, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

   a. The Contract Documents examination report.

   b. The TAB plan.

   c. Needs for coordination and cooperation of trades and subcontractors.

   d. Proposed procedures for documentation and communication flow.

1.7 INFORMATIONAL SUBMITTALS

1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

2. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

3. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

4. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

5. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

6. Certified TAB reports.

7. Sample report forms.

8. Instrument calibration reports, to include the following:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

1.8 QUALITY ASSURANCE

1. TAB Specialists Qualifications: Certified by TABB.
   a. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or TABB.
   b. TAB Technician: Employee of the TAB specialist and certified by AABC or TABB as a TAB technician.
2. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
3. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
4. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.9 FIELD CONDITIONS

A. Contractor will occupy the site and existing building during entire TAB period.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices

are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems

- Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.

2. Strategies and step-by-step procedures for balancing the systems.

3. Instrumentation to be used.

4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

b. Duct systems are complete with terminals installed.

c. Volume, smoke, and fire dampers are open and functional.

d. Clean filters are installed.

e. Fans are operating, free of vibration, and rotating in correct direction.

f. Variable-frequency controllers' startup is complete and safeties are verified.

g. Automatic temperature-control systems are operational.

h. Ceilings are installed.

i. Windows and doors are installed.

j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.

    b. Measure static pressure directly at the fan inlet or through the flexible connection.

    c. Measure static pressure across each component that makes up the air-handling system.

    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Engineer and commissioning authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.

2. Adjust submain and branch duct volume dampers for specified airflow.

3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.

2. Measure inlets and outlets airflow.

3. Adjust each inlet and outlet for specified airflow.

4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.

2. Re-measure and confirm that total airflow is within design.

3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.

4. Mark all final settings.

5. Test system in economizer mode. Verify proper operation and adjust if necessary.

6. Measure and record all operating data.

7. Record final fan-performance data.

3.6 SOUND TESTS

A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 5 locations as designated by the Engineer.

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.

2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).

3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.

4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.

2. Equipment should be operating at design values.

3. Calibrate the sound-testing meter prior to taking measurements.

4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.

5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.

6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.

7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.

8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

a. Location.

b. System tested.

c. dBA reading.

d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.7 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration

meter with or without a built-in printer.

2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.

3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.

4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.

2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.

3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.

4. Record CPM or rpm.

5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.

2. Include horizontal-vertical-axial measurements for tests.

3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."

4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.8 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.10 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.

    b. Notable characteristics of systems.

    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.

    b. Conditions of filters.

    c. Cooling coil, wetand dry-bulb conditions.

    d. Face and bypass damper settings at coils.

    e. Fan drive settings including settings and percentage of maximum pitch diameter.

    f. Inlet vane settings for variable-air-volume systems.

    g. Settings for supply-air, static-pressure controller.

    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.

4. Pipe and valve sizes and locations.

5. Terminal units.

6. Balancing stations.
7. Position of balancing devices.

E. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F .
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft..
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

F. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Engineer.

B. Engineer shall randomly select measurements, documented in the final

report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, The Department may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, The Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment

B. The engineer shall retain commissioning authority.

1.5 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.6 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 CXA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.9 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

A. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

B. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

C. Process and schedule for completing construction checklists and

manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.

D. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

E. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.

F. Test and inspection reports and certificates.

G. Corrective action documents.

H. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports,

sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 14 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 14 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set

simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Engineer. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230923.12 "CONTROL DAMPERS" and Section 230923.27 “TEMPERATURE INSTRUMENTS.” Assist the CxA with preparation of testing plans.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.

3. Minimum flushing water velocity.

4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

SECTION 23 09 23.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work specified herein has progressed to the point where, in the opinion of the Engineer, the Work specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section includes control dampers and actuators for system operation.

1.5 DEFINITIONS

A. DDC: Direct-digital control.

B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.

2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

4. Include diagrams for air and process signal tubing.

5. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:

1. Schedule and design calculations for control dampers and actuators, including the following.

a. Flow at project design and minimum flow conditions.

b. Face velocity at project design and minimum airflow conditions.

c. Pressure drop across damper at project design and minimum airflow conditions.

d. AMCA 500D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.

e. Maximum close-off pressure.

f. Leakage airflow at maximum system pressure differential (fan close-off pressure).

g. Torque required at worst case condition for sizing actuator.

h. Actuator selection indicating torque provided.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, and equipment.

2. Size and location of wall access panels for control dampers and actuators installed behind walls.

3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.

E. Environmental Conditions:

1. Provide electric control-damper actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control-damper actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.

a. Hazardous Locations: Explosion-proof rating for condition.

F. Selection Criteria:

1. Control dampers shall be suitable for operation at following conditions:
   a. Temperature range: -10F to +100F.
2. Fail positions unless otherwise indicated:
   a. Supply Air: Open.
   b. Outdoor Air: Open.
   c. Exhaust Air: Open.
3. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
4. Select modulating dampers for a pressure drop of 2 percent of fan total static pressure unless otherwise indicated.
5. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.
6. Pneumatic, two-position control dampers shall provide a smooth opening and closing characteristic slow enough to avoid excessive pressure. Dampers with pneumatic actuators shall have an adjustable opening time (valve full closed to full open) and an adjustable closing time (valve full open to full closed) ranging from zero to 10 seconds. Opening and closing times shall be independently adjustable.
7. Control-damper, pneumatic-control signal shall not exceed 200 feet. For longer distances, provide an electric/electronic control signal to the damper and an electric solenoid valve or electro-pneumatic transducer at the damper to convert the control signal to pneumatic.

2.2 RECTANGULAR CONTROL DAMPERS

A. General Requirements:

1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.

B. Industrial-Duty Rectangular Dampers with Steel Airfoil Blades:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Belimo.

   b. Ruskin Company.

2. Performance:

   a. Leakage: Leakage shall not exceed 8 cfm/sq. ft. against 4-in. wg differential static pressure.

   b. Pressure Drop: 0.06-in. wg at 2000 fpm across a 48-by-48-inch damper when tested according to AMCA 500-D, figure 5.3.

   c. Velocity: Up to 4000 fpm.

   d. Temperature: Minus 22 to plus 120 deg F.

   e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, minimum 10-in. wg.

3. Construction:

   a. Frame:

      1) Material: stainless steel, 0.11 inch thick.

      2) C-shaped channel. Mating face shall be a minimum of 1 inch.

      3) Width not less than 3 inches.

   b. Blades:

      1) Hollow, airfoil, stainless steel.

      2) Parallel configuration.

      3) Material: stainless steel, 0.06 inch thick.

      4) Width not to exceed 8 inches.

      5) Length not to exceed 48 inches.

   c. Seals:

      1) Blades: Replaceable, mechanically attached EPDM or extruded silicone.

2) Jambs: Stainless steel, double compression type.

d. Axles: 0.5- or 0.75-inch-diameter stainless steel, mechanically attached to blades and continuous from end to end.

e. Bearings:

1) Stainless-steel sleeve type mounted in frame.

2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Face linkage exposed to airstream.

2) Constructed of stainless steel.

3) Hardware: Stainless steel.

2.3 ROUND CONTROL DAMPERS

A. Round Dampers, Sleeve Type:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Belimo.

b. Ruskin Company.

2. Performance:

a. Leakage: Leakage shall not exceed 8 cfm/sq. ft. against 4-in. wg differential static pressure.

b. Pressure Drop: 0.06-in. wg at 2000 fpm across a 48-by-48-inch damper when tested according to AMCA 500-D, figure 5.3.

c. Velocity: Up to 4000 fpm.

d. Temperature: Minus 22 to plus 120 deg F.

e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, minimum 10-in. wg.

3. Construction:

a. Frame:

1) Material: stainless steel, 0.04 in thick.

2) Outward rolled stiffener beads positioned approximately 1 inch inboard of each end.

3) Sleeve-type connection for mating to adjacent ductwork.

4) Size Range: 4 to 24 inches.

5) Length not less than 7 inches.

6) Provide 2-inch sheet metal stand-off for mounting actuator.

b. Blade: Double-thickness circular flat blades sandwiched together and constructed of stainless steel.

c. Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.

1) Axle: 0.5-inch-diameter stainless steel, mechanically attached to blade.

d. Bearings: Stainless-steel sleeve pressed into frame.

2.4 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Provide mounting hardware and linkages for connecting actuator to damper.

G. Select actuators to fail in desired position in the event of a power failure.

H. Actuator Fail Positions As indicated below:

1. Exhaust Air: Open.

2. Outdoor Air: Open.

3. Supply Air: Open

2.5 ELECTRIC AND ELECTRONIC ACTUATORS

A. Type: Motor operated, with or without gears, electric and electronic.

B. Voltage:

1. 120 V, single phase.

2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

C. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

2. 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.

3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

D. Field Adjustment:

1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

E. Two-Position Actuators: Single direction, spring return or reversing type.

F. Modulating Actuators:

1. Capable of stopping at all points across full range, and starting in either direction from any point in range.

2. Control Input Signal:

a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other

input drives actuator to close position. No signal of either input remains in last position.

b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 2- to 10-V dc and 4- to 20-mA signals.

c. Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.

d. Programmable Multi-Function:

1) Control input, position feedback, and running time shall be factory or field programmable.

2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

3) Service data, including at a minimum, number of hours powered and number of hours in motion.

G. Position Feedback:

1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

H. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

I. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

J. Damper Attachment:

1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.

2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.

3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

K. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 22 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 100 percent relative humidity.

L. Enclosure:

1. NEMA 250, Type 4X for outdoor and unprotected applications.

M. Stroke Time:

1. Operate damper from fully closed to fully open within 60 seconds.

2. Operate damper from fully open to fully closed within 60 seconds.

3. Move damper to failed position within 5 seconds.

4. Select operating speed to be compatible with equipment and system operation.

5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

N. Sound:

1. Spring Return: 62 dBA.

2. Non-spring Return: 45dBA

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the

Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL-DAMPER APPLICATIONS

A. Control Dampers:

B. Select from damper types indicated in "Control Dampers" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

1. Rectangular Exhaust Air Duct Applications with SMACNA Construction Class 1 and Velocities to 4000 fpm: Industrial-duty rectangular dampers with stainless steel air-foil blades.

2. Round Exhaust Air Duct Applications with SMACNA Construction Class 1 and Velocities to 4000 fpm: Stainless Steel Round dampers, sleeve type.

3. Rectangular Supply Air Duct Applications with SMACNA Construction Class 1 and Velocities to 4000 fpm: Industrial-duty rectangular dampers with stainless steel air-foil blades.

4. Round Supply Air Duct Applications with SMACNA Construction Class 1 and Velocities to 4000 fpm: Stainless Steel Round dampers, sleeve type.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <Insert valve> force.

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and

tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for the Department's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.

2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

   a. Laboratory exhaust airstreams.

   b. Process exhaust airstreams.

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.

4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

5. Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

C. Furnish and install power wiring. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

D. Furnish and install raceways. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

3.5 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 15 degrees, to dampers smaller than

adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

C. Service Access:

1. Dampers and actuators shall be accessible for visual inspection and service.

2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.6 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 00 03 "Basic Electrical Materials and Methods".

B. Install engraved phenolic nameplate with damper identification on damper.

3.8 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.

2. Check dampers for proper location and accessibility.

3. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

4. For pneumatic products, verify air supply for each product is properly installed.

5. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.

B. Verify that control dampers are installed correctly for flow direction.

C. Verify that proper blade alignment, either parallel or opposed, has been provided.

D. Verify that damper frame attachment is properly secured and sealed.

E. Verify that damper actuator and linkage attachment are secure.

F. Verify that actuator wiring is complete, enclosed, and connected to correct power source.

G. Verify that damper blade travel is unobstructed.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.

C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 23 09 23.27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Air temperature sensors.

1.5 DEFINITIONS

A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

B. RTD: Resistance temperature detector.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.

4. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

C. Samples: For each exposed product installed in finished space.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.

2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

3. Sizes and locations of wall access panels for instruments installed behind walls.

4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:

    a. All enclosure types shall be: Type 4X

2.2 AIR TEMPERATURE SENSORS

A. Platinum RTD, Air Temperature Averaging Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dwyer Instruments.

2. 100 or 1000 ohms.

3. Temperature Range: Minus 50 to 275 deg F

4. Multiple sensors to provide average temperature across entire length of sensor.

5. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.

6. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.

7. Length: As required by application to cover entire cross section of air tunnel.

8. Enclosure: Junction box with removable cover; NEMA 250, Type 4x for all applications.

9. Gasket for attachment to duct or equipment to seal penetration airtight.

10. Conduit Connection: 1/2-inch

B. Platinum RTD Outdoor Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dwyer Instruments.

2. 100 or 1000 ohms.

3. Temperature Range: Minus 50 to 275 deg F

4. Probe: Single-point sensor with a stainless-steel sheath.

5. Solar Shield: Stainless steel.

6. Enclosure: NEMA 250, Type 4X junction box.

7. Conduit Connection: 1/2-inch trade size.

C. Platinum RTD Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dwyer Instruments.

2. 100 or 1000 ohms.

3. Temperature Range: Minus 50 to 212 deg F

4. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.

5. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.

6. Concealed wiring connection.

D. Thermistor Averaging Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dwyer Instruments.

2. Temperature Range: Minus 50 to 275 deg F

3. Multiple sensors to provide average temperature across entire length of sensor.

4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.

5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.

6. Length: As required by application to cover entire cross section of air tunnel.

7. Enclosure: Junction box with removable cover; NEMA 250, Type 4x for all applications.

8. Gasket for attachment to duct or equipment to seal penetration airtight.

9. Conduit Connection: 1/2-inch trade size.

E. Thermistor Outdoor Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dwyer Instruments.

2. Temperature Range: Minus 50 to 275 deg F

3. Probe: Single-point sensor with a stainless-steel sheath.

4. Solar Shield: Stainless steel.

5. Enclosure: NEMA 250, Type 4X junction box or combination conduit and outlet box with removable cover and gasket.

6. Conduit Connection: 1/2-inch trade size.

F. Thermistor Space Air Temperature Sensors:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dwyer Instruments.
2. Temperature Range: Minus 50 to 212 deg F
3. Sensor assembly shall include a temperature sensing element mounted under a flush, brushed-aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPERATURE INSTRUMENT APPLICATIONS

A. Air Temperature Sensors:

1. Duct: Thermistor
2. Outdoor: Thermistor
3. Space: Thermistor

3.3 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Department's access, confirm unrestricted ladder placement is possible under occupied condition.

D. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.

2. If possible, avoid or limit use of materials in corrosive environments.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

C. Furnish and install power wiring. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

D. Furnish and install raceways. Comply with requirements in Section 26 00 03 "Basic Electrical Materials and Methods."

3.5 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:

a. Outline instrument mounting locations before setting instruments

and routing cable, wiring, tubing, and conduit to final location.

b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.

2) Do not begin installation without submittal approval of mounting location.

c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by the Engineer.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.

3. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

4. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.

2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 48 to 72 inches above the

adjacent floor, grade, or service catwalk or platform.

a. Make every effort to mount at 60 inches.

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.

2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.

3. In finished areas, recess electrical box within wall.

4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.

5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:

1. Mount sensor in a discrete location facing north.

2. Protect installed sensor from solar radiation and other influences that could impact performance.

3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.

2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.

3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.

4. If required to have transmitter, mount transmitter in an accessible and

serviceable location.

H. Low-Limit Air Temperature Switch Installation:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.

2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.

3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.

4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 26 00 03 "Basic Electrical Materials and Methods."

B. Install engraved phenolic nameplate with instrument identification.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.8 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment

for calibrating each type of instrument. Submit procedures before calibration and adjustment.

3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.

5. Provide diagnostic and test equipment for calibration and adjustment.

6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.

2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project

design values.

2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections:

1. Perform according to manufacturer's written instruction.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.11 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of final acceptance date of entire project, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.12 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at final acceptance date of entire project, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of worn or defective components, cleaning and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. Train Department's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:

1. Software programming.

2. Calibration and test procedures.

3. Operation and maintenance requirements and procedures.

4. Troubleshooting procedures.

C. Coordinate video with operation and maintenance manuals and classroom instruction for use by the Department in operating, maintaining, and troubleshooting.

D. Record videos on DVD disks.

E. The Department shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.

2. Single-wall round ducts and fittings.

3. Sheet metal materials.

4. Sealants and gaskets.

5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, ductmounting access doors and panels, turning vanes, and flexible ducts.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.

10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.

2. Joint and seam construction and sealing.

3. Reinforcement details and spacing.

4. Materials, fabrication, assembly, and spacing of hangers and supports.

5. Design Calculations: Calculations for selecting hangers and supports.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.

3. Structural members to which duct will be attached.

4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.

6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Sprinklers.

d. Access panels.

e. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct

Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Fabtech.
    b. Ductmate Industries, Inc.
    c. Sheet Metal Connectors, Inc.
    d. Or equal

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. Stainless-Steel Sheets: Comply with ASTM A 167, Type 316. 316L stainless ductwork shall conform to A240/A240M-05a Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications. Stainless steel ductwork shall be ANSI Type 316L with No. 4 directional polish.

B. Tie Rods: 316L steel alloy, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 3 inches.

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.

13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: 316L Stainless steel rods and nuts.

B. Hanger Rods for Corrosive Environments: 316L Stainless steel rods and nuts.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: 316L stainless steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking

and clamping device.

F. Duct Attachments: 316L Stainless steel Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1½”.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
6. Unconditioned Space, Exhaust Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or

structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

3. Test for leaks before applying external insulation.

4. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

5. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by the Engineer, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with 316L stainless steel.

B. Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units:

   a. Pressure Class: Positive 3-inch wg.

   b. Minimum SMACNA Seal Class: A.

   c. SMACNA Leakage Class for Rectangular: 6.

   d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive 3-inch wg.

   b. Minimum SMACNA Seal Class: A.

   c. SMACNA Leakage Class for Rectangular: 6.

   d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

   a. Pressure Class: Negative 1-inch wg.

   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

   c. SMACNA Leakage Class for Rectangular: 12.

   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.

   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

   c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.

b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

c. SMACNA Leakage Class for Rectangular: 6.

d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Intermediate Reinforcement:

1. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Match duct material.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.

2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.

2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct

Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.

b. Velocity 1000 to 1500 fpm: Conical tap.

c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Remote damper operators.
5. Duct accessory hardware.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

e. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Stainless-Steel Sheets: Comply with ASTM A240/A240-05a, Type 316L, and having a No. 4 finish for concealed ducts and No.4 finish for exposed ducts.

B. Reinforcement Shapes and Plates: Stainless steel reinforcement.

C. Tie Rods: Stainless steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Greenheck Fan Corporation.

2. Or approved equal

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 3-inch wg.

E. Frame: Hat-shaped, 0.05-inch-thick stainless steel, with welded corners or mechanically attached.

F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.025-inch-thick, stainless steel with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:

1. Material: Stainless steel.

2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: stainless steel.

K. Return Spring: Adjustable tension.

L. Bearings: Stainless Steel ball.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.

2. Electric actuators.

3. Screen Mounting: Rear mounted.

4. Screen Material: stainless steel.

5. Screen Type: Insect.

6. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Greenheck Fan Corp.

b. Or approved equal

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Frame: Hat-shaped, 0.05-inch-thick stainless steel.

b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Stainless-steel, 0.064 inch thick.

6. Blade Axles: Stainless steel.

7. Bearings:

a. Stainless-steel sleeve.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Stainless steel.

B. Damper Hardware:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ventfabrics, Inc

b. Young Regulator Co.

c. Or approved equal.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12".

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation

2. Or approved Equal.

B. Ultra Low-leakage rating with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. Suitable for pressures to 8-in W.C and velocities to 4,000-fpm with maximum AMCA leakage rate of 6 cfm/sq. ft at 4 in W.C

C. Frames:

1. U shaped.

2. 0.05-inch-thick stainless steel.

3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Parallel-blade design.
3. Stainless steel.
4. 0.0747-inch-thick dual skin.
5. Blade Edging: Silcone blade seals.

E. Blade Axles: 1/2-inch-diameter; stainless steel; blade-linkage hardware of stainless steel; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 22 to plus 122 deg F.

F. Bearings:

1. Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ventfabrics, Inc.
2. Or approved equal

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Aluminum.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Surface.

F. Wall-Box Cover-Plate Material: Stainless steel.

G. Power for the motor shall be 120 VAC, single phase. All damper motors associated with the Electrical Control Room shall be chemical duty rated NEMA 4X. All damper motors associated with the pump room, access stairway enclosure, intermediate levels and wet wells shall be explosion proof rated for use in Class I, Division I areas.

2.7 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. 3M.
2. Or approved Equal.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.8 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers according to UL listing.

H. Access Door Sizes:

3. One-Hand or Inspection Access: 8 by 5 inches.
4. Two-Hand Access: 12 by 6 inches.
5. Head and Hand Access: 18 by 10 inches.
6. Head and Shoulders Access: 21 by 14 inches.
7. Body Access: 25 by 14 inches.
8. Body plus Ladder Access: 25 by 17 inches.

I. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

L. Connect diffusers or light troffer boots to ducts directly.

M. Install duct test holes where required for testing and balancing purposes.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 34 16 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes: For each product.
   A. Plenum fans

1.5 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.

2. Certified fan performance curves with system operating conditions indicated.

3. Certified fan sound-power ratings.

4. Motor ratings and electrical characteristics, plus motor and electrical accessories.

5. Material thickness and finishes, including color charts.

6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AMCA Compliance:

1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.

2. Operating Limits: Classify according to AMCA 99.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Capacities and Characteristics: see drawings

2.2 PLENUM FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier.
2. Chicago Blower Corporation.
3. Daikin.
4. Loren Cook Company.
5. Trane.

B. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

C. Airfoil Wheels:

1. Single-width-single-inlet construction with smooth-curved inlet flange.
2. Heavy backplate.
3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
4. Stainless-steel hub riveted to backplate and fastened to shaft with set screws.

D. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Prelubricated and Sealed Shaft Bearings:

1. Self-aligning, pillow-block-type ball bearings.

2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.

3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

F. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.

3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

G. Grease-Lubricated Shaft Bearings:

1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

2. Ball-Bearing Rating Life: ABMA 9, Ll0 at 120,000 hours.

3. Roller-Bearing Rating Life: ABMA 11, Ll0 at 120,000 hours.

H. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.

2. Service Factor Based on Fan Motor Size: 1.2.

3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

7. Motor Mount: Adjustable for belt tensioning.

I. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

2. Spark-Resistant Construction: AMCA 99.

3. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3 "Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction.

G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install and vibration isolation and seismic-control devices.

3. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

4. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

H. Install units with clearances for service and maintenance.

I. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC"

for testing, adjusting, and balancing procedures.

10. Remove and replace malfunctioning units and retest as specified above.

D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Department's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Propeller Fans.

1.5 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.10 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.11 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Greenheck Fan Corp.

2. Or Approved equal

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Drive:

1. Resiliently mounted to housing.

2. Statically and dynamically balanced.

3. Selected for continuous operation at maximum rated fan speed and motor horse-power, with final alignment and belt adjustment made after installation.

4. Extend grease fitting to accessible location outside of unit.

5. Service Factor Based on Fan Motor Size: 1.4.

6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

   a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.

2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.

3. Wall Sleeve: Galvanized steel to match fan and accessory size.

4. Weathershield Hood: Galvanized steel to match fan and accessory size.

5. Weathershield Front Guard: Galvanized steel with expanded metal screen.

6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Capacities and Characteristics: See drawings

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 3 "Concrete."

2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 7 "Thermal and Moisture Protection" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 26 00 03 "Basic Electrical Materials and Methods."

D. Connect wiring according to Section 26 00 03 "Basic Electrical Materials and Methods."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke

dampers in connected ductwork systems are in fully open position.

9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.

10. Shut unit down and reconnect automatic temperature-control operators.

11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section Includes:

1. Registers.

2. Grilles.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

A. Registers & Grilles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Nailor Industries Inc.

b. Titus.

c. Or approved equal

2. Material: Stainless Steel.

3. Frame: 1-1/4 inches wide.

4. Mounting: Countersunk screw.

5. Damper Type: Adjustable opposed blade.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify the Engineer for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 82 39.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Progress payments will be in accordance with Section 109 of the Standard Specifications.

B. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified under this section shall be included in the contract lump sum price for the item, HEATING AND VENTILATION.

1.4 SUMMARY

A. Section includes propeller unit heaters with electric-resistance heating coils.

1.5 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include location and size of each field connection.

4. Include details of anchorages and attachments to structure and to supported equipment.

5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

6. Indicate location and arrangement of piping valves and specialties.

7. Indicate location and arrangement of integral controls.

8. Wiring Diagrams: Power, signal, and control wiring.

1.7 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which propeller unit heaters will be attached.

3. Method of attaching hangers to building structure.

4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Speakers.

d. Access panels.

B. Seismic Qualification Certificates: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Engineered Air.

2. Marley/QMark.

3. Trane.

4. Or approved equal

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Propeller unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and - tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, explosion proof. Comply with requirements in Section

230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:

1. Wall-mounted, fan-speed switch.
2. Wall-mounted thermostat.

2.8 CAPACITIES AND CHARACTERISTICS (EUH-1 THRU 7)

A. Heating Capacity:

1. Heat Output: 51.18 MBH.
2. Length of Throw: 47 feet.
3. Mounting Height: 8’6” feet min.

B. Supply Air:

1. Airflow: 1450 cfm.

C. Electrical Characteristics for Single-Point Connection:

1. Volts: 460.
2. Phase: 3.
3. Hertz: 60.
4. Full-Load Amperes: 18.7.

2.2 CAPACITIES AND CHARACTERISTICS (EUH-8 THRU 11)

A. Heating Capacity:

1. Heat Output: 10.24 MBH
2. Length of Throw: feet.
3. Mounting Height: 8’6” feet min.

B. Supply Air:

1. Airflow: 700 cfm.

C. Fan Motor:

1. Motor Size: 1/4 horsepower>.

D. Electrical Characteristics for Single-Point Connection:

1. Volts: 460
2. Phase: 3
3. Hertz: 60
4. Full-Load Amperes: 3.6.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Section 260003 "Basic Electrical Materials and Methods."

C. Connect wiring according to Section 260003 "Basic Electrical Materials and Methods."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Department's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION

SPECIAL PROVISIONS

F.A.I. ROUTE 290 (INTERSTATE 290)
IDOT PUMP STATION NO. 4 RECONSTRUCTION
CONTRACT: 62B78

VOLUME II

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DIVISION 26
ELECTRICAL

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SECTION 26 00 01 - GENERAL ELECTRICAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Description

1. The scope of work under this Section shall generally be all electrical work required for the project work as specified or as indicated on the drawings.
2. The electrical work shall include the furnishing and installing of various items of electrical equipment and, unless otherwise indicated, shall also include the electrical connection, including conduit and cable, of various items such as electric pump motors, fan motors, SCADA I/O, as shown on IC drawings and Division 40, and similar items furnished under other Sections. The Contractor shall be responsible for ascertaining the extent of electrical connections required for items furnished under other Sections and for coordination the electrical work accordingly.
3. The specifications and drawings are intended to generally define the work required, but they do not include every equipment and installation detail. The work shall include all items and appurtenances required to fully complete the work, whether specifically identified or not, such that the electrical systems are complete and operational.
4. Refer to Division 1 for other requirements relating to the furnishing and installing of work which shall apply to the work under this Division.

B. Progress payments will be in accordance with Section 109 of the Standard Specifications.

C. Equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section, unless noted otherwise herein, shall be included in the Contract lump sum price for the item, PUMP STATION ELECTRICAL WORK.

B. Payment for work specified under Subsection 3.4 shall be included in the Contract lump sum price for the item, ELECTRIC SERVICE INSTALLATION; except as noted below in Subsection 1.2.C.

C. Payment for work specified under Subsection 3.4.B shall be included in the Contract lump sum price for the item, ELECTRIC UTILITY SERVICE CONNECTION.

D. The work for Telephone specified under Subsection 3.5 shall be paid under the pay item TELEPHONE SERVICE INSTALLATION AND CONNECTION.

1.3 CODE COMPLIANCE

A. Unless otherwise indicated, in the absence of more stringent requirements in the Specifications or on the Drawings, the work shall be in compliance with the requirements of the National Electrical Code.

1.4 STANDARDS

A. Wherever the following abbreviations and the abbreviation in Article 101.01 of SSRBC are used in these Specifications or on the Drawings, they are to be construed the same as the respective expressions represented:

FM Factory Mutual
ICEA Insulated Power Cable Engineers Association
NETA ATS InterNational Electrical Testing Agency, Acceptance Testing Specifications .

B. The Contractor shall familiarize himself with the details of the total construction insofar as they may affect the work under this Division, including floor elevations, physical dimensions of structures, materials of construction and the nature of work required under other Divisions. No additional compensation will be granted for failure to consider the total project work.

C. The contract drawings (Drawings) for electrical work are generally diagrammatic and do not necessarily depict all items to scale. The Drawings indicate the general locations of major elements of the electrical system, outlets, fixtures, pull boxes and the like, however, field conditions or interferences, and may require changes in the installation. The Contractor shall coordinate his work to avoid interferences and shall obtain the approval of the Engineer prior to making any changes from the installation shown.

D. Prior to installation, the Engineer may make reasonable minor changes in the locations of the installation without additional cost to the Department

1.5 COORDINATION

A. The Contractor shall coordinate the work under this Division with the work of other trades. This shall include an orderly exchange of information and shall be accomplished such that the total work is not delayed and that interferences are avoided. The Contractor shall

coordinate all electrical systems into a complete operational package. The Contractor shall assign one contact person for all such coordination work, has an understanding and working knowledge of the electrical control systems on this project. This person shall oversee and assume proper operation of the complete electrical control system including all testing and calibration as outlined herein. The Contractor shall provide the name and phone numbers of this individual at the preconstruction inspection.

1.6 WORKMANSHIP

A. The electrical work shall be performed in a neat and workmanlike manner in accordance with the best practices of the trade.

B. Unless otherwise indicated, all materials and equipment shall be new and installed in accordance with the applicable codes, contract requirements and manufacturer's recommendations.

1.7 TESTING

A. All electrical equipment and systems provided under this Division shall be adjusted and tested. The Contractor shall adjust, repair or replace faulty or improper Divisions 26 and 40 work or equipment discovered during testing.

B. In addition, all electrical items provided under other Divisions and connected and/or adjusted under this Division shall be tested and if a failure occurs due to the connecting or adjusting methods used, the failure shall be remedied under this Division by repair, replacement, or change, as determined by the Engineer, at no additional cost to the Department.

C. Tests may be made progressively as portions of the work are complete; all systems will require demonstration to the Engineer to demonstrate that they are functional and comply with the Contract Documents.

D. Tests shall be made in the presence of the Engineer; Engineer shall be notified a minimum of 14 days prior to testing.

E. A written record of tests shall be maintained by the Contractor and, when complete, it shall be submitted to the Engineer for the record.

F. A recognized independent testing firm, a member of NETA, shall perform all tests necessary to assure proper functioning of materials and equipment. As a minimum, the tests shall include the following:

1. Before making final connections check the insulation resistance of all cables of 3-phase circuits that operate above 150 volts.
2. For medium voltage cables, perform each visual and mechanical inspection and electrical test stated in NETA ATS, Chapter 7.3.3 - Cables, Medium- and High Voltage. Do not exceed cable manufacturer's recommended maximum test voltage.

Certify compliance with test parameters. After installing medium-voltage cables and before they have been energized, test for compliance with requirements.

3. Check wiring for proper phase sequencing including buses, feeder cables and transformers and assure proper connection at motors for proper rotation.
4. Measure and record the line-to-line and line-to-neutral voltages at the line side of the service entrance, all panel buses or main terminals and at the primary and secondary terminals of all transformers furnished under this Division except for control transformers which are integral to motor starter units. Set the taps on transformers as required or as directed by the Engineer.
5. Check and record the motor nameplate data for each motor. Check the ratings of motor circuit protective devices and assure compatibility of the devices for the connected motors. In particular, assure that the motor starter overload elements are proper for the motor nameplate full load current.
6. Set control relays, protective relays and instruments in accordance with manufacturer's recommendations and Electrical Study Report. Record the set points.
7. Check all control circuits for proper functioning of all devices and check all switches, contactors, pushbuttons, limit switches, thermostats, circuit breakers and the like for proper operation.
8. Check all alarm circuits for proper operation and proper set points, as applicable. Record any appropriate set points.
9. Measure and record the line currents of each phase of each 3-phase motor and 3-phase transformer under load.
10. Align and adjust lighting fixtures and assure proper operation of all controls, ballasts and lamps.
11. All equipment must be properly calibrated for proper operation of the system.
12. All equipment devices shall be tested for proper operation, including but not limited to, selector switches, pushbuttons, indicating lights, timers, lock-out relay, and counters.
13. See Testing Electrical Systems under paragraph 3.8 of this Section for further testing requirements.

G. Testing must be completed prior to final inspection. All instruments, tools, etc., required for the tests shall be provided by the Contractor. All equipment shall be properly calibrated for proper operation of the complete system. Additional testing may be requested by the Engineer during final inspection to spot-check test results or to demonstrate proper functioning of the systems. These tests shall be performed by the Contractor at no additional cost to the Department.

H. The Contractor shall simulate the automatic operation of the complete pump station to assure proper operation. After assurance of proper operation, the Contractor shall demonstrate automatic operation including simulation to the Engineer's satisfaction.

I. Equipment will be considered defective if they do not pass tests and inspections. Failure to successfully test the equipment is not an allowance for an extension.

1.8 O&M MANUALS AND DATA TO BE FILED WITH THE ENGINEER

A. Submit legible 11" x 17" shop drawings and product data and O&M manuals under provisions of Section 01 33 00 and data, as specified herein, shall be furnished to the Engineer when installation and testing are complete, before final acceptance.

B. As a minimum, the data files shall include requirements of Section 01 33 00 plus the following:

1. A tabulation of cable insulation / megger tests. Tabulations shall include acceptable insulation resistance test values.
2. A tabulation of motor and equipment technical nameplate data.
3. A tabulation of voltage tests.
4. A tabulation of motor current tests.
5. A tabulation of relay and control device set points.
6. A tabulation of alarm set points.
7. A tabulation of breaker settings, timer set points, and protection relay set points. Tabulation shall include complete model or catalog number of each breaker, protection relay and fuse.
8. A tabulation of motor winding resistance tests for pump motors.
9. A Study Report shall include summary of results of power systems study under Section 26 00 02 including:
   a. Description, purpose, basis, and scope of study and legible single line diagram of power system.
   b. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.
   c. Protective device time versus current color coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   d. Fault current calculations including definition of terms and guide for interpretation of computer printout.
   e. Tabulation of appropriate tap settings for relay units.
   f. Arc flash calculations and tabulation of incident energy level (calories/cm2) for each equipment location and recommended personal protective equipment (PPE).
10. Complete testing report for the testing of electrical systems under paragraph 3.8 of this Section utilizing NETA printed forms. Submit report no later than 30 days after testing is complete. Submit proof of testing agency qualification.

1.9 RECORD DRAWINGS

A. Record Drawings shall be prepared and submitted in accordance with Division 1. Note that equipment wiring diagrams shall be project specific and cross reference terminal and wiring numbers to other equipment. Showing generic terminations and wiring numbers is not acceptable.

1.10 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

1.11 CLASSIFICATION OF ELECTRICAL ENCLOSURES AND INSTALLATIONS IN PROJECT LOCATIONS

A. Unless otherwise specified in the individual Specification Section or shown on Plans, type of electrical enclosures and installations shall be in accordance with the following:

B. NEMA 7(CLASS I, Division 2, GROUP D): All spaces in the pump station including Wet Well, Intermediate Level, Discharge Level, Discharge Chamber and Stairwell, except otherwise indicated.

NEMA 1: Electrical Room.
NEMA 4X Stainless Steel: Outdoor area and other wet or damp area.

1.12 FINAL ACCEPTANCE INSPECTION

A. When the work is complete, tested and fully operational, and only after the O&M Manuals and Record Drawings have been reviewed and accepted, the Contractor shall schedule a Final Acceptance Inspection with the Engineer.

B. The Final Acceptance Inspection shall be made for the complete work at the facility as a whole and shall be as further described in Section 105 of the Standard Specifications.

PART 2 - PRODUCTS:

A. Materials and Equipment

1. Quality
   All materials, equipment and appurtenances shall be new, shall be suitable for the application and shall be the product of established, reputable manufacturers.
2. Standards
   The construction, sizes, ratings and capacities of items shall be in conformance with the requirements under paragraph 1.5 of this Section, as applicable.
3. UL Label
   Unless otherwise indicated, materials and equipment shall bear the UL label whenever such labeling is available for the type of material or equipment being furnished.
4. Service Equipment
   Equipment which is used as electric service equipment shall bear a UL listing: "SUITABLE FOR USE AS SERVICE EQUIPMENT".
5. Other Requirements

Refer to Division 1 for other requirements relating to materials and equipment.

B. Request for Substitution

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

PART 3 - EXECUTION:

3.1 GENERAL

A. Provide other trades with advance information on locations and sizes of concrete pads, frames, boxes, sleeves and openings needed for the Work. Also provide information and shop drawings necessary to permit trades affected to install their Work properly and without delay.

B. Prior to submittal of shop drawings coordinate electrical equipment, particularly motor control equipment and control panels, with all applicable equipment and systems furnished under other Divisions of the Specifications. Acknowledge in submittal drawings any designated instrument tag numbers when tag numbers are assigned in drawings or specifications. Acknowledge that coordination of all applicable equipment has been performed.

C. The electrical system design, including, but not limited to, the type, size and quantity of equipment and components, layout, installation and connections as shown on Plans and/or as indicated in the Specifications, is based on electrical, electro-mechanical and/or electronic equipment supplied by selected manufacturers. If equipment furnished by the Contractor requires a different electrical system than that specified hereinafter or shown on Plans, the Contractor shall make all necessary modifications to the electrical system design, subject to the Engineer's approval, to provide a complete electrical system ready for successful operation. The costs of making the modifications to the electrical system shall be entirely borne by the Contractor without extra cost to the Department. If equipment furnished by the Contractor necessitates changes to electric, gas and/or telephone utilities' service equipment, or to the Work specified under other Sections of the

Specifications, then the cost for making the changes shall also be entirely borne by the Contractor without extra cost to the Department.

D. Locate all equipment such that they are readily accessible for operation, maintenance, repair and replacement. Ready accessibility to removable parts of equipment and to wiring shall be provided without moving other equipment which is to be installed or which is in place. In general, such equipment is not to be blocked or concealed except where specifically permitted. Do not route conduits across or through access or maintenance space of other equipment. Where equipment is permitted to be concealed, provide approved access door. Where equipment is concealed in fire-resistance rated walls or partitions, provide access doors having same fire-resistance rating as well as partitions in which door is placed.

E. Where electrical equipment is to be installed in limited space, provide additional drawings (scale - minimum 1/4 in. = 1 ft.) as necessary to show physical and dimensional relationship between electrical equipment and adjacent equipment furnished under other Divisions of the Specifications. Acknowledge locations of adjacent structural or mechanical systems, including ductwork, piping, or equipment accesses. Acknowledge clearances established by all codes and regulations are met or exceeded.

F. The installation shall be such that its components will function together as workable systems. It shall be complete, with all accessories necessary for its operation, and shall be left with all equipment properly adjusted and in working order. The Work shall be executed in conformity with the best practices and so as to contribute to efficiency of operation, minimum maintenance, accessibility and appearance.

G. Location of electrical equipment shown on Plans are approximate and are subject to minor changes as directed by and at no extra cost to the Department.

H. Perform equipment tests as per manufacturer's instructions except where otherwise specified

3.2 PROTECTION OF WORK

A. All electrical work, including equipment, fixtures and appurtenances shall be protected from damage until final acceptance. Fixtures and equipment shall be covered to protect against dirt, moisture, paint and the like. The work shall be protected from mechanical injury by appropriate covering or shielding.

B. Prior to final acceptance, protective measures shall be removed and equipment and items shall be cleaned as required to deliver the installation to the State in clean, undamaged condition.

3.3 CLEAN-UP AND SAFETY

A. The work site shall be maintained in a clean condition, free of hazards, all in conformance with the requirements of Article 107 of the Standard Specifications. Special care shall be taken to assure that electrical systems are not left in an exposed or otherwise hazardous

condition. All electrical boxes, cabinets, which contain wiring, either energized or non-energized, shall be closed or shall have their covers in place and shall be locked when possible, during off-work hours.

3.4 ELECTRIC SERVICE

A. Work under this Section shall include all equipment, wiring and appurtenances required for both the complete, operational temporary and permanent electric service. The Department and CMS shall be notified a minimum of eight (8) weeks prior to the Contractor requiring electric service arrangement for the new service and account.

B. All electric utility's fees for disconnecting the existing electric service and providing new service to the pump station shall be paid to the utility by the Contractor upon written authorization by the Engineer and the Contractor will be paid in accordance with Section 109.05 of the Standard Specifications. An allowance of $150,000 shall be included for this work under pay item: ELECTRIC UTILITY SERVICE CONNECTION. However, the Contractor will be paid only for the actual fees paid by him to the utility plus an administrative cost in accordance with Section 109.05.

C. The Contractor shall coordinate with the utility and shall provide electric service man hole, transformer pads, switchgear pads, grounding and conduit work on IDOT Right of Way for the utility in accordance with the utility's requirements and standards and other work for the new service requested by the utility, including the customer responsibilities described on the Service Entrance Location sketch. All costs for this work shall be covered under ELECTRIC SERVICE INSTALLATION. The work shall be performed in accordance with the following ComEd standards and other applicable standards referenced in them.

COMED STANDARD	DESCRIPTION
C4171	CONDUIT DUCTBANK INSTALLATION
C4381	PRECAST CONCRETE MANHOLE
C5285	ESS INSTALLATION REQUIREMENTS
C5286L	TRANSFORMER PAD
C5295	VEHICULAR BARRIER (BOLLARDS)
C5300A	INLINE SWITCHGEAR FOUNDATIONS
C8550.CGO	GROUNDING
C4030	ABANDON VAULT AND MANHOLE

D. The Drawings and Specifications indicate the general nature of work required for electric service. The Contractor shall verify the service requirements, shall ascertain the

installation requirements and the items of equipment, wiring, appurtenances being furnished by the utility and shall provide all other material and work required for a complete installation.

E. Power metering cabinets shall consist of metering transformers, and meter socket in a NEMA 3R enclosure and must be approved by the electric utility. Coordinate the transformer rating with the electric utility.

F. All electric service work must conform to the requirements of the electric utility and NEC.

G. The Contractor shall obtain approval of the electric utility for the electric service and metering prior to installation. Copies of approved documents and drawings shall be submitted to the Engineer for the record prior to installation.

H. The existing pump station on site shall remain operational until new electrical service, and the new pump station are fully operational and accepted by IDOT. Contractor is responsible for coordinating with the utility for service outages and for providing temporary power such that reliable power is available for continuous operation of the existing pump station as well as the new pump station.

3.5 TELEPHONE SERVICE

A. Work under this Section shall include all equipment, conduit, wiring, appurtenances, and coordination with the utility required for complete, operational telephone service and a telephone connection for the SCADA system and AEGIS system; relocate existing aerial telephone service to PS04 to underground telephone service as shown in the Plans. Two separate lines shall be installed in each service. One line shall be dedicated to the SCADA and the second line shall be shared between the AEGIS system and station phone. In addition, the work shall also include coordination with the utility and removal of the existing telephone service to the old pump station after it is demolished.

B. Charges by the telephone utility shall be paid to the utility by the Contractor. All work specified in this section and the aforementioned utility charges shall be paid under the pay item, TELEPHONE SERVICE INSTALLATION AND CONNECTION. The installation of the telephone service and lines shall be coordinated with to Kevin Schlenger of IDOT District 1 Business Services, telephone number (847) 705-4011.

C. The Drawings and Specifications indicate the general nature of the work required for telephone service. The Contractor shall verify the service requirements, shall ascertain the installation requirements and the items of equipment, wiring and appurtenances being furnished by the utility and shall provide all other material and work required for a complete installation.

D. All telephone service work must conform to the requirements of the telephone utility.

E. The Contractor shall obtain approval of the telephone utility for the new telephone wiring. Copies of approved documents and drawings shall be submitted to the Engineer for the record prior to installation

3.6 FINAL ACCEPTANCE INSPECTION

A. When the work is complete, tested and fully operational, and only after the O&M Manuals and Record Drawings have been reviewed and accepted by the Engineer, the Contractor shall schedule a Final Acceptance Inspection with the Engineer. The Contractor shall test for the proper operation of all equipment prior to the final acceptance inspection and to make any corrections necessary to establish proper operation. THE FINAL ACCEPTANCE INSPECTION SHALL NOT BE HELD WHILE FINAL CONNECTIONS AND CHECKS ARE BEING MADE.

B. The Final Acceptance Inspection shall be made for the complete work at the facility as a whole and shall be as further described in Division 1.

3.7 MAINTENANCE

A. During the course of the construction work and until final acceptance, the Contractor shall be responsible for maintenance and operational integrity of both the existing pump station and the new pump station as specified in Division 1.

3.8 TESTING ELECTRICAL SYSTEMS

A. Summary

1. Prior to energizing equipment, retain services of recognized independent testing agency for purpose of performing inspections and tests as herein specified. Independent testing agency shall provide four copies of test procedures prior to commencement of testing with applicable NETA ATS tables and the latest version of NETA ATS a minimum of 30 days prior to field testing.
2. Ensure electrical equipment supplied by Contractor is operational within industry and manufacturer's tolerances and installed in accordance with Specifications.
3. Device Ratings and Settings: Verify ratings and settings of overload relays, timers, motor circuit protectors, and overcurrent protection devices. Make final adjustments of devices in accordance with Section 26 00 02.

B. General

1. Testing agency shall meet federal, state, and local safety requirements for accreditation of testing laboratories, CFR Title 29, part 1907, "Accreditation of Testing Laboratories." and have membership in InterNational Electrical Testing Agency (NETA).
   a. Contractor's Responsibilities:
      1) Supply source of test power to testing agency at each equipment location.
      2) Notify testing agency when equipment becomes available for tests.
      3) Coordinate work to minimize project delay.
      4) Supply complete set of approved and updated record electrical drawings, specifications, and pertinent change orders to testing agency prior to commencement of testing.
   b. Testing Agency Responsibilities:
      1) Notify Engineer, a minimum of 15 days prior to commencement of testing.

2) Provide material, test procedures, applicable tables of NETA to verify acceptance of test results, equipment, labor, and technical supervision to perform such tests and inspections.
3) Test labeling: On satisfactory completion of tests for each piece of equipment, attach dated and signed “Satisfactory Test” label to tested component.
4) Testing Personnel must be NETA certified Level 2 or higher
5) Testing Personnel Supervisor must be NETA certified Level 4.
6) Test forms submitted for Engineer review shall include the range of accepted values in the test forms for insulation resistance tests.

c. Test work and equipment installed to ensure proper and safe operation in accordance with intent of Drawings and Specifications.
1) Check interlocking and automatic control sequences and test operation of safety and protective devices.
2) Identify and list deficiencies and correct defects found during testing.
3) Where test results are not within manufacturer’s published data or NETA ATS, investigate and correct problem identified then retest. Repeat until problem is corrected. Contractor is responsible for all costs associated with retesting and corrective actions.
4) Cooperate with utility, supplier, contractor and manufacturer representatives in order to achieve proper intended operation of equipment.

d. Test, adjust, and record operating voltages at each system level before energizing branch circuits.
1) Transformer taps shall be adjusted to obtain as near as possible nominal system voltage.
2) Where transformer is under utility jurisdiction, obtain services of utility to correct voltage.
3) Replace devices and equipment damaged due to failure to comply with this requirement.

e. Balance load among feeder conductors at each panelboard, switchboard or substation and reconnect loads as necessary to obtain reasonable load balance on each phase. Electrical unbalance shall not exceed 10%. Once the loads are balanced within limits accepted by the Engineer, update the record drawings with revised circuit numbers and update the panel directories.

C. Medium-Voltage Switchgear Assembly Field Tests:

1. Visual and Mechanical Inspection:
a. Verify that fuse and circuit breaker sizes and types correspond to Drawings and coordination study, as well as to the circuit breaker's address in the control network.
b. Verify that current and voltage transformer ratios correspond to Drawings.
c. Inspect bolted electrical connections for high resistance using one of the following two methods:
1) Use a low-resistance ohmmeter (Ductor tester) to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-

wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
   1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
   2) Make key exchange with devices operated in off-normal positions.
e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Inspect insulators for evidence of physical damage or contaminated surfaces.
g. Verify correct barrier and shutter installation and operation.
h. Exercise active components.
i. Inspect mechanical indicating devices for correct operation.
j. Verify that filters are in place and vents are clear.
k. Perform visual and mechanical inspection of instrument transformers according to according to Article "Instrument Transformer Field Tests."
l. Inspect control power transformers.
   1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
   2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.
   3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:
   a. Perform dc voltage insulation-resistance tests on each bus section, phase to phase and phase to ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
      1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
      2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
   b. Perform a dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
      1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
   c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 V dc for 300-volt rated cable and 1000 V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state

components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

1) Minimum insulation-resistance values of control wiring shall not be less than two megohms.

d. Control Power Transformers:
   1) Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground. Insulation-resistance values of winding insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
   2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
   3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
   4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.
e. Voltage Transformers:
   1) Perform secondary wiring integrity test. Verify correct potential at all devices.
   2) Verify secondary voltages by energizing the primary winding with system voltage.
f. Perform current-injection tests on the entire current circuit in each section of switchgear.
   1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
   2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
g. Perform system function tests according to according to "System Function Tests" Article.
h. Verify operation of space heaters.

3. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Medium-Voltage Vacuum Circuit Breaker Field Tests:

1. Visual and Mechanical Inspection:
   a. Inspect physical and mechanical condition.
   b. Inspect anchorage, alignment, grounding, and required clearances.
   c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.
   d. Verify the unit is clean.
   e. Perform mechanical operation tests on operating mechanism according to manufacturer's published data.

f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism shall be according to manufacturer's published data.
g. Verify cell fit and element alignment.
h. Verify racking mechanism operation.
i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
k. Record as-found and as-left operation counter readings. Operation counter shall advance one digit per close-open cycle.

2. Electrical Tests:
   a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
   b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Micro ohm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   c. Perform minimum pickup voltage tests on trip and close coils according to manufacturer's published data. Minimum pickup voltage of the trip and close coils shall comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.
   d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features shall operate according to manufacturer's published data.
   e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
   f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values shall comply with manufacturer's published data.
   g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.

h. Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
i. Verify operation of heaters.

E. Instrument Transformer Field Tests

1. Visual and Mechanical Inspection:
   a. Verify that equipment nameplate data complies with Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Verify correct connection of transformers with system requirements.
   d. Verify that adequate clearances exist between primary and secondary circuit wiring.
   e. Verify the unit is clean.
   f. Inspect bolted electrical connections for high resistance using one of the following two methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections.
      2) Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   h. Verify that all required grounding and shorting connections provide contact.
   i. Verify correct operation of transformer withdrawal mechanism and grounding operation.
   j. Verify correct primary and secondary fuse sizes for voltage transformers.
   k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests of Current Transformers:
   a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's written recommendations or NETA ATS, Table 100.5.
   b. Perform a polarity test of each current transformer according to according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
   c. Perform an excitation test on transformers used for relaying applications according to according to IEEE C57.13.1. Excitation results shall match the curve supplied by the manufacturer or be according to according to IEEE C57.13.1.
   d. Measure current circuit burdens at transformer terminals according to according to ANSI/IEEE C57.13.1. Measured burdens shall be compared with and shall match instrument transformer ratings.
   e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.

f. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.

3. Electrical Tests of Voltage Transformers.
   a. Perform insulation-resistance tests winding-to-winding and each winding to ground. Test voltages shall be applied for one minute according to Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
   b. Perform a polarity test on each transformer to verify the polarity marks or H1- X1 relationship as applicable. Polarity results shall agree with transformer markings.
   c. Perform a turns-ratio test on all tap positions.
   d. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared with and shall match instrument transformer ratings.
   e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
   f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

F. Medium Voltage Switchgear Assembly Ground Resistance Tests

1. Visual and Mechanical Inspection:
   a. Verify ground system complies with Contract Documents and NFPA 70 Article 250, "Grounding and Bonding."
   b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
   c. Inspect bolted electrical connections for high resistance using one of the following two methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   d. Inspect anchorage.
2. Electrical Tests.
   a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground shall be no more than 5 ohms**.**
   b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohm. Compare equipment nameplate data with Contract Documents.

c. Inspect physical and mechanical condition.

3. Inspect bolted electrical connections for high resistance using one of the following methods:
   a. Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value
   b. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

G. Metering Devices Field Tests

1. Visual and Mechanical Inspection:
   a. Inspect physical and mechanical condition.
   b. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
   d. Verify the unit is clean.
   e. Verify freedom of movement, end play, and alignment of rotating disk(s).
2. Electrical Tests:
   a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
   b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
   c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
3. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

H. Microprocessor-Based Protective Relay Field Tests

1. Visual and Mechanical Inspection:
   a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
   b. Verify operation of light-emitting diodes, display, and targets.
   c. Record passwords for each access level.
   d. Clean the front panel and remove foreign material from the case.
   e. Check tightness of connections.
   f. Verify that the frame is grounded according to manufacturer's instructions.

g. Set the relay according to results in Section 26 00 02 "Electrical Power System Studies".
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:
   a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
   b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
   c. Functional Operation: Check functional operation of each element used in the protection scheme as follows:
      1) Timing Relay:
         a) Determine time delay.
            (i) Verify operation of instantaneous contacts.
      2) Volts/Hertz Relay:
         a) Determine pickup frequency at rated voltage.
         b) Determine pickup frequency at a second voltage level.
         c) Determine time delay.
      3) Undervoltage Relay:
         a) Determine dropout voltage.
         b) Determine time delay.
         c) Determine time delay at a second point on the timing curve for inverse time relays.
      4) Current Balance Relay:
         a) Determine pickup of each unit.
         b) Determine percent slope.
         c) Determine time delay.
      5) Negative Sequence Current Relay:
         a) Determine negative sequence alarm level.
         b) Determine negative sequence minimum trip level.
         c) Determine maximum time delay.
         d) Verify two points on the I-two-squared-t curve.
      6) Phase Sequence or Phase Balance Voltage Relay:
         a) Determine positive sequence voltage to close the NO contact.
         b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
         c) Verify negative sequence trip.
         d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
         e) Determine time delay to close the NC contact upon removal of voltage when previously set to rated system voltage.
      7) Instantaneous Overcurrent function:
         a) Determine pickup.
         b) Determine dropout.
      8) Time Overcurrent:
         a) Determine minimum pickup.
         b) Determine time delay at two points on the time current curve.

9) Ground Detector Relay:
   a) Determine maximum impedance to ground causing relay pickup.
10) Directional Overcurrent function:
   a) Determine directional unit minimum pickup at maximum torque angle.
   b) Determine closing zone.
   c) Plot operating characteristics.
   d) Determine overcurrent unit pickup.
   e) Determine overcurrent unit time delay at two points on the time current curve.

d. Control Verification:
   1) Functional Tests:
      a) Check operation of all active digital inputs.
      b) Check output contacts or silicone-controlled rectifiers (SCRs), preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
      c) Check internal logic functions used in protection scheme.
      d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.

3. In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

I. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:
   a. Verify that equipment nameplate data complies with Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and clearances.
   d. Verify the arresters are clean.
   e. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
   f. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.
2. Electrical Test:
   a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
   b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
3. Test grounding connections. Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

J. Medium Voltage Motor Control Center

1. Perform visual and mechanical inspection and tests of the motor control in accordance with NETA ATS Section 7.16.1.2.1 and verify conformance of test values to NETA Section 7.16.1.2.3.1.

2. Perform electrical tests in accordance with NETA ATS Section 7.16.1.2.2 and verify conformance of test values to NETA ATS Section 7.16.1.2.3.2.
3. Perform appropriate inspection and tests of the motor control center bus in accordance with NETA ATS Section 7.1.
4. Perform appropriate inspection and tests of the motor control center switches in accordance with NETA ATS Section 7.5.1.1.
5. Perform appropriate inspection and tests of the motor control center starters in accordance with NETA ATS Section 7.16.1.1.

K. Pad Mounted Liquid Filled Transformer Field Tests

1. Visual and mechanical Inspection
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment and grounding.
   d. Verify presence of PCB content labeling.
   e. Verify removal of any shipping bracing after placement
   f. Inspect bolted electrical connections for high resistance using the following:
      1) Low-resistance Ohmmeter
      2) Verify tightness of accessible bolted electrical connections using calibrated torque wrench method in accordance with manufacturer's published data or NETA Table 100.12.
   g. Verify correct liquid level in tank
   h. Perform inspections and mechanical tests as recommended by the manufacturer.
   i. Verify presence of transformer surge arresters.
   j. Verify no-load tap change position is left as specified.
2. Electrical Tests
   1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
   2) Perform power-factor or dissipation-factor tests on all windings according to test equipment manufacturer's published data. Maximum winding insulation power-factor/dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.3.
   3) Measure core insulation resistance at 500-V dc if the core is insulated and the core ground strap is removable. Core insulation-resistance values shall not be less than 1 megohm at 500-V dc.
   4) Perform turns-ratio tests at tap positions. Turns-ratio test results shall not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
   5) Perform an applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91, Sections 10.2 and 10.9. This test is not required for single-phase transformers and for three-phase Y-Y-connected transformers.
   6) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
   7) Remove a sample of insulating liquid according to ASTM D 923, and perform

dissolved-gas analysis according to IEEE C57.104 or ASTM D 3612.

L. Motor Control Center and Panelboard Assemblies

1. Refer to paragraph 3.8.M for appropriate inspections and tests of the motor control center and panelboard bus.
2. Refer to paragraph 3.8.N for appropriate inspections and tests of the motor control center and panelboard circuit breakers.
3. Refer to paragraph 3.8.O for appropriate inspections and tests of the motor control center motor starters.
4. Refer to paragraph 3.8.U for appropriate inspections and tests of the motor control center automatic transfer control system.
5. Verification and marking of phase sequence rotation shall be performed.

M. Motor Control Centers and Panelboard Bussing

1. Visual and Mechanical Inspections:
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect for physical and mechanical damage.
   c. Verify equipment supplied and connected in accordance with Specifications.
   d. Inspect for proper alignment, anchorage, grounding and required clearance areas.
   e. Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles/sections have been removed.
   f. Verify that fuse and circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
   g. Verify that current and voltage transformer ratios correspond to approved shop drawings.
   h. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
   i. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions for proper ft-lb levels or NETA ATS Table 100.12.
   j. Key interlock system shall be physically tested to ensure proper function.
   k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
   l. Inspect insulators for evidence of physical damage or contaminated surfaces.
   m. Verify correct barrier and shutter installation and operation.
   n. Exercise all active components.
   o. Doors, panels, and sections shall be inspected for paint, scratches, and fit.
   p. Inspect mechanical indicating devices for correct operation.
   q. Verify that filters are in place and vents are clear.
   r. Perform visual and mechanical inspection of instrument transformers in accordance with paragraph 3.8.E.
   s. Mechanical operation of relays, switches, and other devices.
   t. Inspect control power transformers.
      1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit breaker ratings match approved shop drawings.
3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests:
   a. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute in accordance with NETA ATS Table 100.1.
   b. Perform a dielectric withstand voltage test on each bus, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. If manufacturer has no recommendation for this test, it shall be in accordance with NETA ATS Table 100.2. The test voltage shall be applied for one minute.
   c. Perform electrical tests on instrument transformers in accordance with paragraph 3.8.E.
   d. Perform ground-resistance tests in accordance with Section 3.8.S.
   e. Determine accuracy of all meters and calibrate watthour meters in accordance with paragraph 3.8.G.
   f. Control Power Transformers.
      1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with NETA ATS Table 100.1 unless otherwise specified by the manufacturer.
      2) Perform a turns-ratio test on all tap positions.
      3) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
      4) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
      5) Verify correct function of control power transfer relays located in the switchgear with multiple control power sources.
   g. Voltage Transformers.
      1) Perform secondary wiring integrity test. Verify correct potential at all devices.
      2) Verify secondary voltages by energizing the primary winding with system voltage.
   h. Perform current-injection tests on entire current circuit in each section of switchgear.
      1) Perform current tests by secondary injection with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
   i. Verify operation of cubicle switchgear/switchboard space heaters.
      1) Perform system function tests to verify the correct operation of all sensing devices, alarms, and indicating devices and the correct operation of all interlock safety devices for fail-safe functions in addition to the design function.
   j. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.
      1) Test Values:
   k. Bolt torque levels shall be in accordance with manufacturer's instructions. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

l. Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1 Values of insulation-resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
m. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
n. Results of electrical tests on instrument transformers shall be in accordance with paragraph 3.8.E.
o. Results of ground-resistance tests shall be in accordance with paragraph 3.8.S.
p. Accuracy of meters shall be in accordance with paragraph 3.8.G.
q. Control Power Transformers.
r. Voltage Transformers.
s. Current-injection tests shall prove current wiring is in accordance with design specifications.
t. Heaters shall be operational.
u. Results of system function tests shall be in accordance with NETA ATS Section 8.
v. Phasing check shall prove the motor control center phasing is correct and in accordance with the system design. Phase sequence shall be identified in the incoming sections of the MCC and labeled.

N. Circuit Breakers (600 V) – Insulated-Case/Molded-Case

1. Visual and Mechanical Inspections:
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect for physical and mechanical damage.
   c. Inspect for proper alignment and anchorage.
   d. Verify the unit is clean.
   e. Operate the circuit breaker to insure smooth operation.
   f. Check tightness of accessible bolted bus joints by calibrated torque wrench method. Refer to manufacturer's instructions for proper ft-lb levels or NETA ATS Table 100.12.
   g. Inspect operating mechanism, contacts, and arc shuts in unsealed units.
   h. Perform adjustments for final protective device settings in accordance with coordination study.
2. Electrical Tests:
   a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1.
   b. Perform a contact/pole-resistance test.
   c. Determine long-time pickup and delay by primary current injection.
   d. Determine short-time pickup and delay by primary current injection.
   e. Determine ground-fault pickup and time delay by primary current injection.
   f. Determine instantaneous pickup by primary current injection.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
h. Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset all trip logs and indicators.
i. Verify operation of charging mechanism.

3. Test Values:
   a. Bolt torque levels shall be in accordance with manufacturer's instructions. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
   b. Settings shall comply with coordination study recommendations.
   c. Insulation-resistance values of bus insulation shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1 Values of insulation-resistance less than this table or manufacturer's recommendations should be investigated.
   d. Long-time pickup values shall be as shown in coordination study, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS Table 100.7.
   e. Short-time pickup values shall be as shown in coordination study, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band.
   f. Ground fault pickup values shall be as shown in coordination study, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band.
   g. Instantaneous pickup voltage shall be as shown in coordination study, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band.
   h. Pickup values and trip characteristics shall be within manufacturer's published tolerances.
   i. Minimum pickup voltage of the shunt trip and close coils shall conform manufacturer's published data. In the absence of the manufacturer's published data, refer to NETA ATS Table 100.20.
   j. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
   k. The charging mechanism shall operate in accordance with manufacturer's published data.

O. Motor Controllers

1. Refer to paragraph 3.8.N for appropriate inspections and tests for motor circuit protectors.
2. Visual and Mechanical Inspections: Include following inspections and related work:
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect for physical and mechanical damage.
   c. Inspect for proper alignment, anchorage, and grounding.
   d. Verify the unit is clean.

e. Check tightness of accessible bolted electrical connections by calibrated torque wrench method. Refer to manufacturer's instructions for proper ft-lb levels or NETA ATS Table 100.12.
f. Test all electrical and mechanical interlocking systems for correct operation and sequencing.
g. Verify correct barrier and shutter installation and operation.
h. Exercise all active components and confirm correct operation of all indicating devices.
i. Inspect contactors.
    1) Verify mechanical operation.
    2) Verify contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.
    3) Verify overload protection rating is correct for its application. Set adjustable or programmable devices according to protective device coordination study.
    4) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:
    a. Perform insulation-resistance tests for one minute on contactor(s), phase-to-phase and phase-to-ground and across the open contacts in accordance with NETA ATS Table 100.1.
    b. Perform a contact resistance test.
    c. Measure blowout coil circuit resistance.
    d. Measure resistance of power fuses.
    e. Energize contactor using an auxiliary source. Adjust armature to minimize operating vibration where applicable.
    f. Test control power transformer in accordance with paragraph 3.8.M.
    g. Test motor protection devices in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Section 7.9.
    h. Verify operation of cubicle space heater.
4. Test Values:
    a. Bolt torque levels shall be in accordance with manufacturer's instructions. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
    b. Mechanical and electrical interlocks shall operate in accordance with system design.
    c. Barrier and shutter installation and operation shall be in accordance with manufacturer's design.
    d. Indicating devices shall operate in accordance with system design.
    e. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1 Values of insulation-resistance less than this table or manufacturer's recommendations should be investigated.
    f. Resistance of blowout coils shall be in accordance with manufacturer's published data.
    g. Resistance values shall not deviate by more than 15 percent between identical fuses.
    h. Contactor coil shall operate within minimal vibration and noise.

i. Control power transformer test results shall be in accordance with paragraph 3.8.M.
j. Motor protection parameters shall be in accordance with manufacturer's published data.
k. System function test results shall be in accordance with manufacturer's published data and system design.
l. Heaters shall be operational.

P.Medium Voltage Cable Tests.

1. Visual and Mechanical Inspection
   a. Compare cable data with plans and specifications.
   b. Inspect exposed sections of cables for physical damage. Inspect cable jacket and insulation condition.
   c. Inspect bolted connections for high resistance using the following methods:
      1) Use low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connection. Investigate those connections that deviate by more than 50% of the lowest value.
      2) Verify tightness of accessible bolted electrical connections using calibrated torque wrench method in accordance with manufacturer's published data or NETA Table 100.12. Bolt torque levels shall be in accordance with manufacturer's instructions. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
   d. Inspect compression-applied connectors for correct cable match and indentation.
   e. Inspect shield grounding, cable supports and terminations.
   f. Verify that visible cable bends meet or exceed ICEA and manufacturer's minimum published bend radius. The minimum bend radius to which the cables may be bent shall be in accordance with NETA ATS Table 100.22.
   g. Where cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are properly placed and that shields are correctly terminated for operation of protective devices.
   h. Inspect for correct identification and arrangement.
2. Electrical tests
   a. Perform resistance measurements through bolted connections with a low resistance ohmmeter. Compare bolted connection resistance values to values of similar connection. Investigate those connections that deviate by more than 50% of the lowest value.
   b. Perform insulation resistance test individually on each conductors with all other conductors and shields grounded. Apply voltage in accordance with manufacturer's published data or NETA Table 100.1 in the absence of such data. Insulation resistance shall be in accordance with manufacturer's published data or NETA ATS Table 100.1 in the absence of such data. Values less than the Table or manufacturer's published data shall be investigated.
   c. Perform shield continuity test on each conductor. Shielding shall exhibit continuity. Investigate resistance values in excess of 10 ohms per 1000 feet of cable.
   d. Perform Dissipation Factor test of each new conductor according to test equipment manufacturer's recommendations.

e. Certify compliance with test parameters.

Q. Low Voltage Cable (600 Volt) Tests,

1. Visual and Mechanical Inspection
   a. Compare cable data with plans and specifications.
   b. Inspect exposed sections of cables for physical damage. Visual and Mechanical Inspection
   c. Inspect exposed sections of cables for physical damage and correct connection in accordance with the one line diagram.
   d. Inspect bolted connections of cables 2/0 AWG and larger for high resistance using the following methods:
      1) Use low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connection. Investigate those connections that deviate by more than 50% of the lowest value.
      2) Verify tightness of accessible bolted electrical connections using calibrated torque wrench method in accordance with manufacturer's published data or NETA Table 100.12. Bolt torque levels shall be in accordance with manufacturer's instructions. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
   e. Inspect compression-applied connectors for correct cable match and indentation.
   f. Inspect for correct identification and arrangement.
   g. Inspect cable jacket and insulation condition.
   h. Inspect shield grounding, cable supports and terminations.
2. Electrical Tests
   a. On all cables, 2/0 AWG and larger, perform resistance measurements through bolted connections with low resistance ohmmeter. Compare bolted connection resistance values to values of similar connection. Investigate those connections that deviate by more than 50% of the lowest value.
   b. On cables, 2/0 AWG and larger, perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied voltage shall be 1000 VDC and test duration shall be 1 minute. Insulation resistance shall be in accordance with manufacturer's published data or NETA ATS Table 100.1 in the absence of such data. Values less than the Table or manufacturer's published data shall be investigated.
   c. Verify uniform resistance of parallel conductors. Deviations in resistance between parallel conductors shall be investigated.

R. Metering and Instrumentation

1. Visual and Mechanical Inspection:
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect meters and cases for physical.
   c. Clean front panel and remove shipping restraint material.
   d. Verify tightness of electrical connections.
   e. Record model number, serial number, firmware revision, software revision, and rated control voltage.
   f. Verify operation of display and indicating devices.
   g. Record passwords.

h. Verify unit is grounded in accordance with manufacturer's instructions.
i. Verify unit is connected in accordance with manufacturer's instructions and approved shop drawings.
j. Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.

2. Electrical Tests:
   a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
   b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.
   c. After initial system energization, confirm measurements and indications are consistent with loads present.
3. Test Values:
   a. Tightness of electrical connections shall assure a low resistance.
   b. Display and indicating devices shall operate per manufacturer's published data.
   c. Measurement and indication of applied values of voltage and current shall be within manufacturer's published tolerances for accuracy.

S. Grounding System

1. Visual and Mechanical Inspection:
   a. Verify grounding system is in compliance with drawings, specifications, and NFPA 70 National Electrical Code Article 250.
   b. Inspect physical and mechanical condition of ground system.
   c. Inspect tightness of accessible bolted electrical connections by calibrated torque wrench method. Refer to manufacturer's instructions for proper ft-lb levels or NETA ATS Table 100.12.
2. Electrical Tests:
   a. Subject completed grounding system to megger test at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
   b. Measure ground resistance not less than 2 full days after last trace of precipitation, and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   c. Perform tests by 2 point method according to Section 9.03 of IEEE 81.
3. Maximum grounding resistance values are as follows:
   a. Equipment Rated 500 kVA and less: 10 ohms.
   b. Equipment Rated 500 to 1000 kVA: 5 ohms.
   c. Equipment Rated More than 1000 kVA: 3 ohms.
   d. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
   e. Manhole Grounds: 10 ohms.
4. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

5. Report: Prepare certified test reports, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

T. Ground Fault Systems

1. Visual and Mechanical Inspections:
   a. Inspect for physical damage and compliance with Drawings and Specifications.
   b. Inspect neutral main bonding connection to ensure following.
      1) Zero sequence system grounded upstream of sensor.
      2) Ground strap systems grounded through sensing device.
      3) Ground connection made ahead of neutral disconnect link.
   c. Inspect control power transformer to ensure adequate capacity for ground fault system.
   d. Manual operate monitor panels (if present) for following:
      1) Trip test.
      2) No trip test.
      3) Non-automatic reset.
   e. Record proper operation and test sequence.
   f. Inspect zero sequence systems for symmetrical alignment of core balance transformers about current carrying conductors.
   g. Verify ground fault device circuit nameplate identification by actuation observation.
   h. Pickup and time delay settings shall be set in accordance with settings developed through coordination study and as approved by Engineer.
2. Electrical Tests:
   a. Test in accordance with manufacturer's instructions.
   b. Measure system neutral insulation resistance to ensure no shunt ground paths exist, neutral-ground disconnect link removed, neutral insulation resistance measured, and link replaced.
   c. Relay pickup current shall be determined by primary injection at sensor and circuit interrupting device operated.
   d. Relay timing shall be tested by injecting 150% and 300% of pickup current into sensor. Total trip time shall be electrically monitored.
   e. System operation shall be tested at 55% rated voltage.
   f. Zone interlock system shall be tested by simultaneous sensor current injective and monitoring blocking function.
3. Test Parameters:
   a. System neutral insulation shall be minimum of 100 ohms, preferably 1 megohm or larger.
   b. Relay pickup current shall be within 10% of device dial or fixed setting, and in no case greater than 1,200 amp.
   c. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves, but in no case longer than 1 sec.

U. Automatic Transfer Control System

1. Visual and Mechanical Inspections:
   a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.
c. Verify tightness of all control connections.
d. Verify positive mechanical interlocking between main circuit breakers and tie circuit breaker.

2. Electrical Tests:
   a. Verify settings and operation of control devices.
   b. Calibrate and set all relays in accordance with NETA ATS Section 7.9.
   c. Verify phase rotation, and phasing, as required by application.
   d. Perform automatic transfer tests:
      1) Simulate loss of normal power source 1.
      2) Restore normal power source 1.
      3) Simulate loss of normal source 2.
      4) Restore normal power source 2
      5) Simulate all forms of single-phase conditions.
   e. Verify correct operation and timing of the following functions:
      1) Source 1 and 2 voltage-sensing and frequency-sensing relays.
      2) Time delay upon transfer.
      3) Automatic transfer operation.
      4) Interlocks and limit switch function.
      5) Time delay and retransfer upon normal power restoration.

V. Dry Type Transformers

1. Tests: Include following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.
   a. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
   b. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A.
   c. Conduct ratio and polarity tests.
   d. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.
      1) Minimum test voltage: 1000 volts, direct current.
      2) Minimum insulation resistance: 500 megohms.
      3) Duration of each test: 10 minutes.
      4) Temperature correction: correct results for test temperature deviation from 20 degrees Celsius standard.
2. Test failures: compare test results with specified performance or manufacturer's published data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

END OF THIS SECTION

SECTION 26 00 02 - ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL:

1.1 ELECTRICAL STUDIES

A. Section includes

1. Short circuit study, protective device evaluation study, protective device coordination study, and arc flash study on entire electrical power distribution system.
2. Portions of electrical distribution system from normal and alternate sources of power throughout distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions and maximum incident energy shall be covered in studies.

B. Contractor shall engage services of independent engineering firm for purpose of performing power system studies as specified. This firm cannot be the same manufacturer of major electrical equipment supplied on project. Independent engineering firm shall have a minimum 10 years of experience in Power System Studies.

C. The studies must be performed utilizing SKM Power Tool or approved software.

D. The Electrical Power System Studies shall be performed and the shop drawing shall be submitted and approved prior to submittal of the electrical equipment shop drawings.

E. A Study Report providing summary of results of power systems study. Include:

1. Description, purpose, basis, and scope of study and single line diagram of power system.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties and commentary regarding same.
3. Protective device time versus current color coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including definition of terms and guide for interpretation of computer printout.
5. Tabulation of appropriate tap settings for relay units.
6. Arc flash calculations and tabulation of incident energy level (calories/cm^2) for each equipment location and recommended personal protective equipment (PPE).

F. Progress payments will be in accordance with Section 109 of the Standard Specifications.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the item, PUMP STATION ELECTRICAL WORK.

1.3 REGULATORY REQUIREMENTS:

A. Conform to those listed in Section 26 00 01.

1.4 QUALIFICATIONS OF ENGINEERING FIRM:

A. Corporately and financially independent engineering organization which can function as unbiased engineering authority, professionally independent of manufacturers, suppliers and installers of equipment or system studies as specified.

B. Study report shall be signed and sealed by Professional Engineer registered in same State as project location.

C. The firm must have performed at least five projects of similar size, service and the type of equipment specified.

D. Engineering organization may be testing organization.

PART 2 - PRODUCTS: (NOT USED)

PART 3 - EXECUTION:

3.1 STUDIES TO INCLUDE THE FOLLOWING:

A. Utility Company incoming service lines.

1. Main switching station.
2. Power transformers.
3. Medium voltage switchgear.
4. Medium Voltage Motor Control Center.
5. Low voltage Motor control centers and its automatic transfer scheme.
6. Power and lighting distribution panels.
7. Cable, wire, and conduit systems.
8. Contractor and company performing the power system studies are responsible for gathering information on the equipment and conductors required to perform the power system studies.

3.2 SHORT CIRCUIT STUDY

A. Provide complete report with printout data sheets using digital computer type programs as part of study.

B. Include utilities' short circuit contribution, resistance and reactance components of branch impedances, X/R ratios, base quantities selected, and other source impedances.

C. Calculate short circuit momentary duty values and interrupting duty values based on assumed 3-ph bolted short circuit at switch gear base medium voltage controller,

switchboard, low voltage MCC, distribution panelboard, pertinent branch circuit panel, and other significant locations through system. Include short circuit tabulation of symmetrical fault currents and X/R ratios. List with respective X/R ratio each fault location, total duty on bus, and individual contribution from each connected branch.

3.3 EQUIPMENT DEVICE EVALUATION STUDY

A. Provide protective device evaluation study to determine adequacy of circuit breakers, molded case switches, disconnect switches, controllers, surge arresters, busways, and fuses by tabulating and comparing short circuit ratings of these devices with calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Notify Engineer of problem areas or inadequacies in equipment due to short circuit currents and provide suggested alternate equipment.

3.4 EQUIPMENT DEVICE COORDINATION STUDY

A. Provide protective device coordination study with necessary calculations and logic decisions required to select or check selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Objective of study to obtain optimum protective and coordination performance from these devices.

B. Include as part of coordination study, medium and low voltage classes of equipment from utility's incoming line protective device down to and including largest rated device in 480V MCCs and panelboards. Include phase and ground overcurrent protection as well as settings of other adjustable protective devices.

C. Draw time-current characteristics of specified protective devices in color on log-log paper or computer printout. Include with plots complete titles, representative one-line diagram and legends, associated Power Company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing in-rush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits, and significant symmetrical and asymmetrical fault currents. Provide coordination plots for phase and ground protective devices on system basis. Provide sufficient number of separate curves to indicate coordination achieved.

D. Provide separate selection and settings of protective devices in tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment, and recommended settings. Tabulate recommended power fuse selection for medium voltage fuses where applied in system. Notify Engineer of discrepancies, problem areas or inadequacies and provide suggested alternate equipment ratings and/or settings.

3.5 ARC FLASH STUDY

A. Provide Incident Energy Study – An incident energy study shall be done in accordance with the IEEE 1584, "IEEE Guide for Performing Arc Flash Hazard Calculations" as referenced in NFPA 70E, "Standard for Electrical Safety in the Workplace", in order to quantify the hazard for selection of personal protective equipment (PPE).

B. Adjust system design to optimize the results of the study as it relates to safety and reliable electrical system operation (e.g. overcurrent device settings, current limiting devices). This includes mitigation, where possible, of incident energy levels that exceed 40 calories/cm^2. Provide suggested alternate equipment and settings to minimize incident energy levels.

C. Provide incident energy level (calories/cm^2) for each equipment location and recommended PPE.

D. Based on the results of the incident energy study provide and install a warning label (orange < 40 cal/cm^2) or danger label (red > 40 cal/cm^2) for each piece of equipment. The label must be readable in both indoor and outdoor environments and contain the following information:

1. Arc hazard boundary (feet and inches).
2. Working distance (feet and inches).
3. Arc flash incident energy at the working distance (calories/cm2).
4. PPE category and description including the glove rating.
5. Voltage rating of the equipment.
6. Limited approach distance (feet and inches).
7. Restricted approach distance (feet and inches).
8. Prohibited approach distance (feet and inches).
9. Equipment/bus name.
10. Date prepared.

E. Provide one day of arc flash safety training, travel time excluded and at jobsite or classroom designated by Engineer for up to ten participants, that contains the requirements referenced in OSHA 1910.269, OSHA 1910 Subpart S and NFPA 70E. Training shall include but not be limited to the following:

1. Proper use of the system analysis data.
2. Interpretation of hazard labels.
3. Selection and utilization of personal protective equipment.
4. Safe work practices and procedures.

3.6 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Comply with Section 26 00 01, see Testing Electrical Systems.

END OF THIS SECTION

SECTION 26 00 03 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL:

1.1 DESCRIPTION

A. Basic materials and methods specified herein shall be incorporated in the work wherever applicable unless specifically indicated otherwise.

B. The basic materials and methods specified herein are intended to define a minimum standard of quality and workmanship.

C. Refer to Division 01 for additional requirements.

D. Progress payments will be in accordance with Section 109 of the Standard Specifications.

E. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the item, PUMP STATION ELECTRICAL WORK.

1.3 RELATED SECTIONS

A. Section 26 00 01 – General Electrical Provisions.

B. Section 26 00 04 – Lighting

C. Section 26 00 05 – Miscellaneous Electrical Equipment

D. Section 26 05 13 – Medium Voltage Cables

E. Section 26 13 26 – Medium Voltage Metal-Clad Switchgear

F. Section 26 18 39 – Medium Voltage Motor Starters

G. Section 26 24 19 – Motor Control Centers

H. Section 40 90 05 – SCADA Equipment.

I. Section 43 21 00 – Pumping Equipment: Basic Requirements

J. Section 43 25 13 – Pumping Equipment: Submersible End-Suction Pumps

1.4 REFERENCES

A. Codes and Standards referred to in this Section are:

Fed. Spec. W-F-408	-	Fittings for conduit, metal (rigid thick wall and thin wall).
ASTM B-3	-	Specification for soft annealed copper wire.
ASTM B-8	-	Specification for concentric lay stranded copper conductors, hard medium, hard or soft.
ASTM B-33	-	Specification for tinned or soft or annealed copper wire for electrical purposes.
ASTM D 635	-	Test method for rate of burning and/or extent and time of burning of self-supporting plastics in a horizontal position.
HH-I-595	-	Insulation tape, electrical, pressure sensitive adhesive, plastic.
EIA/TIA	-	Electronic Industries Association/Telecommunications Industries Association
Fed. Spec. WC-596	-	Electrical power connectors.
NEC	-	National Electrical Code
NEMA WD-1	-	General requirements for ac switches.
RUS	-	Rural Utilities Service
UL 50	-	Cabinets and boxes.
UL 96A	-	Installation Requirements for Lightning Protection Systems.
ANSI/NFPA 780-		Standard for the Installation of Lightning Protection Systems.

1.5 SUBMITTALS

A. Provide shop drawings and product data under provisions of Section 01 33 00 for the following items: Lightning Protection System, Cabinets and Enclosures with NEMA classification higher than NEMA 1.

B. Raceway, Conductors and Cables, Electrical Identification, Grounding, Wiring Devices, Supporting Devices, and Cabinets and Enclosures with NEMA 1 classification submittals are not required if CONTRACTOR supplies material or equipment as specified. If CONTRACTOR proposes substitutes to material or equipment submittals identified below are required.

1. Product data.
2. Submit in accordance with Section 01 33 00.

1.6 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

1.7 LIGHTNING PROTECTION MANUFACTURER REQUIREMENTS

A. Contractor shall retain services of installing manufacturer who is recognized and is UL listed for lighting protection systems and subscribes to the UL Follow-Up Service as herein specified. Installer shall provide four copies of recent project qualifications and project specific layout and detail submittals.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. METAL CONDUIT AND TUBING

1. Galvanized Rigid Steel Conduit: ANSI C80.1.
2. Flexible Metal Conduit: Zinc-coated steel.
3. Liquidtight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.
4. Plastic- Coated Steel Conduit and Fittings: NEMA RN 1; rigid steel conduit system as specified with coated interior walls and external PVC coating, 40 mil (.1 mm) thick.

B. Nonmetallic Conduit

1. Rigid Nonmetallic Polyvinyl Chloride (PVC) Conduit: NEMA TC 2, Schedule 40 or 80 PVC.
2. PVC Conduit Fittings: NEMA TC 3; match to conduit type and material.

C. Fittings

1. Fittings for steel conduit:
   a. Steel or malleable iron, zinc galvanized or cadmium plated.
   b. Do not use set screw or indentor type fittings.
   c. Do not use aluminum or die cast fittings.
   d. GRS Connectors and Couplings:
      1) Threaded.

2) Insulated throat.
3) Gland compression type.
4) Rain and concrete type.

e. Comply with ANSI C80.4.
f. Comply with NEMA FB 1, compatible with conduit materials.

2. Fittings for PVC Coated galvanized rigid steel conduits:
   a. Use only fittings approved for use with that material. Patch nicks and scrapes with PVC coating after installing conduit.
3. Conduit bodies:
   a. Malleable iron with galvanized finish.
4. Fittings for flexible metal conduit:
   a. Insulated throat type.
   b. Threaded.
   c. Grounding type.
   d. Liquidtight: 1 piece sealing “O” rings with connectors when entering boxes or enclosures.
5. PVC Conduit Fittings:
   a. NEMA TC 3; match to conduit type and material.
6. Expansion Joints:
   a. Conduit expansion fittings complete with copper bonding jumper, Crouse-Hinds Type XJ.
   b. Conduit expansion/deflection fittings with copper bonding jumper, Crouse-Hinds Type XD.
7. Seals:
   a. Wall entrance, OZ/Gedney Type FSK or FSC.
8. Drain Fittings:
   a. Automatic Drain Breather:
      1) Explosion-proof - Safe for Class 1, Group C and D.
      2) Capable of passing minimum 25 cc water/min and minimum 0.05 cu ft air/min at atmospheric pressure.
   b. Condensate Drain:
      1) Conduit outlet body, Type T.
      2) Threaded, galvanized plug with 3/16 in. drilled holed through plug.
9. Hazardous Areas:
   a. Explosion-proof.
   b. Horizontal seal fittings, Crouse-Hinds Type EYS.
   c. Vertical seal fittings, Crouse-Hinds Type EYD.
   d. Vertical seal fittings shall have drain type plug.

D. Raceway/Duct Sealing Compound

1. Non-hardening, putty-like consistency workable at temperatures as low as 35°F.
2. Compound shall not slump at temperature of 300°F and shall readily adhere to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

2.2 CONDUCTORS AND CABLES

A. Building Wire and Cables

1. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as required to meet application and NEC requirements.
2. Wire and cable for 600 volts and below: Soft drawn, copper wire with 600 volt insulation.
   a. Conductors:
      1) Annealed, copper in accordance with ASTM B33.
      2) Stranding: Class B in accordance with ASTM B8.
   b. Insulations and Coverings:
      1) Rubber: Conform to NEMA WC 3.
      2) Thermoplastic: Conform to NEMA WC 5.
      3) Cross-Linked Polyethylene: Conform to NEMA WC 7.
      4) Ethylene Propylene Rubber: Conform to NEMA WC 8.
3. Feeders and service conductors: Single conductor Type XHHW-2.
4. Branch Circuits: Single Conductor Type THHN/THWN (90° C): Above ground and underfloor conduits.
5. Single Conductor Type XHHW-2: Duct bank conduit.
6. No. 12 AWG minimum size (unless otherwise noted) for branch circuit wiring, including motor circuits.
7. Size 120V branch circuits for length of run on following basis.
   a. Wiring sized for 3% maximum voltage drop.
   b. For other branch circuits, voltage drop for branch circuits and feeder circuit combined shall not exceed requirements of the NEC 215.
8. Control Circuits:
   a. Single conductor Type THHN/THWN (90° C): Above ground and underfloor conduits.
   b. No. 14 AWG minimum size (unless otherwise noted).
   c. Multi-wire cable assembly: Duct bank conduits.
9. Non-shielded Instrumentation, Graphic Indication, and Other Control Wiring Operating at Less Than 120V: No. 14 AWG except as otherwise indicated with same insulation as control circuits.
   a. Single conductor Type THHW/THWN (90° C), above ground and underfloor conduits.
   b. Multi-wire cable assembly: Duct bank conduits.
10. Shielded instrumentation wiring, above ground and underfloor conduits:
    a. PVC insulation, tinned copper (19 by 27) stranded, No. 16 AWG, twisted pair or triplet cabled with aluminum mylar shielding, stranded, tinned, No. 18 AWG copper drain wire, and overall black FR-PVC, 90°C, 600 volt jacket.
    b. Multi-wire cable assembly: Duct bank conduits.
11. Telephone wire, above ground conduits:
    a. Vinyl insulation, tinned copper, solid twisted pair, cabled conductors, and silver gray vinyl jacket.
       1) Up to 4 conductors per cable: 22 AWG solid wire.
       2) Over 4 conductors per cable: 24 AWG solid wire.

3) Duct Bank: High density polyethylene jacketed multi-wire cable assemblies.

12. Copper Ethernet cable – 4 Pair, 23 AWG, solid uncoated copper conductors, Polyolefin insulation, Unshielded, with PVC jacket, CAT 6+, ANSI/NEMA WC-66 and ANSI/ICEA S90-661 and ANSI/UL 444 compliant.
13. Coaxial Cable – RG-8/U, GPS antenna cable, 10 AWG solid .108" uncoated copper conductor, semi-solid polyethylene insulation, aluminum foil tape and tinned copper braid shield with 90% coverage, PVC jacket. Belden #9913 or approved equal.
14. Coaxial Cable – RG-58/U for time synchronization wiring to protective relays, 20 AWG, solid 0.033" uncoated copper conductor, polyethylene insulation, copper braid shield with minimum 80% coverage, PVC jacket, Belden #9201 or approved equal.
15. Devicenet cable: 4/C shielded, Type XLP/PVC jacket
16. Fire Alarm Circuits: Type THHN/THWN, copper conductor, in raceway.
17. Multi-Wire Control and Instrumentation Cable Assemblies:
    a. Multi-conductor, color-coded cable with number and size of conductors indicated.
    b. Where spare conductors are not indicated provide 10% spare conductors. One pair minimum.
    c. Control and non-shielded instrumentation.
        1) Bare soft stranded No. 14 or 12 AWG copper in accordance with ASTM B3.
        2) Class B stranded in accordance with ASTM B8.
        3) Type THWN insulation also meeting requirements of NEMA WC-5 with armor-nylon in accordance with UL 83-THHN/THWN.
        4) Color coded in accordance with NEMA WC-5 Method I Table K-2.
        5) Cabled with suitable fillers.
        6) Overall black FR-PVC, 90°C, 600 volt sunlight resistant jacket.
    d. Shielded Instrumentation:
        1) Bare soft stranded No. 16 AWG copper in accordance with ASTM B3, unless noted otherwise.
        2) Gas Sensor cable - minimum 3/C (Triad), bare soft stranded No. 16 AWG, in accordance with ASTM B3, with overall shield, or as recommended by selected CGM supplier.
        3) Pump instrumentation cable – minimum 12 Pair, bare soft stranded No. 18 AWG, in accordance with ASTM B3, with overall shield, or as recommended by selected pump supplier.
        4) Class B stranded tinned copper in accordance with ASTM B8.
        5) PVC with nylon armor insulation.
        6) Twisted pairs color coded in accordance with NEMA WC-5 Method I Table K-2, and numbered.
        7) Individual and overall aluminum mylar shields and seven strand tinned copper drain wires.
        8) Overall black FR-PVC 90°C 600 volt sunlight resistant jacket.
18. Fiberoptic cable – Single mode, 12 count, loose buffer-tube, single sheathed, non-armored, indoor/outdoor rated, RUS 7 CFR1755.900 compliant, with the following characteristics:

Core Diameter	8.3 µm,
Cladding Diameter	125.0±0.7 µm,
Core-Clad Connectivity	0.05 µm maximum,
Zero Dispersion Wavelength	1300-1322 nm,

Cladding Diameter	245 ±10 µm
Coating-Cladding Concentricity	12 µm maximum
Mode Field Diameter	9.2 ± 0.4 µm at 1310 nm
Mode Field Diameter	10.4 ± 0.5 µm at 1550 nm
Maximum Attenuation	0.4 dB/km at 1310 nm and 0.3 dB/km at 1550 nm
Minimum Bending Radius	20 X Outer Diameter during installation and 20 X Outer Diameter during operation
Operating Temperature	-40^0 F to 158^0 F

The individual fibers and buffer tubes shall be color coded as specified in EIA/TIA-598.

B. Connectors and Splices

1. Underwriters Laboratories (UL) -listed factory-fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated.
2. Select to comply with Project's installation requirements and as required to meet application.
3. Conductors No. 10 AWG and Smaller: 3M Electric Products, Skotchlok, or equal pre insulated spring connector. Comply with manufacturer's packaging requirements for number, size, and combination of conductors.
4. Conductors No. 8 AWG and Larger: Bronze 2-bolt type connectors with spacer.

C. Terminations

1. Power Conductors: Compression crimp type lugs.
2. Control and Instrumentation Conductors: Compression crimp type fork tongue, insulated support type lugs on terminal strips. Do not splice.

2.3 REQUEST FOR SUBSTITUTION

A. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

B. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.

C. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.4 ELECTRICAL IDENTIFICATION

A. Raceway and Conductor Labels

1. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide a single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.
2. Conform to ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.
   a. Color: Black legend on orange field.
   b. Legend: Indicates voltage.
3. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.
4. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
5. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 in. wide (0.08 mm thick by 25 to 51 mm wide).
6. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:
   a. Size: Not less than 6 in. wide by 4 mils thick (152 mm wide by 0.102 mm thick).
   b. Compounded for permanent direct burial service.
   c. Embedded continuous metallic strip or core.
   d. Printed Legend: Indicates type of underground line.
7. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 in. (0.4 mm) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
8. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.
9. Aluminum Faced Card Stock Tags: Wear resistant, 18 point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 in. (0.05 mm) thick, laminated with moisture resistant acrylic adhesive, and punched for fastener. Preprinted legends suit each application.
10. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 in. (51 by 51 mm) by 0.05 in. (1.3 mm).

B. Engraved Nameplates and Signs

1. Manufacturer's Standard Products: Where more than one type is listed or specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, or as specified elsewhere.
2. Engraved stock, melamine plastic laminate, 1/16 in. (1.6 mm) minimum thick for signs up to 20 sq in. (129 sq cm), 1/8 in. (3.2 mm) thick for larger sizes.
3. Engraved Legend: Black letters on white face.
4. Punched for mechanical fasteners.
5. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 in. (6.4 mm) grommets in corners for mounting.

6. Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 in. (1 mm), galvanized steel backing, with colors, legend, and size appropriate to application. 1/4 in. (6.4 mm) grommets in corners for mounting.
7. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

C. Miscellaneous Identification Products

1. Cable Ties: Fungus-inert, self-extinguishing, 1 piece, self-locking, Type 6/6 nylon cable ties with following features:
   a. Minimum Width: 3/16 in. (5 mm).
   b. Tensile Strength: 50 lb (22.3 kg) minimum.
   c. Temperature Range: Minus 40 to 185°F (Minus 4 to 85°C).
   d. Color: As indicated where used for color coding.
2. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

2.5 GROUNDING

A. Grounding and Bonding Products

1. Governing Requirements: Where types, sizes, ratings, and quantities are in excess of NEC requirements, more stringent requirements and greater size, rating, and quantity indications govern.

B. Wire and Cable Grounding Connectors

1. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
   a. Material: Copper.
2. Equipment Grounding Conductors: Insulated with green color insulation.
3. Grounding-Electrode Conductors: Stranded cable.
4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
5. Bare Copper Conductors:
   a. Solid Conductors: ASTM B3.
   b. Assembly of Stranded Conductors: ASTM B8.
   c. Tinned Conductors: ASTM B33.

C. Miscellaneous Conductors

1. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
2. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.
3. Bonding Straps: Soft copper, 0.05 in. (1 mm) thick and 2 in. (50 mm) wide, except as indicated.

D. Connector Products

1. Pressure Connectors: High-conductivity-plated units.

2. Bolted Clamps: Heavy-duty type.
3. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

E. Grounding Electrodes and Test Wells

1. Grounding Rods: Copper-clad steel.
   a. Size: 3/4 in. by 120 in. (19 by 3000 mm).
2. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 in (3 mm) thick, size as indicated.
3. Test Wells: Fabricate from 15 in. (400 mm) long, square-cut sections of 8 in. (200 mm) diameter, Schedule 80, PVC pipe or as detailed on Drawings.

2.6 WIRING DEVICES

A. Manufacturers

1. Wiring Devices:
   a. Bryant Electric, Inc.
   b. GE Company; GE Wiring Devices.
   c. Hubbell, Inc.; Wiring Devices Div.
   d. Killark Electric Manufacturing Co.
   e. Pass & Seymour/Legrand; Wiring Devices Div.
   f. Pyle-National, Inc.; an Amphenol Co.
2. Wiring Devices for Hazardous (Classified) Locations:
   a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.
   b. Killark Electric Manufacturing Co.
   c. Pyle-National, Inc.; an Amphenol Co.
3. Poke through, Floor Service Outlets and Telephone/Power Poles:
   a. Hubbell, Inc.; Wiring Devices Div.
   b. Pass & Seymour/Legrand; Wiring Devices Div.
   c. Square D Co.
   d. Wiremold.

B. Receptacles

1. Straight Blade and Locking Receptacles: Heavy Duty specification grade.
2. GFCI Receptacles: Termination type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle. Design units for installation in 2-3/4 in. (70 mm) deep outlet box without an adapter.
3. Isolated Ground Receptacles: Equipment grounding contacts connected only to green grounding screw terminal of device with inherent electrical isolation from mounting strap.
   a. Devices: Listed and labeled as isolated ground receptacles.
   b. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
4. Industrial Heavy Duty Receptacles: Comply with IEC 309-1.
5. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

a. Appleton or Crouse-Hinds with NEMA 5-20R.
b. Plugs: Match receptacles. Furnish 1 plug for each receptacle installed.
    1) Color: White unless otherwise indicated or required by Code.

C. Pendant Cord/Connector Devices

1. Matching, locking type, plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy Duty grade.
    a. Body: Nylon with screw open cable gripping jaws and provision for attaching external cable grip.
    b. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

D. Cord and Plug Sets

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
    a. Cord: Rubber insulated, stranded copper conductors, with type SOW-A jacket. Green insulated grounding conductor, and equipment rating ampacity plus minimum of 30%.
    b. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

E. Switches

1. Snap Switches: Heavy duty: quiet type.
2. Snap Switches in Hazardous (Classified) Locations:
    a. Appleton EFS series, Crouse-Hinds EDS series.
    b. Comply with UL Standard 894.
3. Color: White unless otherwise indicated or required by Code.

F. Wall Plates

1. Single and combination types match corresponding wiring devices.
    a. Plate Securing Screws: Metal with head color to match plate finish.
    b. Finished Spaces: 0.04 in. (1 mm) thick, Type 302, satin finished stainless steel.
    c. Unfinished Spaces: Galvanized steel.
    d. Exterior and wet locations: Weatherproof plates and covers.

2.7 SUPPORTING DEVICES

A. Materials

1. Stainless Steel.

B. Manufactured Supporting Devices

1. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
2. Fasteners: Types, materials, and construction to match support materials listed above.

3. Modular Mechanical Conduit Seals: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
4. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for unarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.
5. U-Channel Systems: Channels, with 9/16-in. dia holes, at minimum of 8 in. on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

C. Fabricated Supporting Devices

1. Shop- or field-fabricate supports or manufacture supports assembled from U-channel components.
2. Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
3. Pipe Sleeves: Provide pipe sleeves of one of following:
   a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from following gage metal for sleeve diameter noted:
      1) 3 in. and smaller: 20 ga.
      2) 4 in. to 6 in.: 16 ga.
      3) Over 6 in.: 14 ga.
   b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
   c. Plastic Pipe: Fabricate from Schedule 40 galvanized steel pipe.

D. Fire Resistant Joint Sealers

1. Manufacturers:
   a. “Dow Corning Fire Stop Foam,” Dow Corning Corp.
   b. “Pensil 851,” General Electric Co.
   c. Or Equal.
2. Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
3. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.8 CABINETS, BOXES, AND FITTINGS

A. General

1. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for use and location. Provide items complete with covers and accessories required for intended use. Provide gaskets for units in damp or wet locations.

B. Miscellaneous Materials and Finishes

1. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
2. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
3. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.
4. Finishes:
   a. Exterior Finish: Galvanized or Gray baked enamel for items exposed in finished locations except as otherwise indicated.
   b. Interior Finish: Where indicated, white baked enamel.
5. Fastener Style:
   a. Stainless steel door clamp assembly (Hoffman SS6LP series, Weigmann SSN4 series of equal) for stainless steel boxes. Screw-down clamps are not acceptable.
   b. Snap-hinge covers or quarter turn semi-flush oil tight latch for non-metallic boxes.
   c. External quick-release or quarter turn semi-flush oil tight latches for galvanized boxes.
   d. Spring loaded, triple-thread, captive hex-head bolts for cast metal boxes.

C. Metal Outlet, Device, and Small Wiring Box

1. General:
   a. Conform to UL 514A and UL 514B.
   b. Boxes shall be of type, shape, size, and depth to suit each location and application.
2. Steel Boxes: Conform to NEMA OS 1. Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.
3. Galvanized Cast-Iron Boxes: Iron alloy, waterproof, with threaded raceway entries and features and accessories suitable for each location, including mounting ears, threaded screw holes for devices and closure plugs.

D. Pull and Junction Boxes

1. General: Comply with UL 50 for boxes over 100 cu in. volume. Unless otherwise noted, boxes shall have continuous hinge on one side with fastening mechanism on the opposite side. Cover and fasteners shall be of material same as box and shall be of size and shape to suit application.
2. Galvanized Steel Boxes: Flat rolled, code gauge, sheet steel with welded seams. Where necessary to provide rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

3. Stainless-Steel Boxes: Fabricate of stainless steel conforming to Type 316 of ASTM A167. Where necessary to provide rigid assembly, construct with internal structural stainless steel bracing. Cover shall be gasketed.
4. Galvanized Cast-Iron Boxes: Molded of cast iron alloy with gasketed cover and integral threaded conduit entrances.
5. Boxes Approved for Classified Locations: Cast metal boxes conforming to UL 886 listed and labeled for use in specific location classification, and with specific hazardous material encountered. Conduit entrances shall be integral threaded type. Provide flat cover with multiple hinges and stainless steel, spring loaded, triple-thread, captive hex-head bolts.

E. Terminal Strips for Junction Boxes

1. Manufacturers:
   a. Square D Co.
   b. Buchanan.
   c. Or Equal.
2. Channel mount snap-on type.
3. Individual gangable with nylon bases.
4. Solderless box lug type rated at 600 v to accommodate No. 22 to 8 AWG wire or as otherwise indicated.
5. Provide 50% spare terminals.

2.9 LIGHTNING PROTECTION

A. Acceptable Manufacturers

1. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

B. Materials

1. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:
   a. Conductors –Copper.
   b. Air Terminals –Copper.
2. All materials furnished for the lightning protection system shall bear the inspection label of UL.
3. Class I materials shall be used on structures that do not exceed 75 feet in height and Class II materials shall be used on structures that are 75 feet or higher above average grade.
4. Copper materials shall not be mounted on aluminum surfaces including Galvalume, galvanized steel and zinc; this includes these materials that have been painted.
5. Aluminum materials shall not come into contact with earth or where rapid deterioration is possible. Aluminum materials shall not come into contact with copper surfaces.

C. Air Terminals

1. Air terminals shall project a minimum of ten inches above the object or area it is to protect and shall be located at intervals not exceeding 20'-0" along ridges and along the perimeter of flat or gently sloping roofs (flat or gently sloping roofs include roofs that have a pitch less than 3:12). Flat or gently sloping roofs exceeding 50'-0" in width shall be protected with additional air terminals located at intervals not exceeding 50'-0". Air terminals shall be located within two feet of roof edges and outside corners of protected areas.
2. Air terminals shall be installed on stacks, flues, mechanical units and other metallic objects not located within a zone of protection and which have an exposed metal thickness less than 3/16 of an inch. Objects having an exposed metal thickness 3/16 of an inch or greater shall be connected to the lightning protection system as required by the specific standards using main size conductor and bonding plates having a minimum of three square inches of surface contact area.
3. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards including the use of adhesive that is compatible with the surface it is to be used on or stainless steel fasteners.
4. Main conductors shall be sized in accordance with the specified standards for Class I or Class II structures and shall provide a two way horizontal or downward path from each air terminal to connection with the ground system. Conductors shall be free of excessive splices and no bend of a conductor shall form a final included angle of less than neither 90 degrees nor have a radius of bend less than eight inches.
5. Down conductors shall be sized in accordance with specified standards and in no case shall be smaller than the main roof conductor. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than two down conductors. Where down conductors are installed exposed on the exterior of a structure and are subject to physical damage or displacement, guards shall be used to protect the conductor a minimum of six feet above grade. Metallic guards shall be bonded at each end.

D. Roof Penetrations

1. Roof penetrations required for down conductors shall be made using thru-roof assemblies with solid riser bars and appropriate roof flashing. Conductors shall not pass directly through roof.

E.Ground Terminations

1. The down conductor shall be connected to the ground electrode using an exothermically welded connection.

PART 3 - EXECUTION:

3.1 RACEWAYS

A. Examination

1. Examine surfaces to receive raceways, wireways, and fittings for compliance with installation tolerances and other conditions affecting performance of raceway system.

2. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.
3. Install conduit identification tags as shown on Drawings.

B. Wiring Methods

1. Outdoors, Damp or Wet Locations: Use following wiring methods unless otherwise noted on Drawings:
   a. Outdoor Exposed: PVC-Coated galvanized rigid steel.
   b. Concealed: Galvanized rigid steel.
   c. Underground Power and Control, Single Run: Rigid nonmetallic (PVC) conduit.
      1) Concrete encased except as otherwise noted on Drawings.
   d. Underground Power and Control, Grouped: Rigid nonmetallic (PVC) conduit.
      1) Concrete encased except as otherwise noted on Drawings.
   e. Underground Shielded Instrumentation Cables and Shielded Instrumentation Cables run in concrete slabs, Single Run or Grouped: Galvanized rigid steel.
      1) Concrete encased except as otherwise noted on Drawings.
   f. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.
2. Indoor Non-Hazardous Dry Locations: Use following wiring methods unless otherwise noted.
   a. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit.
   b. Exposed: Galvanized rigid steel conduit.
      1) Hazardous classified locations: Use the following wiring methods unless otherwise noted on drawings.
      2) Exposed and concealed: PVC-Coated Galvanized rigid steel conduit.
      3) Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Stainless steel explosion proof flexible conduit.
3. Use 3/4 in. minimum size unless otherwise noted except conduit runs to room light switches may be 1/2 in.
4. Unless specifically indicated otherwise on Drawings or in Specifications, use galvanized rigid steel conduit for general wiring.
5. Encase galvanized rigid steel conduits installed underground or underfloor in at least 3 in. of concrete. PVC conduit may be used without encasing in concrete for underfloor conduit or where specifically indicated on Drawings.
   a. Underground conduit shall be minimum of 1 in., buried at depth of not less than 30 in. below grade.
   b. Provide conduits or ducts terminating below grade with means to prevent entry of dirt and moisture.
   c. When using concrete encased PVC conduit provide PVC coated galvanized rigid steel elbows.
6. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1 in. (25 mm) concrete cover.

a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
b. Space raceways laterally to prevent voids in concrete.
c. Run conduit larger than 1 in. trade size parallel to or at right angles to main reinforcement and spaced on center of at least 3 times conduit trade dia. with minimum 2 in. concrete covering. Conduits over 1 in. may not be installed in slab without approval of Engineer, unless shown on drawings otherwise.
    1) When at right angles to reinforcement, place conduit close to slab support.
    2) Conduits embedded in concrete frame shall comply with applicable provisions of ACI 318.

C. Installation

1. Conceal raceways by enclosing within finished walls, ceilings, and floors, unless otherwise indicated.
2. Provide watertight conduit system where installed in wet places, underground or where buried in masonry or concrete.
    a. Use threaded hubs when entering top of enclosures.
    b. Use sealing type locknuts when entering sides or bottom of enclosures.
3. Install two spare 1 in. conduits from top of each flush mounted panelboard to area above ceiling for future use. On flush mounted panelboards located on first and higher level floors, provide two spare 1 in. conduits from bottom of panelboard to ceiling area of floor below for future use.
4. Keep raceways at least 6 in. (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
5. Install raceways level and square and at proper elevations. Provide adequate headroom.
6. Complete raceway installation before starting conductor installation.
7. Support raceway as specified in Section 26 00 03-2.06.
8. Use temporary closures to prevent foreign matter from entering raceway.
9. Run concealed raceways with minimum of bends in shortest practical distance considering type of building construction and obstructions, except as otherwise indicated.
10. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow surface contours as much as practical.
    a. Mount exposed horizontal runs as high above floor as possible, and in no case lower than 7 ft above floors, walkways, or platforms in passage areas.
    b. Run parallel or banked raceways together, on common supports where practical.
    c. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.
11. Join raceways with fittings designed and approved for purpose and make joints tight.
    a. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
    b. Use insulating bushings to protect conductors.

12. Terminations: Where raceways are terminated with locknuts and bushings, align raceway to enter squarely, and install the locknuts with dished part against the box. Use two locknuts, one inside and one outside the box. Use insulating bushings. Provide insulated grounding bushings to terminate ground wire.
13. Where terminations in threaded hubs, screw raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to box, and tighten chase nipple so no threads are exposed.
14. Install pull wires in empty raceways. Use monofilament plastic line having not less than 200 lb (90 kg) tensile strength. Leave not less than 12 in. (300 mm) of slack at each end of pull wire.
15. Telephone and Signal System Raceways 2 in. Trade Size and Smaller: In addition to above requirements, install in maximum lengths of 150 ft (45 m) and with maximum of two 90° bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
16. PVC Externally Coated Galvanized Rigid Steel Conduit: Use only fittings approved for use with that material. Patch nicks and scrapes in PVC coating after installing conduit.

D. Conduit Stub-Ups

1. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above finished slab.
2. Transition under floor conduit to PVC coated galvanized rigid steel conduit before rising above floor. Under floor conduit elbows shall be PVC coated galvanized rigid steel conduit. Extend the PVC coated galvanized rigid steel conduit portion of the stub-up minimum 12 inch above floor or slab.

E. Conduit Bends

1. Make bends and offsets so inside diameter is not reduced. Unless otherwise indicated, keep legs of bend in same plane and straight legs of offsets parallel.
2. Provide NEMA standard conduit bends, except for conduits containing medium voltage cable, fiber optic cable, or conductors requiring large radius bends.

F. Flexible Connections

1. Use maximum of 6 ft (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures.
2. Terminate conduits at motor terminal boxes, motor operated valve stations or pipe-mounted instruments and other equipment subject to vibration with maximum of 3 ft (915 mm) liquidtight flexible metal conduit unless otherwise indicated.
3. Use liquidtight flexible conduit in wet or damp locations.
4. Use approved flexible connections in hazardous locations.
5. Install separate ground conductor inside flexible conduit connections.

G. Fittings

1. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. Install raceway sealing fittings at following points and elsewhere as indicated:
   a. Where conduits enter or leave hazardous locations.
   b. Where conduits pass from warm locations to cold locations, such as boundaries of refrigerated spaces and air-conditioned spaces.
   c. Where otherwise required by NEC.
2. Use raceway fittings compatible with raceway and suitable for use and location. For GRS, use threaded galvanized rigid steel conduit fittings, except as otherwise indicated.
3. Install automatic breather drain fittings according to manufacturer's written instructions. Locate fittings to drain conduit system and prevent condensate from entering device enclosures. Install automatic breather drain fittings at following points and elsewhere as indicated.
   a. Where vertical seals are installed.
   b. Low points in conduit system.
   c. Below filed instrumentation at junction boxes of flexible and rigid conduit.
   d. Where otherwise required by NEC.
4. Install wall entrance seal as dictated by application where conduits pass through foundation walls below grade.
5. Install conduit expansion fittings complete with bonding jumper in following locations.
   a. Conduit runs crossing structural expansion joints.
   b. Conduit runs attached to 2 separate structures.
   c. Conduit runs where movement perpendicular to axis of conduit may be encountered.
6. Where conduit passes from inside of building to outdoors, it shall be firmly packed at fitting nearest wall line with Johns-Manville Duxseal to depth of at least 1 in. after wires and cables are pulled in; or, if conduit enters directly into equipment, it shall be fitted with seal and drain fitting to prevent water entering equipment.

H. Grounding

1. Ground in accordance with Section 26 00 03-2.4.
2. Provide grounding connectors for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.

I. Protection

1. Provide final protection and maintain conditions, in manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.
   a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

b. Repair damage to PVC or paint finishes with matching touch-up coating recommended by manufacturer.

J. Cleaning

1. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.2 ELECTRICAL IDENTIFICATION

A. Installation

1. Install as indicated where used for color coding.
2. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
3. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.
4. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
5. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.
6. Install painted identification as follows:
   a. Clean surfaces of dust, loose material, and oily films before painting.
   b. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
   c. Apply one intermediate and one finish coat of silicone alkyd enamel.
   d. Apply primer and finish materials according to manufacturer's instructions.
7. Identify Raceway Systems containing power, control and instrumentation conductors with adhesive labels. Locate labels at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.5 m) in congested areas. Labels shall be color coded and identify the contents (i.e. orange label with black print reading 480V FEEDER – ID #P001)
8. Identify Raceways and Exposed Cables of Certain Systems with Color Banding: Band exposed and accessible raceways of systems listed below for identification.
   a. Fire Alarm Systems: Red.
   b. Combined Fire Alarm and Security System: Red and blue.
   c. Security System: Blue and yellow.
   d. Telecommunications System: Green and yellow.
9. Install Circuit Identification Labels on Boxes: Label externally as follows:
   a. Exposed Boxes: Pressure sensitive, self-adhesive plastic label on cover.
   b. Concealed Boxes: Plasticized card stock tags.
   c. Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.

10. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 in. (150 to 200 mm) below finished grade. Where multiple lines installed in common trench or concrete envelope provide multiple underground line warning tapes, one for each 16 inches of width of lines. If lines do not exceed an overall width of 16 in. (400 mm), use single line marker.
    a. Install line marker for underground wiring, both direct buried and in raceway.
11. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.
    a. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than No. 10 AWG.
        1) Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 in. (150 mm) from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 in. (25 mm) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
        2) Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 in. (76 mm) from terminal and spaced 3 in. (76 mm) apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.
    b. 208/120-V Systems: As follows:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
        4) Neutral: White.
        5) Ground: Green.
    c. 480/277-V Systems: As follows:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
        4) Neutral: Grey (comply with NEC exhibit 200.3).
        5) Ground: Green.
    d. 4.16/2.4-kV Systems: As follows:
        1) Phase A: Brown, one stripe.
        2) Phase B: Orange, two stripes.
        3) Phase C: Yellow, three stripes.
        4) Neutral: White
        5) Ground: Green
12. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, and switchboard rooms.
    a. Legend: 1/4 in. (6.4 mm) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
    b. Fasten tags with nylon cable ties; fasten bands using integral ears.
13. Apply identification to conductors as follows:
    a. Conductors to Be Extended in Future: Indicate source and circuit numbers.

b. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
c. Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.

14. Apply warning, caution, and instruction signs and stencils as follows:
    a. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
    b. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 in. (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.
15. Install identification as follows:
    a. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2 in. (13 mm) high lettering on 1-1/2 in. (38 mm) high label; where 2 lines of text are required, use lettering 2 in. (51 mm) high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.
        1) Panelboards, electrical cabinets, and enclosures.
        2) Access doors and panels for concealed electrical items.
        3) Electrical switchgear.
        4) Motor control centers.
        5) Push button stations.
        6) Power transfer equipment.
        7) Transformers.
        8) Power generating units.
        9) Telephone switching equipment.
        10) Fire alarm master station or control panel.
        11) Security monitoring or control panel.
    b. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.3 CONDUCTORS AND CABLES

A. Installation

1. Install wires and cables as indicated, in accordance with NEC, according to manufacturer's written instructions and NECA "Standard of Installation".

2. Run wire and cable in conduit unless otherwise indicated on Drawings. Pull conductors into raceway simultaneously where more than 1 is being installed in same raceway.
   a. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.
   b. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
   c. Do not draw conductor into conduits until building is enclosed, watertight, and work causing cable damage has been completed.
3. Install cable supports for vertical feeders in accordance with NEC.Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.
4. For panelboards, cabinets, switches, and equipment assemblies, neatly form, train, and tie cables in individual circuits.
5. Seal cable and wire entering building from underground between wire and conduit, where cable exits conduit, with non-hardening approved compound.
6. Install wire and cables in separate raceway systems as follows:
   a. Exit lights.
   b. Shielded Instrumentation
   c. Telephone cables.
   d. Fire Alarm System.
   e. As required by NEC.
7. Where control or instrumentation cables are run in underground conduit and ducts provide multi-wire cable assemblies.
8. Where power cables and instrument/signal cables enter and pass through same or distribution box, steel barrier or separate raceways shall continue through box to avoid magnetic interaction between power cables and instrumentation conductors.
9. Do not run instrumentation cables into control cabinets or MCC unless cables are terminated in cabinet or MCC.
10. Wiring at Outlets: Install with at least 12 in. (300 mm) of slack conductor at each outlet.
11. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL 486A.
12. Drawings do designate number of conductors in conduit. CONTRACTOR is responsible for verifying number of conductors in conduit prior to installation. Location of branch circuits and switch legs indicated on Drawings may be routed differently as dictated by construction and these Specifications.

B.Terminations and Splices

1. Terminate control, instrumentation, and communication cables on terminal strips in separate terminal cabinets located near conduit entrances of buildings or as shown on Drawings.

2. Power Cable Splices:
   a. Provide continuous lengths of cable without splices in motor circuits and feeders unless otherwise noted. Splices may be installed in motor circuits and feeders with prior approval by Engineer.
   b. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
   c. Use splice and tap connectors that are compatible with conductor material.
      1) Where pre-insulated spring connectors are used for equipment connections, tape connector to wire to prevent loosening under vibration.
      2) Each tap, joint or splice in conductors No. 8 AWG and larger shall be taped with two half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape where required by code.
      3) Cable splices shall be made only in distribution boxes and junction boxes.
3. Power Cable Terminations:
   a. Termination of wires with full compression type lugs installed with appropriate hand or hydraulic tool. Use proper dies to achieve the desired compression.
   b. For screw type terminal blocks, terminations for stranded conductors shall be made with T & B lock-on fork connector with insulated sleeves.
   c. Motor lead conductor terminations shall be made with a T & B or approved equal, full compression lug, full ring type, bolted, and taped as required. For connecting motor lead to service wiring fasten full ring lugs together with cadmium plated steel cap screws, and cover with a minimum of 2 layers 1/2 lap, M Scotch No. 33 tape; option: T & B "Motor Stub Splice Insulator".

C. Control Circuits

1. Control circuit wiring from same area for the same system returning to same panel, (e.g., LCP, DPC, etc.,) may be combined provided signal and voltage types are not mixed.
2. Following types of wiring shall not be combined with other types:
   a. 4-20 ma dc analog; shielded cable.
   b. 24 vdc discrete (e.g., field or panel powered dry contacts).

D. Branch Circuits

1. Motor branch circuits and branch circuits for 3 phase circuits shall not be combined.
2. Branch circuits for single phase equipment devices from same lighting panel or power panel may be combined provided that such combining does not result in having to derate ampacity of conductors.

E. Feeders

1. Extend feeders at full capacity from origin to termination.
2. Each conduit raceway shall contain only those conductors constituting single feeder circuit.
3. Where multiple raceways are used for single feeder, each raceway shall contain conductor of each phase and neutral if used.
4. Where feeder conductors run in parallel, conductors shall be of same length, material, circular-mil area, insulation type, and terminated in same manner.

5. Where parallel feeder conductors run in separate raceways, raceways shall have same physical characteristics.
6. Confine feeders to insulated portions of building unless otherwise shown.
7. On network systems, neutral shall be run with phase wires. Unbalanced neutral current shall not exceed normal or derated conductor capacity.

F. Motor and Equipment Wiring

1. Provide motor circuits in accordance with diagrams and schedules on Drawings and code requirements, from source of supply to associated motor starter and starter to motor terminal box, including necessary and required intermediate connections.
2. Do not include associated control conductors in same conduit with power conductors.
3. Provide branch circuits to conform with NEC requirements and nameplate ratings. CONTRACTOR responsible for verification of ratings of motors and installing proper branch circuits.

G. Color Coding

1. Conductors for Lighting and Power wiring:

Phase	208/120 V	480/277 V
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Travelers	Pink	Purple
Neutral	White	Grey
Ground	Green	Green

2. Colored pressure-sensitive plastic tape.
   a. Apply in half overlapping turns for minimum of three inches at terminal points, and in junction boxes, pull boxes, and troughs.
   b. 3/4 in. wide with colors as specified.
   c. Apply last two laps of tape with no tension to prevent possible unwinding.
   d. Where cabling markings are covered by tape, apply tags to cable starting size and insulation type.
3. Color code for insulated power system wiring shall be in accordance with NEC.
4. Color code for intrinsically safe systems shall be light blue.

H. Control, Communication and Signal System Identification

1. Install permanent wire marker at termination.
2. Identifying numbers and letters on wire markers shall correspond to those on terminal blocks or wiring diagrams used for installing systems.
3. Plastic sleeve or self-adhesive vinyl cloth.

I. Feeder Identification

1. Pullboxes and junction boxes, install metal tags on circuit cables and wires to clearly designate circuit identification and voltage.

J. Field Quality Control

1. Visual and Mechanical Inspection:

    a. Inspect cables for physical damage, proper connection and tagging in accordance with single-line diagram and schematics.
    b. Test cable mechanical connections to manufacturer's recommended values using calibrated torque wrench.
    c. Check cable color coding with specifications and NEC standards.
2. Electrical Tests:
    a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 min.
    b. Perform continuity test to insure proper cable connection.
3. Test Values:
    a. Evaluation results by comparison with cables of same length and type. Investigate any value less than 50 megohms.

3.4 GROUNDING

A. Application

1. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
    a. Install equipment grounding conductor with circuit conductors for items below in addition to those required by Code:
        1) Feeders and branch circuits.
        2) Lighting circuits.
        3) Receptacle circuits.
        4) Singe-phase motor or appliance branch circuits.
        5) Three-phase motor or appliance branch circuits.
    b. Isolated Grounding-Receptacle Circuits: Install separate insulated equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding-conductor terminal of applicable derived system or service, except as otherwise indicated.
    c. Isolated Equipment Enclosure Circuits: For designated equipment supplied by branch circuit or feeder, isolate equipment enclosure from supply raceway with nonmetallic raceway fitting listed for purpose. Install fitting where raceway enters enclosure, and install separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding-conductor terminal of applicable derived system or service, except as otherwise indicated.
2. Signal and Communications Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
    a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on 1/4 by 2 by 12 in. (6 by 50 by 300 mm) grounding bus.

b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-30.
4. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.
5. Piping Systems and Other Equipment: Comply with NEC Article 250 for bonding requirements.

B. Installation

1. Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
2. Grounding Rods: Locate minimum of 1 rod length from each other and at least same distance from any other grounding electrode.
   a. Drive until tops are 2 in. (50 mm) below finished floor or final grade, except as otherwise indicated.
   b. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
3. Grounding Conductors: Route along shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
4. Underground Grounding Conductors: Use bare tinned copper wire. Bury at least 24 in. (600 mm) below grade.
5. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.
6. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.
7. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
8. Test Wells: One for each driven grounding electrode system, except as otherwise indicated. Set top of well flush with finished grade or floor. Fill with 1 in. 25 mm) maximum-size crushed stone or gravel.

C. Connections

1. Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

a. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.
c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

2. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
3. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
4. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
5. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.
6. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
7. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make visible indication that connector has been adequately compressed on grounding conductor.
8. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

D. Underground Distribution System Grounding

1. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substation by connecting them to underground cable and grounding electrodes.

E. Field Quality Control

1. Test in accordance with NETA ATS.
2. Testing Agency: Provide services of qualified independent testing agency to perform specified acceptance testing.

3. Testing: Upon completion of installation of ground-fault protection system and after electrical circuits have been energized, demonstrate capability and compliance with requirements.
   a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

F. Restoration

1. Restore surface features, including vegetation, at areas disturbed by work of this Section.
   a. Re-establish original grades, except as otherwise indicated.
   b. Where sod has been removed, replace it as soon as possible after backfilling is completed.
   c. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition.
   d. Include topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
   e. Maintain restored surfaces.
   f. Restore disturbed paving.

3.5 WIRING DEVICES

A. Installation

1. Mounting height as follows unless otherwise shown on Drawings:
   a. Switches: 48 in. above floor.
   b. AC Receptacles and Telephone Outlets: 15 in. above floor or 6 in. above counters, counter back-splashes, and baseboard radiators in finished areas; 48 in. above floor in unfinished areas.
2. Install devices and assemblies plumb and secure.
3. Install wall plates when painting is complete.
4. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
5. Protect devices and assemblies during painting.

B. Identification

1. Comply with Section 26 00 03-2.3.
   a. Switches: Identify each switch with approved legend engraved on wall plate and identify panel board circuit number that it controls/is powered from.
   b. Receptacles: Identify panelboard and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

C. Connections

1. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

2. Isolated Ground Receptacles: Connect to isolated ground conductor routed to designated isolated equipment ground terminal of electrical system.
3. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A.

D. Field Quality Control

1. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
3. Replace damaged or defective components.

E.Cleaning

1. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

3.6 SUPPORTING DEVICES

A. Installation

1. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.
2. Coordinate with structural system and with other electrical installation.
3. Raceway Supports: Comply with NEC and following requirements:
   a. Conform to manufacturer's recommendations for selection and installation of supports.
   b. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least four. Where this determination results in safety allowance of less than 200 lbs, provide additional strength until there is minimum of 200 lbs safety allowance in strength of each support.
   c. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
   d. Support parallel runs of horizontal raceways together on trapeze-type hangers.
   e. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 in. and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 in. dia or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
   f. In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.
4. Vertical Conductor Supports: Install simultaneously with installation of conductors.

5. Miscellaneous Supports: Support miscellaneous electrical components as required to produce same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
6. Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.
7. Conduit Seals: Install seals for conduit penetrations of slabs below grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
8. Conduit extending through roof shall pass through ceiling box at roof line.
   a. Provide 14 ga minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.
   b. Install conduit and pitch pocket in advance of roofing work.
9. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:
   a. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
   b. Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.
   c. Load applied to any fastener shall not exceed 25% of proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

3.7 CABINETS, BOXES AND FITTINGS

A. Installation, General

1. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
2. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
3. Support and fasten items in accordance with Section 26 00 03-2.6.
4. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated
5. Remove sharp edges where they may come in contact with wiring or personnel.

B. Applications

1. Hinged Door Enclosures: Sheet steel, baked enamel finish, NEMA type 12 enclosure except as indicated.

2. Hinged Door Enclosures in Corrosive Locations: NEMA type 4X stainless steel metal enclosure, or as indicated on Drawings.
3. Outlet Boxes and Fittings: Install outlet and device boxes and associated covers and fittings of materials and NEMA types for each location in conformance with following requirements unless otherwise noted:
   a. Interior Dry Locations: Install outlet and device boxes and associated covers and fittings of materials and NEMA types for each location in conformance with following requirements unless otherwise noted:
   b. Locations Exposed to Weather or Dampness: Galvanized, cast metal, NEMA Type 3R.
   c. Wet Locations: Stainless Steel, NEMA type 4X enclosures.
   d. Corrosive Locations: Stainless Steel, NEMA type 4X enclosures.
   e. Hazardous (Classified) Locations: NEMA type listed and labeled for location and class of hazard indicated.
4. Pull and Junction Boxes:
   a. Interior Dry Locations: Sheet steel, NEMA type 1 for flush mounting and feraloy Type FS or FD cast boxes with threaded conduit hubs for surface mounting.
   b. Locations Exposed to Weather or Dampness: Stainless Steel, NEMA type 4X enclosures.
   c. Wet Locations: Stainless Steel, NEMA type 4X enclosures.
   d. Corrosive Locations: Stainless Steel, NEMA type 4X enclosures.
   e. Hazardous (Classified) Locations: NEMA type listed and labeled for location and class of hazard indicated.

C. Installation of Outlet Boxes

1. Outlets at Windows and Doors: Locate close to window or door trim.
2. Column and Pilaster Locations: Locate outlet boxes for switches and receptacles on columns or pilasters so centers of columns are clear for future installation of partitions.
3. Locations in Special Finish Materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block, marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install boxes without plaster rings. Saw cut recesses for outlet boxes in exposed masonry walls.
4. Gasketed Boxes: At following locations use cast metal, threaded hub type boxes with gasketed weatherproof covers:
   a. Exterior Locations.
   b. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).
   c. Where exposed to moisture laden atmosphere.
   d. Where indicated.
5. Mounting: Mount outlet boxes for switches with long axis vertical or as indicated. Mount boxes for receptacles vertically. Gang boxes shall be mounted with long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on side opposite hinges and close to door trim, even though electrical floor plans may show them on hinge side.

6. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 in. sq by 1-1/2 in. deep, minimum with raised plaster or tile cover. Provide 3/8 in. fixture stud.
7. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.
8. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.
9. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6 in. depth.
10. Secure boxes rigidly to substrate upon which being mounted or solidly embed boxes in concrete or masonry. Do not support from conduit, mechanical ductwork or piping.
11. Set boxes in concealed conduit runs, flush with wall surfaces, with or without covers as required.
12. Do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall minimum 12 in.
13. Set outlet boxes parallel to construction, securely mounted and adjusted to set true and flush with finished surface.
14. Do not burn holes, use knockout punches or saw.
15. Provide outlet box divider barriers between 277/480 V and 120/240 V devices as required and per NEC.
16. Where emergency switches occur adjacent to normal light switches, install in separate boxes in accordance with NEC and device plate color coding separation.

D. Outlet Box Locations

1. Locate flush mounted wall boxes in corner of nearest brick or block to keep cutting to minimum.
2. Location of outlets and equipment as shown on Drawings is approximate and exact location to be verified and shall be determined by:
   a. Construction or code requirement.
   b. Conflict with equipment or other trades.
   c. Equipment manufacturer's drawings.
3. Minor modification in location of outlets and equipment shall not be considered as incidental up to distance of 10 ft with no additional compensation.
4. Mounting heights for devices and equipment to be measured from finished floor to centerline of device and unless otherwise noted on Drawings as follows.
   a. Switches: 48 in. above floor.
   b. AC Receptacles and Telephone Outlets: 15 in. above floor or 6 in. above counters, counter backsplashes, and baseboard radiators in finished areas; 48 in. above floor in unfinished areas.
   c. Wall Bracket Lighting Fixtures: 7'-6" above floor.
   d. Pushbuttons: 48 in. above floor.
   e. Disconnect Switches: 60 in. above floor

E. Installation of Junction Boxes

1. Box Selection: For boxes in main feeder conduit runs, use sizes not smaller than 8 in. sq by 4 in. deep. Do not exceed 6 entering and 6 leaving raceways in single box.

a. Cable Supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 in. inside boxes.
b. Mount pull boxes in inaccessible ceilings with covers flush with finished ceiling.
c. Size: Provide pull and junction boxes for telephone, signal, instrumentation, control, and other systems at least 50% larger than would be required by the NEC for boxes smaller than 24 in. by 24 in., or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

F. Grounding

1. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes grounding conductor, provide grounding terminal in interior of cabinet, box or enclosure.

G. Cleaning and Finish Repair

1. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.
2. Galvanized Finish: Repair damage using zinc-rich paint recommended by manufacturer.
3. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.
4. PVC Coated conduit shall be repaired as specified in conduit section.

3.8 EXCAVATION AND BACKFILL

A. Excavation and backfill for work under this Division shall be provided under this Division in conformance with Division 31.

3.9 CONCRETE

A. Concrete for equipment pads, duct banks, hand holes, manholes and other work under this Division shall be provided under this Division in conformance with Division 03.

3.10 CUTTING AND PATCHING

A. All cutting and patching of building materials required for work under this Division shall be provided under this Division.

B. No structural members shall be removed, cut or otherwise modified without approval of the Engineer and any such work shall be done in a manner as directed by the Engineer.

C. Cutting and patching shall be performed in a neat and workmanlike manner, consistent with the best practices of the appropriate trade. All patching shall be done in a manner consistent with the building material being patched.

D. Holes made in concrete shall be made using a suitable core drill. The use of a star drill or air hammer will not be permitted.

E. In new construction, sleeves, chases, inserts and the like required for work under this Division shall be provided under this Division and the furnishing and placement of these items shall be fully coordinated with the other trades involved so as not to delay the construction.

3.11 LIGHTNING PROTECTION

A. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

B. Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

C. The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

D. Copper lightning protection system components shall not be mounted to aluminum surfaces. Aluminum components shall be used to avoid electrolytic corrosion.

E. Grounded metal bodies within the bonding distance determined by NFPA 780 shall be bonded to the system in accordance with those requirements.

F. Underground metallic piping entering the building shall be bonded to the nearest down conductor or ground electrode.

G. Adhesive used with adhesive air terminal bases and conductor fasteners shall be compatible with roofing membrane. Verify with roofing contractor.

1. Terminals and cables attached to skylights and ventilation equipment must be attached so the panels are not compromised in any way. Fasteners used can only attach through the aluminum.
2. All roof and parapet penetrations must be sealed to insure no leaking.

END OF THIS SECTION

SECTION 26 00 04 - LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes:

1. Basic materials and methods specified herein shall be incorporated in the work wherever applicable unless specifically indicated otherwise.
2. The basic materials and methods specified herein are intended to define a minimum standard of quality and workmanship.
3. Refer to Division 1 for additional requirements.

B. Related Sections:

1. Section 26 00 01 – General Electric Provisions.
2. Section 26 00 03 – Basic Electrical Equipment Materials and Methods.

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump price for the Item, PUMP STATION ELECTRICAL WORK.

1.3 REFERENCES

A. Codes and Standards referred to in this Section are:

1. ANSI C82.2 - Fluorescent lamp ballasts, methods of measurement of.
2. UL 50 - Cabinets and boxes.

1.4 SUBMITTALS

A. Provide shop drawings and product data under provisions of Division 01 33 00 for the following items: Light Fixtures, Lamps, Ballasts, and Emergency Lighting Units, Panelboards, and Lighting Contactors.

1.5 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. Fixtures and Fixture Components

1. Metal Parts: Free from burrs, sharp corners, and edges.
2. Sheet Metal Components: Steel, except as indicated. Form and support to prevent warping and sagging.
3. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.
4. Reflecting Surfaces: Minimum reflectance as follows, except as otherwise indicated:
   a. White Surfaces: 85%.
   b. Specular Surfaces: 83%.
   c. Diffusing Specular Surfaces: 75%.
   d. Laminated Silver Metallized Film: 90%.
5. Lenses, Diffusers, Covers, and Globes: 100% virgin acrylic plastic or water white, annealed crystal glass, except as otherwise indicated.
6. Fixture Support Components: Comply with Section 26 00 02.
   a. Single-Stem Hangers: 1/2 in. (12 mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.
   b. Twin-Stem Hangers: Two, 1/2 in. (12 mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.
   c. Rod Hangers: 3/16 in. (5 mm) minimum diameter, zinc-plated, threaded steel rod.
   d. Hook Hanger: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug..
7. Light-emitting diode (LED) Fixtures: CSA verified, light engines IP 66 rated, luminaire IP 65 rated for non-hazardous locations and Class I, Division 2 rated for hazardous locations.
   a. Class 1 electronic driver with power factor greater than 90%.
   b. Total harmonic distortion less than 20%.

c. Expected life of 100,000 hours.
d. Five year warranty.
e. Rated for -40° C.

8. Exit Signs: Conform to UL 924 and following:
   a. Sign Colors: Conform to local code.
   b. Minimum height of Letters: Conform to local code.
   c. Arrows: Include as indicated.
9. Emergency Lighting Units: Conform to UL 924.
   a. Battery: Sealed, maintenance-free, lead-acid type with minimum 10 yr nominal life and special warranty.
   b. Charger: Minimum 2-rate, fully automatic, solid-state type, with sealed transfer relay.
   c. Operation: Relay automatically turns lamp on when supply circuit voltage drops to 80% of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. Relay disconnects lamps and battery and automatically recharges and floats on trickle charger when normal voltage is restored.
   d. Wire Guard: Where indicated, provide heavy-chrome-plated wire guard arranged to protect lamp heads or fixtures.
   e. Time-Delay Relay: Provide time-delay relay in emergency lighting unit control circuit arranged to hold unit ON for fixed interval after restoration of power after outage. Provide adequate time delay to permit HID lamps to restrike and develop adequate output.

B. Lamps

1. Comply with ANSI C78 series that is applicable to each type of lamp.

C. Finishes

1. Manufacturer's standard, except as otherwise indicated, applied over corrosion-resistant treatment or primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

2.2 LIGHTING CONTACTORS

1. Manufacturer: Square-D Model 8903LXG80V02CR6X2NO or equal.
2. Description: NEMA ICS 2, magnetic lighting contactor, 100% rated.
3. Configuration: Mechanically held.
   a. Coil Voltage: 120 volts, 60 Hertz.
   b. Poles: Eight.
   c. Contact Rating: 30 amperes.
4. Enclosure: ANSI/NEMA ICS 6, Type 11.
5. Accessories:
   a. Selector Switch: ON/OFF/Auto
   b. 2 NO Auxiliary contacts
   c. Pushbuttons and Selector Switches: NEMA ICS 2, general duty type.
6. Lighting Timer:
   a. Tork, Intermatic or equal.

b. Electronic time switch type with astronomical option.
c. 24 hour timer.
d. Manual override.
e. NEMA 1 steel enclosure.
f. 120 VAC contact rating.
g. UL listed.

2.3 REQUEST FOR SUBSTITUTION

A. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

B. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.

C. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

PART 3 - EXECUTION:

3.1 LIGHTING FIXTURES

A. Installation

1. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's written instructions and approved Shop Drawings. Support fixtures according to Section 26 00 02.
2. Supports for Suspended Fixtures: Brace pendants and rods over 48 in. (1200 mm) long to limit swinging. Support stem-mounted, single-unit, suspended fluorescent fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.
3. Identification: Each luminaire shall be provided with a tag detailing the fixture number and which panel circuit the power feed originates.
4. Lamping: Where specific lamp designations are not indicated, lamp units according to manufacturer's instructions.
5. Connections
   a. Ground lighting units. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

6. Field Quality Control
   a. Inspect each installed fixture for damage. Replace damaged fixtures and components.
      1) Verify normal operation of each fixture after fixtures have been installed and circuits have been energized with normal power source.
      2) Give advance notice of dates and times for field tests.
      3) Provide instruments to make and record test results.
      4) Interrupt electrical energy to demonstrate proper operation of emergency lighting installation. Include following information in tests of emergency lighting equipment:
         a) Duration of supply.
         b) Low battery voltage shutdown.
         c) Normal transfer to battery source/retransfer to normal.
         d) Low supply voltage transfer.
         e) Replace or repair malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.
         f) Report results of tests.
   b. Replace fixtures that show evidence or corrosion during Project warranty period.
7. Adjusting and Cleaning
   a. Clean fixtures after installation. Use methods and materials recommended by manufacturer.

END OF THIS SECTIION

SECTION 26 00 05 - MISCELLENEOUS ELECTRICAL EQUIPMENT

PART 1 - GENERAL:

1.1 DESCRIPTION

A. Section includes:

1. Basic materials and methods specified herein shall be incorporated in the work wherever applicable unless specifically indicated otherwise.
2. The basic materials and methods specified herein are intended to define a minimum standard of quality and workmanship.
3. Refer to Division 1 for additional requirements.

B. Related Sections:

1. Division 3 - Concrete.
2. Division 23 – Ventilation
3. Section 26 00 01 – General Electric Provisions.
4. Section 26 00 02 – Electrical Power System Studies
5. Section 26 00 03 – Basic Electrical Equipment Materials and Methods.
6. Section 40 90 05 – SCADA Equipment.
7. Section 43 21 00 – Pumping Equipment: Basic Requirements

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section, unless noted otherwise, shall be included in the Contract lump sum price for the Item, PUMP STATION ELECTRICAL WORK.

B. Payment for work specified under Section 2.6 shall be included in the Contract lump sum price for the Item, FIRE DETECTION PANEL.

C. Payment for work specified under Section 2.7 shall be included in the Contract lump sum price for the Item, AEGIS PANEL.

1.3 REFERENCES

A. Codes and Standards referred to in this Section are:

1. Fed. Spec
2. W-P-115 - Panel, power distribution.
3. NEMA KS1 Enclosed and miscellaneous distribution equipment switches, 600 volt maximum.

1.4 SUBMITTALS

A. Provide shop drawings and product data under provisions of Section 01 33 00 and as specified herein for the following items: Panelboards, Disconnects and Safety Switches, Transformers, Motors, SPD units, Fire Alarm System and AEGIS Intrusion System.

1.5 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Manufacturer's

1. Eaton.
2. Square-D Co.
3. General Electric

B. Panelboard Fabrication

1. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
2. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.
3. Directory Frame: Metal, mounted inside each panelboard door.
4. Bus: Hard drawn copper of 98% conductivity.
5. Main and Neutral Lugs: Copper, Compression type.
6. Equipment Ground Bus: Copper with adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

7. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.
8. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for overcurrent protective device ampere ratings indicated for future installation of devices.
9. Special Features: Include following features for panelboards as indicated:
    a. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
10. Extra Gutter Space: Dimensions and arrangement as indicated.
    a. Subfeed: Overcurrent protective device or lug provision as indicated.
11. Feed-through Lugs: Sized to accommodate feeders indicated.
12. Factory installed nameplate describing technical ratings of panelboard including short circuit current rating. Nameplate to be located outside of the gear on front face of incoming section.

C. Lighting and Appliance Branch Circuit Panelboards

1. Branch Overcurrent Protection Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
2. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, keyed alike.
3. Surge protection device:
    a. Protection modes and UL 1449 third edition clamping voltages coordinated with circuit system and circuit voltage.
    b. Factory mounted with UL listed and labeled mounting device.
    c. 60 kA per phase surge current capacity minimum.
    d. Door mounted diagnostic lights.
    e. Audible alarm, with silencing switch, to indicate when protection has failed. Switch shall be accessible from outside of enclosure and not require door to be opened to access.
    f. Replaceable modular design.
    g. Mounted next to breaker in panelboard.
    h. One form C contact to indicate suppressor is operational.
    i. Minimum of 10 year warranty.

D. Distribution Panelboards

1. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

E. Overcurrent Protective Devices

1. Molded-Case Circuit Breakers: NEMA AB 1, handle lockable.
    a. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.

b. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads, Type HACR for heating, air-conditioning, and refrigerating equipment and Class B GFCI for pipeline and vessel fixed electrical heating equipment unless otherwise indicated.
c. Circuit Breakers, 200A and Larger: Trip units interchangeable within frame size.
d. Circuit Breakers, 400A and Larger: Field-adjustable short-time and continuous current settings.
e. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
f. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
g. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
h. Shunt Trip: Where indicated.

2.2 DISCONNECTS, FUSES, AND CIRCUIT BREAKERS

A. Manufacturers

1. Motor and Circuit Disconnects:
   a. Square D Co.
   b. Eaton.
2. Molded-Case Circuit Breakers:
   a. Square D Co.
   b. Eaton.

B. Enclosed Switches

1. Enclosed Nonfusible Switch: NEMA KS 1, Type HD handle lockable with 3 padlocks.
2. Enclosed Fusible Switch, 800 Amps and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in closed position.
   a. Minimum Fault Current Rating: 10,000 symmetrical rms amperes.

C. Enclosed Circuit Breakers

1. Enclosed Molded-Case Circuit Breaker: NEMA AB 1, handle lockable with 3 padlocks.
2. Characteristics:
   a. Frame size, trip rating, number of poles, and auxiliary devices as indicated.
   b. Interrupting capacity rating to meet available fault current, 22,000 symmetrical rms amps minimum.
   c. Appropriate application listing when used for switching fluorescent lighting loads or heating, air conditioning, and refrigeration equipment.
3. Interchangeable Trips: Circuit breakers, 200 amps and larger, with trip units interchangeable within frame size.
4. Field-Adjustable Trips: Circuit breakers, 400 amps and larger, with adjustable short time and continuous current settings.
5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
6. Current Limiters: let-through ratings less than NEMA FU 1, Class RK-5.

7. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
8. Lugs: Copper, mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
9. Shunt Trip: Where indicated, 120 volts, 60 Hz.
10. Accessories: As indicated on drawings.

D. Safety Switches

1. NEMA heavy duty Type HD. Where indicated, 120 volts, 60 Hz.
2. Dual cover interlock.
3. Visible blades.
4. Provisions for control circuit interlock.
5. Pin type hinges.
6. Tin plated current carrying parts.
7. Quick make and break operator mechanism.
8. Handle attached to box, not cover.
9. Handle position indication, ON in up position and OFF in down position.
10. Padlock provisions for up to 3 padlocks in OFF and ON positions.
11. UL listed lugs for type and size of wire specified.
12. Spring reinforced fuse clips for Class R fuses.
13. Provisions for insulated or groundable neutral.
14. UL listed short circuit rating 200,000 RMS amp with Class R fuses.

E. Three Phase Manual Motor Switch

1. Quick make and break operator mechanism.
2. Padlock provisions in OFF position.
3. NEMA type.

F. Enclosures

1. Enclosure: NEMA AB 1, Type 1, unless specified or required otherwise to meet environmental conditions of installed location.
   a. Outdoor or Other Wet or Damp Indoor Locations: NEMA Type 4X 316 stainless steel.
   b. Hazardous Areas Indicated on Drawings: NEMA Type 7C.

2.3 TRANSFORMERS

A. Manufacturers

1. Eaton.
2. Square D Co.

B. Transformers, General

1. Factory-assembled and -tested, air-cooled units of types specified, designed for 60 Hz service.
2. Cores: Grain-oriented, nonaging silicon steel.
3. Coils: Continuous copper windings without splices, except for taps.

4. Internal Coil Connections: Brazed or pressure type.
5. Enclosure: Class complies with NEMA 250 for environment in which installed.

C. General-Purpose Distribution and Power Transformers

1. Comply with NEMA ST 20 and list and label as complying with UL 1561.
2. Efficiency: Efficiency equal to or greater than that stated in NEMA TP 1, for that type and rating of transformer.
3. Cores: 1 leg per phase.
4. Windings: One coil per phase in primary and secondary.
5. Enclosure: Indoor, ventilated.
6. Insulation Class: 220℃ class 115℃ maximum rise above 40℃ for transformers 15 kVA or smaller; 220℃ class 80℃ maximum rise above 40℃ for transformers larger than 15 kVA.
7. Taps: 220℃ class 115℃ maximum rise above 40℃ for transformers 15 kVA or smaller; 220℃ class 80℃ maximum rise above 40℃ for transformers larger than 15 kVA.
   a. Taps, 3 through 15 kVA: Two 5% taps below rated high voltage.
   b. Taps, 15 through 500 kVA: Six 2.5% taps, 2 above and 4 below rated high voltage.
8. K-Factor Rating: 220℃ class 115℃ maximum rise above 40℃ for transformers 15 kVA or smaller; 220℃ class 80℃ maximum rise above 40℃ for transformers larger than 15 kVA.
   a. Transformer design prevents overheating when carrying full load with harmonic content corresponding to designated K-factor.
   b. Nameplate states designated K-factor of transformer.

D. Finishes

1. Indoor Units: Separate; marked "Shield" for grounding connection.
2. Outdoor Units: Comply with ANSI C57.12.28.

E. Source Quality Control

1. Factory Tests: Design and routine tests comply with referenced standards.

2.4 ELECTRIC MOTORS

A. Manufacturers

1. Siemens.
2. General Electric.
3. Nidec – U.S. Motors.
4. Toshiba.

B.. General

1. Requirements below apply to motors covered by this Section except as otherwise indicated.
2. Motors 1/2 hp and larger: Polyphase.
3. Motors Smaller Than 1/2 hp: Single-Phase.

4. Frequency Rating: 60 Hz.
5. Voltage Rating: Determined by voltage of circuit to which motor is connected for following motor voltage ratings:
   a. 120 V Circuit: 115 V motor rating.
   b. 208 V Circuit: 200 V motor rating.
   c. 240 V Circuit: 230 V motor rating.
   d. 480 V Circuit: 460 V motor rating.
   e. 4160 V Circuit: 4160V motor rating
6. Service factors indicated for motors are minimum values and apply at frequency and utilization voltage at which motor is connected. Provide motors which will not operate in service factor range when supply voltage is within 10% of motor voltage rating.
7. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100% of rated capacity.
8. Temperature Rise: Based on 40°C ambient except as otherwise indicated.
9. Enclosure: Totally Enclosed Fan Cooled (TEFC) unless otherwise indicated in other sections and as required by NEC.
   a. Explosion proof motors approved for specific hazard classifications covered by NEC.
   b. Weather proof motors designed for outdoors and in wet areas.
10. Copper Windings.
11. Winding Insulation Class F.

C. Polyphase Motors

1. Squirrel-cage induction-type conforming to following requirements except as otherwise indicated.
2. NEMA Design Letter Designation: "B"
3. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading for application.
4. Motor Efficiencies:
   a. General purpose motors, which are not inverter duty/vector duty or explosion proof: NEMA Premium Energy Efficient Motors with nominal efficiency equal to or greater than that stated in NEMA MG 1 for NEMA Premium Energy Efficient Motors for that type and rating of motor.
   b. Explosion proof motors: NEMA Energy Efficient/High Efficiency Motors with nominal efficiency equal to or greater than that stated in NEMA MG 1 for NEMA Energy Efficient/High Efficiency Motors for that type and rating of motor.
5. Multi-Speed Motors: Separate windings for each speed.
6. Internal thermal Overload Protection for Motors: For motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to temperature rating of motor insulation.
7. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

8. Torque:
   a. Breakdown torque shall be 200% or more of maximum torque load placed on motor shaft.
   b. Provide torque shall be 200% or more of maximum torque load placed on motor shaft.
   c. Supply special motors where load requirements exceed standard design.
9. Totally Enclosed Fan Cooled (TEFC) and Totally Enclosed Non Ventilated (TENV).
   a. Energy Efficient.
   b. 1.15 Service Factor, Class “F” Insulation.
   c. Cast iron construction; frame, conduit box, end shields, fan cover, inner caps for 182T frames and larger.
   d. Positive lubrication system.
   e. Removable eyebolt.
   f. Suitable for indoor and outdoor installations.
   g. Diagonally split, neoprene gasketed, rotatable oversized conduit box with NPT threaded lead hole.
   h. Conduit box mounted, UL approved clamp type grounding lug.
   i. Permanently numbered non-wicking loads.
   j. Rust inhibitive non-washing lubricant.
   k. Stainless steel nameplate with:
      1) NEMA nominal efficiency.
      2) AFBMA bearing numbers.
      3) Lubrication instructions.
10. Explosion Proof.
    a. Same features as TEFC.
    b. Approved for NEC hazardous classified location as noted in equipment specification or as indicated on Drawings.
    c. Automatic explosion proof breather drains.
11. Submersible pump and mixer motors.
    a. As explosion proof breather drains.
    b. 1.15 service factor, unless otherwise indicated in equipment specification sections.

D. Single-Phase Motors

1. One of the following types as selected to suit starting torque and other requirements of specific motor application:
   a. Permanent Split Capacitor.
   b. Split-Phase Start, Capacitor-Run.
   c. Capacitor-Start, Capacitor-Run.
2. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.
3. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens power supply circuit to the motor, or control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to temperature rating of motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.

4. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

E. Source Quality Control

1. Testing:
   a. Perform belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.
   b. Test shall be standard NEMA routine production test in accordance with NEMA MG 1.

2.5 EXTERNAL SURGE PROTECTION DEVICE

A. Surge Protective Drives (SPD)

1. Current Technology or equal.
2. Surge suppressor shall have UL 1449 listed suppression ratings for each mode of protection, as follows:
   a. 480/277 volt, 3 phase “WYE” – 800 volts.
   b. 120/208 volt, 3 phase “WYE” – 400 volts.
   c. 480 volt 3 phase “Delta” – 1500 volts.
3. Provide protection in all modes. Ten modes for “WYE” systems, L-L, L-N, L-G and N-G, and six modes for “Delta” systems, L-L and L-G per NEMA 2.2.7 & IEEE Std. 1100-1992.
4. Include a predetermined number of Selenium cells in parallel with arrays of non-linear voltage dependent metal oxide varistors to protect against system voltage swells.
5. The Catastrophic Protection System shall provide temporary over voltage and voltage swell protection to the following:
   a. TOV - should be capable of surviving and continue to protect critical loads against multiple TOV events, described as 200% nominal voltage by 8 msec.
   b. Swell- should be capable of protection against swells up to 180% nominal for 0.7 ohms load >18,000 cycles.
6. MOV’s tested per ANSI/IEEE C62.33-1982.
7. Minimum Single Pulse Surge Current Capacity per ANSI/IEEE C62041 1991’s standard 8 X 20 microsecond current waveform, shall not be less than as follows:
   a. 150,000 amps, L-N
   b. 150,000 amps, L-G min. amps per phase
   c. 300,000 amps, L-N plus L-G
   d. 150,000 amps, N-G
   e. 150,000 amps, L-L
8. Test system for repetitive sequential ANSI/IEEE C62.41 Category C3 waveforms. Minimum repetitive strikes of 1.2 X 50 microsecond, 20 KV open circuit voltage and 8 X 20 microsecond, 10 KA short circuit current with no more than 10% degradation of clamping voltage at the specified surge current.

9. Provide an extended range noise tracking filter system between 50 kHz and 100 MHz with a minimum insertion loss ratio of 50:1 or 34 db over the entire range per NEMA LS-1, 1992, Section 2.2.11. UL 1283 Listed as an Electromagnetic Interference Filter.
10. Minimum continuous operating voltage of any component shall not be less than 115% of nominal operating voltage.
11. The primary suppression path shall be Line to Neutral.
12. All surge current devices shall incorporate low impedance plated busbars. No small gauge round wire, printed circuit boards, silicon avalanche diodes or plug-in connections are acceptable.
13. Each individual Selenium cell, MOV and capacitor shall be fused so that the failure of any component does not affect the operation or protection of the entire unit.
14. Provide in PVC/Fiberglass or metal enclosure NEMA rated suitable for the installed location.

B. Accessories

1. Monitoring. One set of status monitoring lights that will provide visual indication of voltage present to the SPD. The lights shall also indicate when any value of less than 50% suppression protection is available from the SPD.
   a. An audible alarm with battery backup, indicating lights showing loss of power or with any value less than 50% suppression protection is available, a surge counter, and two sets of Form C contacts for remote monitoring and data communication module for Modbus TCP interface to PLC.
   b. Monitoring system shall include a local character display to provide a time, date, magnitude, and duration stamp for when the following power quality events occur: indication of the number of swells (voltage > 110% of nominal), surges (voltage > 130% of peak voltage), sags (voltage < 90% of nominal), and outages (power interruptions > 1 cycle) the device has encountered.
2. High Performance Interconnect. Dual shielded, triple insulated multi-core power conductor, UL approved.

2.6 FIRE ALARM SYSTEM

A. Provide a complete fire alarm system for the station including an emergency power supply consisting of a battery, minimum 10 year nominal life expectancy and sized to operate complete alarm system for period of 24 hours, charger, solid-state, fully automatic, variable-charging-rate type that will completely charge fully discharged batteries in 4 hours or less, automatic transfer switch, that transfers load to battery without loss of signals or status indications when normal power fails, fire alarm annunciator panel, heat detectors, smoke detectors, pull stations, horn and strobe devices, wiring to all fire alarm system devices and wall mounted control panel with 120 VAC power supply. The devices shall be rated for the area, where they are located. The system shall be supervised and shall be provided with two dry contact outputs for both trouble and alarm status for remote connection to SCADA. Fire panel shall have the ability to provide alarm status output to the AEGIS system and receive a horn relay signal from the gas system.

B. The system shall be complete with minimum five zones - electrical room, pump room EL 624.83, pump room EL 603.75, East stairwell and West stairwell, as indicated on the

Contract Drawings. Smoke detectors shall be provided in the electrical room, as indicated on the Contract Drawings and shall be of the ionization type. Electronic horn/strobes as manufactured by System Sensors or Edwards shall be provided as shown Plans. All appliances shall meet the NFPA-72 requirements. Heat detector units shall have be combination fixed-temperature and rate-of-rise with mounting plate arranged for outlet box mounting; 135° F (57° C) fixed temperature setting, except as indicated.

C. The system shall have terminals and space for receiving a signal from the gas system from the Combustible gas monitor horn relay per the Drawings. The contact closure shall activate the horn/strobes only; the other fire alarm system functions shall not be affected. The horns/strobes are common to the fire and gas detection systems. The audible horns and visual devices shall be configured to be re-settable and silenced from either the gas panel or fire panel.

D. Submittal shall include a detailed bill of material with technical descriptions and summary of quantities, product data, project specific catalog cutsheets of all proposed devices with applicable features highlighted, riser diagrams, Cause and Effects matrix, as illustrated in NFPA 72, defining the system operation, floor plans depicting the location of all devices, equipment, risers and electrical power connections, all necessary internal and external wiring diagrams, and installation requirements. Complete system connection diagrams of all initiating devices and their addresses, notification appliance, number, size and type of conductors and conduit, and end of line resistors shall be included. The submittal shall also include battery power calculations, voltage drop calculations and raceway fill calculations.

E. The system shall be the product of a single manufacturer having local available service. The system shall be UL listed and Factory Mutual approved.

F. Horns: Electric-vibrating-polarized type, operating on 120 VAC, with provision for housing operating mechanism behind grille. Horns produce sound-pressure level of 90 dB, measures at 10 ft (3 m) from source. Sound-pressure shall be adjustable. Provide with red enclosure suitable for environment listed on drawings, explosion proof and weather proof.

1. Provide with enclosure suitable for environment listed on drawings explosion proof, and weather proof.

G. Visual Alarm Devices: Xenon strobe lights with clear or nominal white polycarbonate lens operating on 120 VAC. Mount lenses on aluminum faceplate. Word “FIRE” is engraved in minimum 1 in. high letters on lens. Provide with red enclosure suitable for environment listed on drawings explosion proof, and weather proof.

1. Devices have candela reading as stated in NFPA 72.
2. Provide with enclosure suitable for environment listed on drawings explosion proof, and weather proof.

H. Manual Pull Stations: Double-action type, fabricated of metal or plastic, and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Break-Glass Feature: Stations requiring breaking of glass are unacceptable. Stations requiring breaking of concealed glass rod are acceptable.
2. Station Reset: Key or wrench operated, double pole, double throw, switch rated for voltage and current at which it operates. Stations have screw terminals for connections.
3. Provide with enclosure suitable for environment listed on drawings, explosion proof, and weather proof.

2.7 AEGIS/INTRUSION ALARM SYSTEM

A. Intrusion detection systems shall be provided and utilize an ADEMCO Vista 20-P circuit board / digital dialer. The AEGIS (Abnormal Event Guidance and Information System) Intrusion system provides detection of unauthorized entry into the station including the pump room, electrical room and stairway. The system detection is monitored via explosion proof rated magnetic reed switches located at each door leading to the exterior; the electrical room door switches shall be non-explosion proof rated. The switches shall consist of two elements, the magnet mounted to the interior face of the door and the magnetically operated reed switch which mounts to the door frame. The switch contacts shall be closed when the door is open and open when the door is closed. Switch mounting shall be farthest point away from hinge located on top of door.

B. An 'intrusion' alarm condition shall be sent to the SCADA panels when a door is opened. The door switches can be disabled via an override switch located on the outside of the electrical room. The override switch shall be weatherproof and key operated, key to be coordinated with the Department's existing key system (Medeco cylinder type, biaxial high security switch lock) and removable from both positions. The switch shall contain a LED status light to indicate open or closed position and include a tamper pushbutton to be held open by the cover plate and spring closed if the cover is removed. The override switch shall have two contacts, one contact for shutting the door switches and one contact for connection to the SCADA panel.

C. The system shall be equipped with a wall mounted intrusion panel that houses a ADEMCO circuit board, digital dialer, 120 volt AC power source, 120 volt to 12 volt transformer, DC power supply with battery, sized for 24 hours of operation, and battery charger, panel mounted LED beacon, terminal strips for field wiring and all control relays. Factory installed wiring shall be clearly identified with conductor labels that match approved shop drawing. The panel will report alarms via a dedicated telephone lines (shared with pump station telephone) as part of the Department's system wide AEGIS alarm system, the following signals shall be monitored by the intrusion system setup to alarm on a contact closure:

1) Intrusion Alarm
2) Fire Alarm & Gas Alarms
3) Electrical Service Failure
4) Pavement Flooded Alarm
5) High Wet Well Water Level
6) SCADA Panel/PLC Failure Alarm
7) Low Wet Well Water Level

8) Pump Alarm*
9) Internal Battery Low
10) AEGIS Heartbeat

- Pump Alarm is generated in SCADA when any one of the Main Pumps or Low Flow Pumps fails to start upon pump call OR when a pump trips due to an overload or fault OR High Moisture OR High Temperature OR when a pump fails to stop at its respective Stop elevation.

D. The systems primary function is intrusion detection and the secondary function is alarm reporting of above listed inputs at EMC Contractor's Maintenance Facility, IDOT District 1, and IDOT TSC. Reporting is performed via telephone output in the event SCADA is lost or disrupted.

E. Submittal information shall include all necessary internal and external wiring diagrams and installation requirements. Complete system connection diagrams of all initiating devices and notification appliance A detailed bill of material with technical descriptions and summary of quantities, project specific catalog cutsheets, one line riser diagram and applicable features of components shall be included.

2.8 REQUEST FOR SUBSTITUTION

A. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

B. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.

C. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

PART 3 - EXECUTION

3.1 PANELBOARDS

A. Installation

1. Install panelboards and accessory items according to NEMA PB 1.1.
2. Mounting Heights: Top of trim 74 in. above finished floor, unless otherwise indicated.
3. Mounting: Plumb and rigid without distortion box. Mount flush panelboards uniformly flush with wall finish.
4. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.

5. Install filler plates in unused spaces.
6. Provision for future circuits at Flush Panelboads: Stub four 1 in. empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in future. Stub four 1 in. empty conduits into raised floor space or below slab not on grade.
7. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

B. Identification

1. Identify field-installed wiring and components and provide warning signs as specified in Section 26 00 03.
2. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws. Nameplates shall have black letters over white background.

C. Grounding

1. Make equipment grounding connections for panelboards.
2. Provide ground continuity to main electrical ground bus.

D. Connections

1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A.

E. Field Quality Control

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
2. Make continuity tests of each circuit.
3. Visual and Mechanical Inspection.
   a. Check circuit breaker for proper mounting and compare nameplate data to drawings and specifications.
   b. Operate circuit breaker to ensure smooth operations.
   c. Inspect case for cracks or other defects.
4. Balancing Loads: After Substantial Completion, conduct load-balancing measurements and make circuit changes as follows:
   a. Perform measurements during period of normal working load as advised by Engineer.
   b. Perform load-balancing circuit changes outside normal occupancy/working schedule of facility. Make special arrangements with Engineer to avoid disrupting critical 24 hr services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
   d. Tolerance: Difference exceeding 10% between phase loads, within panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

F. Adjusting

1. Set field-adjustable pick-up and time-sensitivity ranges in accordance with Section 26 00 02.

G. Cleaning

1. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.2 DISCONNECTS, FUSES AND CIRCUIT BREAKERS

A. Examination

1. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
2. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Installation

1. Install enclosed switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
2. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.
3. Install enclosed switches and circuit breakers level and plumb.
4. Install wiring between enclosed switches and circuit breakers and control/indication devices.
5. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

C. Identification

1. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

D. Coordination Study

1. Where coordination study recommends changes in types, classes, features or ratings of equipment or devices specified in Section 26 00 02 from those indicated, make written request for instructions. Obtain instructions from the Engineer before ordering equipment or devices recommended to be changed.

E. Field Quality Control

1. Manufacturer’s Field Services:

a. Supplier's or manufacturer's representative for equipment specified herein shall be present at job site of classroom designated by the Engineer for minimum mandays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of the Engineer for operation. Include minimum of:
   1) 1/2 manday for Installation Services.
   2) 1/2 manday for Instructional Services / Training.

2. Test in accordance with Section 26 00 01.
3. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
   a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for enclosed switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
   b. Correct malfunctioning units at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

F. Adjusting

1. Set field-adjustable pick-up and time-sensitivity ranges in accordance with Section 26 00 02.

G. Cleaning

1. Upon completion of installation, inspect OCPDs. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.3 TRANSFORMERS

A. Installation

1. Comply with safety requirements of IEEE C2.
2. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.
3. Identify transformers and install warning signs according to Section 26 00 02-2.3.
4. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Grounding

1. Comply with NFPA 70 requirements separately derived systems for connecting to grounding electrodes and for bonding to metallic piping near transformer.
2. Comply with Section 26 00 03.

C. Field Quality Control

1. Testing in accordance with Section 26 00 01.

D. Cleaning

1. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

E. Adjusting

1. After installing and cleaning, touch up scratches and mars on finish to match original finish.
2. Adjust transformer taps and connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings or connections and submit with test results.

3.4 ELECTRIC MOTORS

A. Installation

1. Field install motors in accordance with manufacturer's instructions and following:
   a. Direct Connected Motors: Mount securely in accurate alignment.
   b. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts furnished by manufacturer and tension belts in accordance with manufacturer recommendations.

B. Commissioning

1. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with commissioning of equipment for which motor is part.
2. Report unusual conditions.
3. Correct deficiencies of field-installed units.

C. Alignment

1. Installer of motor is responsible for alignment.
2. Check alignment of motors prior to startup.

D. Field Quality Control

1. Inspect wire and connections for physical damage and proper connection.
2. Conduct insulation resistance (megger) test on each motor 25 hp and larger before energizing. Conduct test with 500 or 1,000 vdc megger. Test each phase separately and follow procedures listed below.
   a. Disconnect voltage sources, lightning arrestors, capacitors, and other potential low insulation sources from motor before connecting megger to motor.
   b. When testing phase, connect phases not under test to ground.
   c. Apply test voltage, phase to ground on each phase being tested. Record resistance reading at 30 sec and at 1 min after test voltage is applied. Divide 1 min reading by 30 sec reading to obtain dielectric absorption ratio (DAR). DAR shall be 1.25 or greater for phase to pass test.
   d. If phases have DAR of 1.25 or greater, attach tag to motor and mark tag "Insulation Resistance Test OK" and sign.

e. If phases have DAR of less than 1.25, attach tag to motor and mark tag “Insulation Resistance Test Failed” and sign. Provide new motor and retest. Notify Engineer of failure and actions taken to correct.
f. Connect equipment removed in Item 1 above.

3. Before energizing motor, record motor's nameplate current on record drawing line diagrams. Verify size motor starter overload heaters with approved drawing and starter manufacturer's recommendation for given motor nameplate current, service factor, and power factor correcting capacitors, is provided.
4. Check rotation of motor before connecting to driven equipment; before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated. When rotation is correct, mark insulation resistance test tag "Rotation OK". Sign or initial test tag by person who checked motor rotation.
5. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas.
6. In addition to the services specified above, provide manufacturer’s services as required to successfully complete systems demonstration.

3.5 SURGE PROTECTIVE DEVICE

A. System Testing and Installation

1. Factory test before shipment:
   a. Testing shall include, but not be limited to production-line tests, quality assurance checks, MCOV, and benchmark clamping voltage tests.
   b. A copy of the benchmark clamping tests for each individual SPD shall be included with each unit.
2. Manufacturer’s Field Services:
   a. Supplier’s or manufacturer's representative for equipment specified herein shall be present at jobsite or classroom designated by Engineer for minimum mandays indicated, travel time excluded, for assistance during plant construction, plant startup, and training of Engineer for operation. Include:
      1) 1/2 man-day for Installation and Testing Services.
      2) 1/2 man-day for Instructional Services.
   b. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than wastewater treatment process.
   c. Obtain the services of a factory-authorized local service representative to provide the following tests:
      1) Voltage measurements from Line-to-Ground, Line-to-Neutral, Line-to-Line and Neutral-to-Ground, as applicable,
      2) Impulse injection to verify the system suppression voltage tolerances for all suppression paths. (Note: This testing is separate from any motor control center or other system tests. Completely disconnect the SPD from the motor control center prior to any motor control center or other system tests, including any hi pot testing.)
      3) Record and compare test results to factory benchmark test parameters supplied with each individual unit.
      4) Submit a copy of the start-up test results and the factory benchmark testing

results to the Engineer for confirmation of proper system function.

B. Installation

1. SPDs shall be installed on the load side of the main disconnects.
2. SPDs shall have a dedicated circuit breaker disconnect at the connection point in the electrical distribution equipment. Low impedance (HPI) cable shall be used to connect the SPD to the electrical distribution equipment. The total cable length between the electrical distribution equipment and the SPD shall be less than 10 feet.

C. System Warranty

1. The SPD system manufacturer shall warranty the entire system against defective materials and workmanship for a period of fifteen years following delivery from the manufacturer.
2. The internal SPD protection suppression system shall be protected by a fifteen year warranty following delivery from the manufacturer providing the SPD system is installed per the manufacturer's specifications.

3.6 FIRE ALARM AND INTRUSION SYSTEMS

A. Verify location and layout of Aegis/Intrusion alarm equipment and Fire alarm equipment.

B. Verify that electrical power is available and of correct characteristics.

C. Verify the interface with the combustible gas monitoring system functions as specified and detailed on the Drawings.

D. Install system, its components and wiring in accordance with manufacturer's specifications and approved submittals.

E. The installer shall provide all labor and perform all work to install and make operable all mechanical and electrical equipment necessary to assure safe and reliable operation.

F. Representative of the Manufacturer

1. The services of a qualified representative of the manufacturer shall be provided to instruct on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct operating personnel in its operation and maintenance. This service shall include the Intrusion Alarm and Fire Alarm Systems. Include:
   a. 1 manday for Installation Services for Intrusion Alarm Panel and Fire Alarm Panel.
   b. 1 manday for Instructional Services / Training for Intrusion Alarm Panel and Fire Alarm Panel.
2. The start-up services for the following equipment shall be coordinated with the Department and it shall be notified at least two weeks in advance:
   Intrusion Alarm Panel.
   Fire Alarm Panel.

END OF THIS SECTION

SECTION 26 05 13 – MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. SUMMARY: Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 5,000 V) electrical distribution system.

C. Progress Payment will be in accordance with Section 109 of the Standard Specifications.

D. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the contract lump sum price for PUMP STATION ELECTRICAL WORK.

1.3 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.

B. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch lengths for each type of cable specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer AND testing agency.

B. Material Certificates: For each type of cable and accessory.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS.

A. Interruption of Existing Electric Service: Do not interrupt electric service to the Department's facilities or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Engineer no fewer than five days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Engineer's written permission.

1.8 WARRANTY

A. The cable supplier shall warrant that its cable shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cables:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. General Cable.
   b. Okonite.
   c. Prysmian Power Cables and Systems USA, LLC.
   d. Southwire Company.

B. Cables Splicing and Terminating Products and Accessories:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M.
   b. Cooper Power Systems, an Eaton business.
   c. Raychem; TE Connectivity.
   d. Thomas & Betts Corporation; A Member of the ABB Group.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

D. Request for Substitution

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

2.3 CABLES

A. Cable Type: Type MV 105

B. Comply with UL 1072, AEIC CS8**,** ICEA S-93-639/NEMA WC 74, and ICEA S-94-649.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: 115 mils Ethylene-propylene rubber.

1. Voltage Rating: 5 kV, 133%.

2. Insulation Thickness: 133 percent insulation level.

F. Insulation Screen: Extruded semiconducting insulation screen applied directly over the insulation.

G. Shielding: 5 mil bare copper tape, helically applied over semiconducting insulation shield with 25% overlap.

H. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

I. Cable Jacket: Sunlight-resistant PVC, suitable for wet or dry locations, and 105^0C continuous operating temperature.

2.4 CONNECTORS

A. Copper conductor connectors: Copper barrel crimped connectors.

2.5 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

2.6 SPLICE KITS

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

2.7 MEDIUM-VOLTAGE TAPES

A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.

B. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches wide.

C. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.8 ARC-PROOFING MATERIALS

A. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

B. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Include details on Drawings for sizing raceways for the number and size of conductors. Consider the conductor insulation voltage level and its impact on raceway sizing due to conduit fill and jam ratios.

D. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

F. Include details on Drawings for transitions from underground to aboveground cable or conduit systems. Coordinate ductbank details and requirements with those in Division 3 and with those in Division 200, “Earthwork” of SSRBC.

G. Install "buried-cable" warning tape 12 inches above cable duct bank. The warning tape shall be conductive

H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

I. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

J. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

K. Coordinate first paragraph below with Drawings by indicating locations of separable insulated connectors.

L. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable jacket.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of 1-inch wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

M. Seal around cables passing through fire-rated elements according to Section 07 84 00 "Firestopping."

N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

O. Identify cables according to Section 26 00 03 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Retain services of a recognized independent testing agency in accordance with Section 26 00 01-3.8.A.

B. Perform Mechanical and Visual Inspections and Electrical Tests in accordance with Section 26 00 01-3.8.P.

C. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 12 19 - PAD-MOUNTED LIQUID-FILLED MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 GENERAL

A. Summary

1. Section includes pad-mounted, liquid-filled, 4.16 kV medium-voltage distribution transformers, with primary and secondary bushings with terminal enclosures

B. Related Documents

2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION ELECTRICAL WORK.

1.3 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or non-load break, separable insulated connector (bushing).

E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

F. Elbow Connector: See "bushing elbow" above.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.

1. Include plans and elevations showing major components and features.
   a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.
2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate data.
6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

B. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement.

C. Seismic Qualification Certificates: For transformer assembly, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For transformers, signed by product manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: The transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI..

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event]
2. Component Importance Factor: 1.5.
3. Component Amplification Factor: 2.5
4. Component Response Modification Factor: 6.0

B. Windings Material: Copper

C. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into the inserts provided

in the high-voltage section of the transformer. Connected in each phase of incoming circuit and ahead of any disconnecting device.

D. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.

E. Efficiency: Comply with 10 CFR 431, Subpart K.

F. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.

G. Tap Changer: External handle, for de-energized operation.

H. Tank: Sealed, with welded-on cover. Designed to withstand internal pressure of not less than 7 psig without permanent distortion and 15 psig without rupture. Comply with IEEE C57.12.36.

I. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

J. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

K. Insulating Liquids:

1. Less-Flammable Liquids:
   a. Edible-Seed-Oil-Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic, having passed the Organization for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.
   b. Biodegradable and Nontoxic Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92.

L. Sound level shall comply with NEMA TR 1 requirements.

M. Corrosion Protection:

1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton/Cooper Industries
2. General Electric Company.
3. ABB

B. Request for Substitution

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

C. Description:

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with IEEE C57.12.26.

D. Compartment Construction:

1. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.

E. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.

1. 150-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
2. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse shall sense both high currents and high oil temperature to provide thermal protection to the transformer.
4. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close when fuse holder is removed and an external drip shield is installed.

5. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

F. High-Voltage Section: Dead-front design.

1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 26 05 13 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.
2. Bushing inserts:
   a. Conform to the requirements of IEEE 386.
   b. Rated at 200 A, with voltage class matching connectors. Provide a parking stand near each bushing well. Parking stands shall be equipped with insulated standoff bushings for parking of energized load-break elbow connectors on parking stands.
   c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts and insulated standoff bushings.
3. Bushing wells configured for loop-feed application.
4. Access to liquid-immersed fuses.
5. Dead-front surge arresters.
6. Tap-changer operator.
7. Load-Break Switch:
   a. Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12 kA rms symmetrical.
8. Ground pad.

G. Low-Voltage Section:

1. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings."

H. Capacities and Characteristics:

1. Power Rating (kVA): 750.
2. Voltage Ratings: 4160 V - 480Y/277 V.
3. Taps: Comply with IEEE C57.12.26 requirements.
4. Transformer BIL (kV): 95.
5. Minimum Tested Impedance (Percent at 85 deg C): 5.75
6. K-factor: complying with UL 1562.
7. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

I. Transformer Accessories:
1. Drain and filter connection.
2. Filling and top filter press connections.
3. Pressure-vacuum gauge.
4. Dial-type analog thermometer with alarm contacts.
5. Magnetic liquid level indicator with high and low alarm contacts.

6. Automatically resetting pressure-relief device. Device flow shall be as recommended by manufacturer, with alarm contacts and a manual bleeder**.**
7. Stainless-steel ground connection pads.
8. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
9. Sudden pressure relay for remote alarm or trip when internal transformer pressure rises at field-set rate. Provide with seal-in delay.

2.4 SERVICE CONDITIONS

A. Transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.00, except for the following:

2.5 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 26 00 03.

1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch- ((50-mm)-)high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.6 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.

1. Perform the following factory-certified routine tests on each transformer for this Project:
   a. Resistance.
   b. Turns ratio, polarity, and phase relation.
   c. Transformer no-load losses and excitation current at 100 percent of ratings.
   d. Transformer impedance voltage and load loss.
   e. Operation of all devices.
   f. Lightning impulse.
   g. Low frequency.
   h. Leak.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.

2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.
5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
7. Verify presence of polychlorinated biphenyl content labeling.
8. Unload transformers carefully, observing all packing label warnings and handling instructions.
9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer termination compartments against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
6. Use jacks only at corners of tank base plate.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.

2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.
2. Remove a sample of insulating liquid according to ASTM D 923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
   a. Dielectric Breakdown Voltage: ASTM D 877 or ASTM D 1816.
   b. Acid Neutralization Number: ASTM D 974.

H. Verify that ground connections are in place and that requirements in Section 26 00 03 have been met. Maximum ground resistance shall be 5 ohms at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 for cast-in-place concrete and pre-cast concrete bases**.**

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 00 03.

1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
2. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 feet. Bond each gate section to fence post using 1/8 by 1 inch flexible braided copper strap and clamps.
3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
4. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
5. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 26 00 03.

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of transformers according to Section 26 05 13 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 26 00 03.

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Retain services of recognized independent testing agency to test and inspect components, assemblies, and equipment installations, including connections in accordance with Section 26 00 01-3.8.

1. Medium-Voltage Surge Arrester Field Tests:
   a. Visual and Mechanical Inspection:
      1) Inspect physical and mechanical condition.

2) Verify arresters are clean.
3) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.

b. Electrical Test:
1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to comply with recommended minimum insulation resistance listed in that table.
2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

2. Liquid-Filled Transformer Field Tests:
a. Visual and Mechanical Inspection
1) Perform visual and mechanical inspection in accordance with Section 26 00 01-3.8.K.1.
b. Electrical Tests
1) Perform electrical tests in accordance with Section 26 00 01-3.8.K.2.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Engineer, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Engineer, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
a. Adjust transformer taps.
b. Prepare written request for voltage adjustment by electric utility.
3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:
a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.

3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:
   a. Description of equipment to be tested.
   b. Discrepancies.
   c. Temperature difference between area of concern and reference area.
   d. Probable cause of temperature difference.
   e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
   f. Identify load conditions at time of inspection.
   g. Provide photographs and thermographs of deficient area.
4. Act on inspection results according to recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Department's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Department’s maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION

SECTION 26 13 26 - MEDIUM-VOLTAGE, METAL-CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY AND RELATED DOCUMENTS

A. Section includes indoor metal-clad 5kV switchgear.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

C. Related Sections

Section 26 00 01 General Electrical Provisions

Section 26 00 02 Electrical Power System Studies

Section 26 00 03 Basic Electrical Materials and Methods

Section 26 00 05 Miscellaneous Electrical Equipment

Section 26 18 39 Medium Voltage Motor Starters

Section 40 90 05 Supervisory Control Data Acquisition (SCADA)

Section 43 25 13 Pumping Equipment

D. Progress payments will be in accordance with Section 109 of the Standard Specifications.

E. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, SWITCHGEAR - 5KV.

1.3 REFERENCES

A. Metal clad switchgear shall meet or exceed the following standards:

1. ANSI/IEEE C37.20.2
2. NEMA SG-5

B. Motor Control Center shall meet or exceed the following standards:

1. ANSI/NEMA ICS-3
2. UL 347

1.4 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. NETA ATS: InterNational Electrical Testing Association, Acceptance Testing Specification.

C. NRTL: Nationally Recognized Testing Laboratory

D. UPS: Uninterruptable power supply.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices.

B. Shop Drawings: For each medium-voltage, metal-clad switchgear.

1. A comprehensive bill of material with functional description, technical ratings and complete catalog number of each device
2. Include a tabulation of installed devices with features and ratings.
3. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations shall show major components, features, and mimic bus diagram.
4. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts and leveling channels.
5. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
6. Locate accessory and spare equipment storage.
7. Include internal physical layout
8. Include single-line diagram.
9. Include control power wiring diagrams.
10. Include internal point to point wiring diagram

11. Include Nameplate schedule describing functional description and tag number for all devices located on the panel front and inside the cubicle.
12. Include copy of nameplate
13. Include recommended Spare Parts list.
14. Include corrosion-resistant certification
15. Test results of enclosure corrosion resistant finish.
16. Ratings the switchgear assembly:
    a. Voltage.
    b. Continuous current.
    c. Short-circuit current.
    d. Lightning impulse full-wave withstand voltage.
17. Utility company's metering provisions with indication of approval by utility company.
18. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
19. Relay settings.
20. Interface to SCADA equipment.
21. Wiring Diagrams: For each switchgear assembly include the following:
    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices including connection details to the SCADA equipment.
22. Include Factory and Field test procedures.

C. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

D. Submit three certified copies of factory tests

E. Submit three certified copies of field testing.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings for Indoor Installations:

1. Dimensioned concrete base, outline of the switchgear, conduit entries, and grounding equipment locations.
2. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, cable trays, and seismic anchors.
3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

B. Seismic Qualification Certificates: For switchgear and control power, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchgear and switchgear components, in addition to items specified in Section 01 33 04 "Operation and Maintenance Manuals," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. Stamped and signed approved shop drawings and catalog cuts
4. Stamped and signed O&M Manuals
5. Stamped and signed record drawings

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish spare parts described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:
   a. Primary disconnect fuses.
   b. Potential transformer fuses.
   c. Control power fuses.
   d. Fuses and fusible devices for fused circuit breakers.
2. One Remote Operating mechanism for racking the circuit breakers remotely.
3. Spare Indicating Lights: Six of each type installed.
4. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.
5. Primary Switch Contact Lubricant: One container(s).

1.9 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

1.10 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer’s instructions and in accordance with the provisions of Section 26 00 01.

B. Medium voltage motor control center and switchgear sections shall be delivered in shipping splits that can be moved through the door openings shown on Plans and past obstructions in delivery path.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Square D; by Schneider Electric.

B. Medium Voltage Metal-Clad Switchgear, Medium Voltage Motor Starters and LV MCC shall all be furnished by the same manufacturer.

C. Request for Substitution

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 SYSTEM DESCRIPTION

A. Manufactured Unit: Indoor, metal-clad switchgear, and medium voltage motor control center designed for application in solidly grounded neutral system.

B. Comply with IEEE C37.20.2.

C. The switchgear ratings shall comply with IEEE C37.04, and shall be the preferred ratings of IEEE C37.06.

D. Switchgear Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: The switchgear shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means the switchgear will remain in place without separation of any parts when subjected to the seismic forces specified and the switchgear will be fully operational after the seismic event.
2. For life-safety components required to function after an earthquake, the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Service Conditions:

1. Switchgear shall be suitable for operation under service conditions specified as usual service conditions in IEEE C37.20.2.

2.4 SWITCHGEAR ENCLOSURE

A. Indoor Enclosure: Steel.

B. Gasketed doors

C. Switchgear Enclosures Finish: Factory-applied corrosion-resistant finish in manufacturer's standard color that withstands 120 hours of exposure to the salt-spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be conducted according to ASTM D 1654, with a rating of not less than 7 arrived at according to Table 1 (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill-galvanized sheet steel shall be coated with a manufacturer's standard zinc-rich paint. All electrical equipment in the Electrical Room shall have manufacturer’s standard gray finish to match.

2.5 SWITCHGEAR CONSTRUCTION

A. Deadfront, metal-clad, drawout, switchgear assembly of vertical sections, each with vacuum circuit breakers. Provide additional vertical sections to house accessories related to the switchgear functions.

1. Front and rear access switchgear.
2. Front section with hinged do with ¼ turn handle and rear vertical section with hinged door with 3 point latching hardware with key.

B. Phase Bus: Tin-plated copper

C. Bus: Tin-plated copper.

1. Ground Bus: Sized to carry the rated short-time withstand current, extended full length of the switchgear assembly, and connected to the metal enclosures of each vertical section.

D. Circuit Breaker Compartments: Include a racking mechanism, circuit breaker operated automatic shutters covering the high-voltage bus connections, safety interlocks and an electrical racking motor and accessories for remote racking of the circuit breaker.

E. Auxiliary Vertical Sections and Compartments:

1. Customer Metering: A vertical section with a front hinged door for isolated access to meters and associated terminal and fuse blocks for maintenance, calibration, or testing while the gear is energized.

F. Circuit Breakers: Horizontally mounted, drawout, vacuum circuit breakers, operated by a motor-charged stored-energy mechanism, and having manual means of charging the mechanism.

1. Electrically Operated: 120 V ac close, ac capacitor trip. Powered from fused control transformers powered from each service sections with automatic selective transfer relay (Device 83) integral to the switchgear.

G. Breaker Status Indicators, LED Type: Breaker Open, Closed, Tripped, Control Power, Charged/Available

H. Breaker Status Indicators, Mechanical, of the Breaker Position in the Cubicle: Connected, Test, Disconnected

I. Provide dry contacts of breaker status for each breaker: Open, Closed, Tripped and Not Available (When breaker is not in connect position)

J. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation.

1. One of each size handling device to remove the circuit breaker from metal-clad switchgear and to move the breaker about on the floor.
2. Test cabinet with accessories to connect to the secondary contacts on an electrically operated removable element, permitting operation and testing of the removable element when it is removed from the housing.

K. Capacities and Characteristics:

1. Comply with IEEE C37.06.
2. Switchgear Assembly:
   a. Rated Maximum Design Voltage and BIL (Dielectric Test): 15 kV, 95 kV.
   b. Rated Continuous Current: 1200 A.
   c. Rated Short-Circuit Current and Short-Time Current: 25 kA rms
3. Circuit Breakers:
   a. Same capacities and characteristics as the switchgear assembly, and as follows:
      1) Rated Continuous Current and Load Switching Current: 1200 A.
      2) According to IEEE C20.06, for 60 Hz, rated closing and latching current (kA,

peak) of the circuit breaker is 2.6 times the rated short-circuit current. (If expressed in terms of kA, rms total current, the equivalent value is 1.55 times rated short-circuit current.)

3) Rated Closing and Latching Current: 39 kA, rms.
4) Rated Interrupting Time: 50 ms

2.6 INFRARED WINDOWS

A. Infrared red windows shall be provided for inspection under fully energized condition.

B. Infrared red window certifications: UL94, UL746, IEEE C37.20.2.a.3.6, IP65/NEMA4.

C. The windows shall be gasketed and shall have 316 stainless steel cover.

2.7 SURGE ARRESTERS

A. Comply with IEEE C62.11, distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of disconnecting device.

2.8 INSTRUMENTS

A. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C 12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital Meter and Monitor: Microprocessor-based unit suitable for three- or four-wire systems.

1. Inputs from 5-A current-transformer secondaries, and potential terminals rated to 600 V.
2. Switch-selectable digital display with the following features:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Three-Phase Real Power: Plus or minus 2 percent.
   e. Three-Phase Reactive Power: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
   i. Accumulated energy, in megawatt hours, plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.
3. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 40 90 05 SCADA Equipment.

4. Mounting: Display and control unit that is flush or semiflush mounted in instrument compartment door.

2.9 PROTECTIVE RELAYS

A. Multifunctional, solid-state microprocessor-based relay systems, complying with IEEE C37.90.

B. Relay Mounting:

1. Each relay shall be mounted in a drawout case with a two-stage quick-release operation.
2. Removal of the relay from the case shall disconnect the trip circuits and short the current-transformer secondaries before the unit control power is disconnected.
3. When the relay is inserted into the case, control power connections shall be made before the trip circuits are activated.
4. Include a self-shorting contact on the case terminal block for alarm indication and tripping of circuit breaker upon removal of the relay from the case.

C. Equip each relay system with a communications module to transmit the following data according to Section 40 90 05 SCADA Equipment."

1. Relay's metered and target data, such as currents, set points, cause of trip, and magnitude of trip current.

D. Overcurrent and Ground-Fault Protective Relays:

1. Provide Ground Fault Protective Relays for Mains, 52-M1 and 52-M2.
2. Provide Line Protective Relays, SEL-351 or approved equal for Mains 52-M1 and 52-M2. Protective features must include Overcurrent (50/51), Under/Over Voltage (27/59), Phase Sequence (47), and Under/Over Frequency (81).
3. Provide Bus Differential Relay, SEL-587Z or approved equal, for bus differential protection of Bus1 and Bus 2.
4. Provide Feeder Protection Relays, SEL-751A or approved equal for 52-T1 and 52-T2.
5. Provide Tie Protective Relay, SEL-751A or approved equal, for Automatic Transfer Control System as described in Section 2.12.
6. Provide Generator Protective Re/ay, SEL-700G or approved equal for generator feeder protection.
7. Field-Selectable Relay Settings: Required by the overcurrent protective device coordination study and arc-flash study.
8. Primary Current-Transformer Ratings: Programmable from 5 to 5000 A.
9. Phase and Ground Protection: Field-selectable curves from IEEE moderately inverse, very inverse, or extremely inverse.
10. Phase Instantaneous Overcurrent Trip Pickup Point: Field selectable as "none" or from 1.0 to 25 times current-transformer primary rating. Include discriminator circuit with "on" and "off" switch so that when phase instantaneous overcurrent has been programmed to "none," the discriminator circuit protects against currents exceeding

11 times current-transformer primary rating when the breaker is being closed and shall be deactivated after approximately eight cycles.

11. Contacts:
    a. Two Form-A contacts.
    b. Field selectable into contact pairs as follows and as required by the overcurrent protective device coordination study and arc-flash study:
        1) One contact assigned ANSI 51 phase and ANSI 51 ground, and the other contact assigned ANSI 50 phase and ANSI 50 ground.
        2) One contact assigned ANSI 51/50 phase, and the other contact assigned 51/50 ground.
12. Alphanumeric display to show the following parameters with metering accuracy not to exceed 2 percent of full scale:
    e. Individual phase currents.
    f. Ground current.
    g. Cause of trip.
    h. Magnitude and phase of current-causing trip.
    i. Phase or ground indication.
    j. Peak current demand for each phase and ground since last reset.
    k. Current-transformer primary rating.
    l. Programmed phase and ground set points.
13. Relay alarm and trip contacts shall not change state if power is lost or an undervoltage occurs. These contacts shall only cause a trip on detection of an overcurrent or fault condition based on programmed settings. A "protection off" alarm shall be normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. On loss of power or relay failure, this alarm relay shall be de-energized, providing a fail-safe protection off alarm.

1.2 SCADA AND REMOTE CONTROL STATION INTERFACE

A. Provide hard wired inputs and outputs from pump motor starter section and switchgear section as described below

1. Pump Motor Starter Sections
    a. Provide dry contact for remote indication of motor fault/overload.
    b. Provide dry contact for remote indication of selector switch in Auto position.
    c. Provide dry contact for remote indication of selector switch in Off position
    d. Provide dry contact for remote indication of disconnect open.
    e. Provide dry contact for remote indication of pump running.
    f. Provide dry contact for remote indication of pump moisture.
    g. Provide dry contact for remote indication of pump overtemp.
    h. Ability to accept pump call signal from SCADA.
    i. Ability to accept pump call signal from float switch
    j. Ability to accept pump and motor protection relay (PMPR) override signal from SCADA.
    k. Ability to accept and send signals to remote control stations as shown on Drawings.
    l. Ability to accept and send other signals IC Drawings and listed in Specification Section 40 90 05.

2. Switchgear Sections
   a. Provide dry contact for remote indication of 52-M1 breaker open
   b. Provide dry contact for remote indication of 52-M1 breaker tripped.
   c. Provide dry contact for remote indication of Service 1 ground fault.
   d. Provide dry contact for remote indication of Service 1 Failure.
   e. Provide dry contact for remote indication of 52-M2 breaker open
   f. Provide dry contact for remote indication of 52-M2 breaker tripped.
   g. Provide dry contact for remote indication of Service 2 ground fault.
   h. Provide dry contact for remote indication of Service 2 Failure
   i. Provide dry contact for remote indication of 52-T breaker closed
   j. Provide dry contact for remote indication of 52-T breaker tripped
   k. Provide dry contact for remote indication of 52-G breaker closed
   l. Provide dry contact for remote indication of 52-G breaker Tripped
   m. Provide dry contact for remote indication of 52-T1 Open
   n. Provide dry contact for remote indication of 52-T1 Tripped
   o. Provide dry contact for remote indication of 52-T2 Open
   p. Provide dry contact for remote indication of 52-T2 Tripped
   q. Provide dry contact for remote indication of Auto Transfer Fail
   r. Ability to accept and send other signals shown on IC Drawings and listed in Specification Section 40 90 05.

B. Provide data via Modbus TCP, to SCADA the following from pump motor starter sections and switchgear sections as described below.

1. Motor Starter Sections
   a. Provide each phase current, line-to-line voltages, KW, KVA, KVAR and power factor of each pump motor through the microprocessor based motor protective relay (MPR), as shown on Drawings.
2. Switchgear Sections
   a. Provide each phase current, line-to-line voltages, KW, KVA, KVAR and power factor of each pump motor through the line protection relays (LPR), feeder protection relays (FPR), and generator protection relay (GPR).

C. Provide GPS clock, SEL-2407 or approved equal and antenna for time synchronization of SCADA and all microprocessor based relays in the motor starter and switchgear sections, as shown on IC Drawings.

1.2 CONTROL POWER SUPPLY

A. Description: Control power transformers (CPT), one for each incoming service section, shall supply 120 V ac control circuits through secondary disconnect and overcurrent protective devices.

1. Dry-type transformer, in separate compartment, with primary and secondary fuses to provide current-limiting and overload protection.
2. Automatic Transfer and Selection Relay to select available source when one of the services fail.

B. Control Wiring: Factory installed, complete with bundling, lacing, and protection.

3. Conductors across Hinges and for Interconnections between Shipping Units: Flexible conductors for No. 8 AWG and smaller.
4. Conductors: Sized according to NFPA 70 for duty required.

2.10 DUAL SOURCE, WITH TIE, OPEN TRANSITION AUTOMATIC TRANSFER CONTROL SYSTEM

A. Provide an automatic transfer control system for control of three circuit breakers, Main1, Tie and Main2. The logic of the transfer control system functions shall be provided via a microprocessor based protective relay of each breaker. The set points shall be field adjustable without the use of special tools

B. The transfer control system shall be provided with a local display. The display shall show the status of the system as it is operating. When timers are functioning, the display shall show the timer counting down. All time delays shall be capable of being set from the front of the display using a timer setting screen

C. The transfer control system includes the following features:

1. Time delay to transfer on loss of Source 1, adjustable.
2. Time delay to transfer on loss of Source 2, adjustable.
3. Time delay re-transfer to Source 1, adjustable.
4. Time delay re-transfer to Source 2, adjustable.
5. Time delay neutral (main and tie open), adjustable.
6. The local system display shall show the following: Main- Tie- Main one line diagram; main and tie breaker status (open, closed, tripped, out of cell); readout marked “Source 1” and “Source 2” to indicate that respective source voltages are available; automatic/manual mode select pushbutton; pushbuttons for manual breaker control; and alarm information (loss of source, breaker trip).

D. Sequence of Operation – Automatic Mode

1. Under normal conditions, the main breakers are closed and the tie breaker is open.
2. Upon phase loss or loss of phase-to-phase voltage of either utility source to between 80% and 100% of nominal, and after a time delay, adjustable from 1 to 60 seconds to override momentary dips and outages the transfer control system shall open the affected main breaker and close the tie breaker.
3. When normal voltage has been restored after a time delay, adjustable from 10 to 600 seconds (to ensure the integrity of the source), the transfer control system shall open the tie breaker. The transfer control system shall have an adjustable neutral position timer (0-10 seconds) to allow voltage to decay sufficiently before the affected main breaker is then closed (open transition retransfer).
4. If Source 2 should fail while carrying the load, transfer to Source 1 shall be made instantaneously upon restoration of Source 1 to satisfactory conditions.
5. If both sources should fail simultaneously, no action shall be taken.
6. If the main or tie breakers trip due to a fault, the transfer control system shall be reset to manual mode and manual operation of that breaker shall be prevented until its overcurrent trip switch is reset.

E. Sequence of Operation – Manual Mode

1. While in manual mode, breakers shall be capable of being opened and closed using control switches or pushbuttons on the transfer control system display. Electrical interlocking shall be provided to prevent the closing of both mains and the tie simultaneously.

F. Provide a control power transformer for each source with control power transfer scheme, as specified in Paragraph 2.11.

G. Provide an industrial display panel for operator interface.

2.11 REMOTE OPERATING UNIT

A. Provide motorized remote racking system to remotely rack VCP-W circuit breakers and auxiliary draw out compartments in 5kV switchgear. It shall include one remote control unit for the switchgear, motor and logic controller built in each circuit breaker compartment and other auxiliary draw out compartments. The racking system shall be powered by the CPTs in the switchgear. The remote unit shall be equipped with controls to open, close and rack the breaker remotely, using the pendant. Motor, logic controller and safety interlocks for the racking system shall be built into each breaker and auxiliary draw out compartments. The remote unit shall include a pendant station with minimum 30 foot long cable to facilitate breaker operation and racking, while standing outside the arc flash zone, per NFPA-70E. When the cable is plugged into the compartment to be racked, all circuit breaker and auxiliary compartment safety interlocks must remain intact per IEEE TC37.20.2. Pendant, when plugged into a compartment, shall override remote controls of the compartment. Dynamic brake and torque limiter shall be incorporated in the racking system to improve reliability and to insure smooth operation. The racking system shall be factory installed and tested as a complete racking system with the circuit breakers and auxiliary compartments in the switchgear.

2.12 GENERATOR TERMINATION CABINET

A. Provide 600A, 4.16 kV, 3 Phase generator termination switchgear outside the Electrical Room, as shown on the Electrical Drawings, to facilitate connection of a 4.16 kV, 2000 KW, 3 Phase, portable generator during an outage of both utility services to the station. The unit shall be Advanced Power Technologies' MVFS series, 600A, 4.16 kV Termination Switchgear or approved equal.

B. The unit shall be rated NEMA 3R for outdoor installation. It shall be supplied as a complete system and shall include all the necessary components and equipment to accommodate described system operation unless otherwise noted.

C. Enclosure shall be a floor standing manufactured from Carbon Steel and powder coated ANSI 61 gray.

D. The enclosure shall include a full front padlockable door and an integral lower flip open door to allow cable connection of the portable temporary source leads. It shall include a Kirk key interlock to prevent opening the door when the Generator circuit breaker in USS1 is closed.

E. The nameplates shall be produced from clear textured polycarbonate, laminated on high performance pressure sensitive adhesive. The printing shall be done on the interior surface of the laminate to avoid scratching or other deterioration of text. The lettering shall be white on black background.

F. Internal Climate Control to include (2) Space Heaters with a Thermostat; requires customer supplied 120VAC, 10A circuit.

G. Two (2) sets of three Generator Connection Receptacle(s) with loose shipped with deadbreak elbows:

1. 600A, up to 25kV Air-Insulated Bushing Well
2. 600A Deadbreak Insulated Caps
3. Bushing Hanger for insulated caps when cables are connected to the bushings

H. Provide silver-plated copper, appropriately sized bus bar and extensions with NEMA standard hole pattern to accommodate cable connections. Terminate cables from the generator circuit breaker as shown in Conduit and Cable Schedules.

B. Provide Phase Rotation Monitoring to insure portable generator phase rotation matches that of the station. An indicating light will provide visual assurance of correct phasing and to prevent the breaker from being closed if phase rotation is incorrect.

I. Provide Voltage Transformers (VTs) for phase rotation monitoring. Potential transformers shall be appropriately fused, fixed mounted, 4200:120VAC connected in open delta configuration.

J. The unit dimensions shall not exceed 100”H x 36”W x 72”D

2.13 WARNING LABELS AND SIGNS

A. Install appropriate precautionary labels to warn about potential hazards that are inherent to the equipment. Comply with requirements for labels and signs specified in Section 26 00 03 "Basic Electrical Materials and Methods."

1. Warning signs shall be baked enamel.
2. Equipment Identification Labels: Engraved, laminated or melamine label
3. Mimic Bus: Continuous mimic bus applied to front of switchgear, arranged in single-line diagram format, using symbols and lettered designations consistent with approved final mimic-bus diagram.
   a. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   b. Medium: Painted graphics, as approved.
   c. Color: Contrasting with factory-finish background; selected by the Engineer.

2.14 SOURCE QUALITY CONTROL

A. Perform production tests on each circuit breaker housing for this Project, complying with IEEE C37.09.

1. Perform mechanical operation tests to ensure proper functioning of shutters, operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
2. Conduct an alignment test with master circuit breaker to verify all interfaces.
3. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence.
4. Perform the control wiring dielectric test at 1500 V for one minute.
5. Perform the dielectric test on primary and secondary circuits.

B. Perform production tests, on each circuit breaker supplied for this Project, complying with IEEE C37.09.

1. Perform mechanical operation tests to ensure proper functioning of the switch.
2. Conduct an alignment test with master cell to verify all interfaces and interchangeability.
3. Verify the contact gap. Perform terminal-to-terminal resistance test.
4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of relays and devices to ensure they function properly and in the intended sequence. Operate the circuit breakers over the range of minimum to maximum of the control voltage.
5. Perform the control wiring dielectric test at 1500 V for one minute.
6. Set the contact gap.

C. Perform functional tests of all protective relays, instruments and control devices by application of secondary three-phase voltage to voltage circuits and injection of current in current transformer circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of switchgear and prior to unloading, inspect equipment for damage.

1. Examine tie rods and chains to verify they are undamaged and tight and that blocking and bracing are tight.
2. Verify that there is no evidence of load shifting in transit and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories conform to the manufacturer's quotation and shop drawings. If the shipment is not complete or does not comply with project requirements, notify the manufacturer in writing immediately.
5. Unload switchgear, observing packing label warnings and handling instructions.
6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle switchgear according to according to manufacturer's recommendations, avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
2. Protect switchgear compartments against the entrance of dust, rain, and snow.
3. Transport switchgear upright to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
5. Do not damage structure when handling switchgear.

C. Storage:

1. Store switchgear in a location that is clean and protected from weather. Protect switchgear from dirt, water, contamination, and physical damage. Do not store switchgear in the presence of corrosive or explosive gases.
2. Store switchgear with compartment doors closed.
3. Regularly inspect switchgear while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions.

D. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will have to cross section barriers to reach load or line lugs.

E. Pre-Installation Checks:

3. Verify removal of any shipping bracing after placement.

F. Verify that ground connections are in place and that requirements in Section 26 00 03 "Basic Electrical Materials and Methods" have been met. Maximum ground resistance shall be 5 ohms ohms at switchgear location.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SWITCHGEAR INSTALLATION

A. Comply with the provisions of IEEE C37.20.2 subclause titled "Guide for Handling, Storage, and Installation."

B. Equipment Mounting:

1. Install switchgear on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 “Concrete”.
2. Comply with requirements for vibration isolation devices specified in Section 26 00 03 " Basic Electrical Materials and Methods."

C. Switchgear shall be installed level and plumb. Switchgear shall tilt less than 1.5 degrees while energized.

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

E. Comply with NECA 1.

F. Comply with NECA 430.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 00 03 "Basic Electrical Materials and Methods"

B. Grounding Connections at Interior Locations:

1. Install bare copper cable not smaller than No. 4/0 AWG for grounding to grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors.
3. Keep leads as short as practicable with no kinks or sharp bends.
4. Make joints in grounding conductors and loops by exothermic weld or compression connector.

C. Grounding at Exterior Locations:

1. Install tinned bare copper cable not smaller than No. 4/0 AWG, for counterpoise buried not less than 30 inches (765 mm) below grade interconnecting the grounding electrodes.
2. Bond surge arrester and neutrals directly to the switchgear enclosure and then to the grounding electrode system with bare copper conductors, sized as shown.
3. Keep lead lengths as short as practicable with no kinks or sharp bends.
4. Fence and equipment connections shall not be smaller than No. 4 AWG.
5. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft. (3050 mm).
6. Bond each gate section to the fence post using 1/8 by 1 inch (3 by 25 mm) flexible braided copper strap and clamps.
7. Make joints in grounding conductors and loops by exothermic weld or compression connector.

D. Terminate grounding and bonding conductors on a common equipment grounding terminal on the switchgear enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate the number of conductors for termination.

E. Complete switchgear grounding and lightning arrester connections prior to making any other electrical connections.

F. Terminate medium-voltage cables according to Section 26 05 13 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with the installation requirements for labels and signs specified in Section 26 00 03 "Basic Electrical Materials and Methods".

B. Install warning signs as required to comply with OSHA 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections in accordance with Section 26 00 01-3.8.B.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

C. General Field Testing Requirements:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods."
2. After installing switchgear and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

D. Medium-Voltage Switchgear Assembly Field Tests:

1. Visual and Mechanical Inspection:
   a. Verify that fuse and circuit breaker sizes and types correspond to Drawings and coordination study, as well as to the circuit breaker's address in the control network.
   b. Verify that current and voltage transformer ratios correspond to Drawings.
   c. Inspect bolted electrical connections for high resistance using one of the following two methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
      1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
      2) Make key exchange with devices operated in off-normal positions.
   e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
   f. Inspect insulators for evidence of physical damage or contaminated surfaces.
   g. Verify correct barrier and shutter installation and operation.
   h. Exercise active components.

i. Inspect mechanical indicating devices for correct operation.
j. Verify that filters are in place and vents are clear.
k. Perform visual and mechanical inspection of instrument transformers according to according to Article "Instrument Transformer Field Tests."
l. Inspect control power transformers.
   1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
   2) Verify that primary and secondary fuse or circuit breaker ratings match drawings.
   3) Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

2. Electrical Tests:
   a. Perform dc voltage insulation-resistance tests on each bus section, phase to phase and phase to ground, for one minute. If the temperature of the bus is other than plus or minus 20 deg. C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
      1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
      2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
   b. Perform a dielectric withstand voltage test on each bus section, each phase to ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
      1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
   c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 V dc for 300-volt rated cable and 1000 V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
      1) Minimum insulation-resistance values of control wiring shall not be less than two megohms.
   d. Control Power Transformers:
      1) Perform insulation-resistance tests. Perform measurements from winding to winding and each winding to ground. Insulation-resistance values of winding insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.1.
      2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source.

Verify correct potential at all devices.

3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

e. Voltage Transformers:

1) Perform secondary wiring integrity test. Verify correct potential at all devices.

2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

2) Perform current tests by primary injection with magnitudes such that a minimum of 1.0 A flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests according to according to "System Function Tests" Article.

h. Verify operation of space heaters.

i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

E.Medium-Voltage Vacuum Circuit Breaker Field Tests:

3. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.

b. Inspect anchorage, alignment, grounding, and required clearances.

c. Verify that maintenance devices such as special tools and gages specified by the manufacturer are available for servicing and operating the breaker.

d. Verify the unit is clean.

e. Perform mechanical operation tests on operating mechanism according to manufacturer's published data.

f. Measure critical distances on operating mechanism as recommended by the manufacturer. Critical distances of the operating mechanism shall be according to manufacturer's published data.

g. Verify cell fit and element alignment.

h. Verify racking mechanism operation.

i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

k. Record as-found and as-left operation counter reading. Operation counter shall advance one digit per close-open cycle.

4. Electrical Tests:

a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than this table or manufacturer's recommendations. Dielectric-withstand-voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
b. Perform a contact/pole-resistance test. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform minimum pickup voltage tests on trip and close coils according to manufacturer's published data. Minimum pickup voltage of the trip and close coils shall comply with manufacturer's published data. In the absence of the manufacturer's published data, comply with NETA ATS, Table 100.20.
d. Verify correct operation of any auxiliary features, such as electrical close and trip operation, trip-free operation, and anti-pump function. Auxiliary features shall operate according to manufacturer's published data.
e. Trip circuit breaker by operation of each protective device. Reset trip logs and indicators.
f. Perform power-factor or dissipation-factor tests on each pole with the breaker open and each phase with the breaker closed. Power-factor or dissipation-factor values shall comply with manufacturer's published data.
g. Perform vacuum bottle integrity (dielectric-withstand-voltage) test across each vacuum bottle, with the contacts in the "open" position according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the vacuum bottle integrity test, the test specimen is considered to have passed the test.
h. Perform a dielectric-withstand-voltage test according to manufacturer's published data. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric-withstand-voltage test, the test specimen is considered to have passed the test.
i. Verify operation of heaters.

F. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:
   a. Verify that equipment nameplate data complies with Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Verify correct connection of transformers with system requirements.
   d. Verify that adequate clearances exist between primary and secondary circuit wiring.
   e. Verify the unit is clean.

f. Inspect bolted electrical connections for high resistance using one of the following two methods:
   1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections.
   2) Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
h. Verify that all required grounding and shorting connections provide contact.
i. Verify correct operation of transformer withdrawal mechanism and grounding operation.
j. Verify correct primary and secondary fuse sizes for voltage transformers.
k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:
   a. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1000 V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's written recommendations or NETA ATS, Table 100.5.
   b. Perform a polarity test of each current transformer according to according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
   c. Perform an excitation test on transformers used for relaying applications according to according to IEEE C57.13.1. Excitation results shall match the curve supplied by the manufacturer or be according to according to IEEE C57.13.1.
   d. Measure current circuit burdens at transformer terminals according to according to ANSI/IEEE C57.13.1. Measured burdens shall be compared with and shall match instrument transformer ratings.
   e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
   f. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by the engineer in the project drawings.
3. Electrical Tests of Voltage Transformers.
   a. Perform insulation-resistance tests winding-to-winding and each winding to ground. Test voltages shall be applied for one minute according to Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's recommendations. Investigate and correct values of insulation resistance less than manufacturer's recommendations or NETA ATS, Table 100.5.
   b. Perform a polarity test on each transformer to verify the polarity marks or H1- X1 relationship as applicable. Polarity results shall agree with transformer markings.
   c. Perform a turns-ratio test on all tap positions.
   d. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared with and shall match instrument transformer ratings.

e. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.
f. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

G. Ground Resistance Test

1. Visual and Mechanical Inspection:
   a. Verify ground system complies with Contract Documents and NFPA 70 Article 250, "Grounding and Bonding."
   b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
   c. Inspect bolted electrical connections for high resistance using one of the following two methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
   d. Inspect anchorage.
2. Electrical Tests.
   a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. The resistance between the main grounding electrode and ground shall be no more than 5 ohms.
   b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohm. Compare equipment nameplate data with Contract Documents.
   c. Inspect physical and mechanical condition.
   d. Inspect bolted electrical connections for high resistance using one of the following two methods:

H. Metering Devices Field Tests

1. Visual and Mechanical Inspection:
   a. Inspect physical and mechanical condition.
   b. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In

the absence of manufacturer's published data, use NETA ATS, Table 100.12.

c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
d. Verify the unit is clean.
e. Verify freedom of movement, end play, and alignment of rotating disk(s).

2. Electrical Tests:
   a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
   b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
   c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
   d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

I. Medium-Voltage Surge Arrester Field Tests:

1. Visual and Mechanical Inspection:
   a. Verify that equipment nameplate data complies with Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and clearances.
   d. Verify the arresters are clean.
   e. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
   f. Verify that the stroke counter is correctly mounted and electrically connected if applicable. Record the stroke counter reading.
2. Electrical Test:
   a. Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in the table.
   b. Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.
   c. Test grounding connections. Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

J. Microprocessor-Based Protective Relay Field Tests:

1. Visual and Mechanical Inspection:
   a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
   b. Verify operation of light-emitting diodes, display, and targets.
   c. Record passwords for each access level.
   d. Clean the front panel and remove foreign material from the case.
   e. Check tightness of connections.
   f. Verify that the frame is grounded according to manufacturer's instructions.

g. Set the relay according to results in Section 26 00 02 "Electrical Power System Studies."
h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.

2. Electrical Tests:
   a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
   b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
   c. Functional Operation: Check functional operation of each element used in the protection scheme as follows:
      1) Timing Relay:
         a) Determine time delay.
            (1) Verify operation of instantaneous contacts.
      2) Volts/Hertz function:
         a) Determine pickup frequency at rated voltage.
         b) Determine pickup frequency at a second voltage level.
         c) Determine time delay.
      3) Undervoltage function:
         a) Determine dropout voltage.
         b) Determine time delay.
         c) Determine time delay at a second point on the timing curve for inverse time relays.
      4) Current Balance function:
         a) Determine pickup of each unit.
         b) Determine percent slope.
         c) Determine time delay.
      5) Negative Sequence Current function:
         a) Determine negative sequence alarm level.
         b) Determine negative sequence minimum trip level.
         c) Determine maximum time delay.
         d) Verify two points on the I-two-squared-t curve.
      6) Phase Sequence or Phase Balance Voltage function:
         a) Determine positive sequence voltage to close the NO contact.
         b) Determine positive sequence voltage to open the NC contact (undervoltage trip).
         c) Verify negative sequence trip.
         d) Determine time delay to close the NO contact with sudden application of 120 percent of pickup.
         e) Determine time delay to close the NC contact upon removal of voltage when previously set to rated system voltage.
      7) Instantaneous Overcurrent function:
         a) Determine pickup.
         b) Determine dropout.
      8) Time Overcurrent:
         a) Determine minimum pickup.
         b) Determine time delay at two points on the time current curve.

9) Ground Detector Relay:
   a) Determine maximum impedance to ground causing relay pickup.

b. Control Verification:
   1) Functional Tests:
      a) Check operation of all active digital inputs.
      b) Check output contacts or silicone-controlled rectifiers (SCRs), preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
      c) Check internal logic functions used in protection scheme.
      d) Upon completion of testing, reset min/max recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.
   2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.

K. Switchgear will be considered defective if it does not pass tests and inspections.

L. Remove and replace defective units and retest.

M. Prepare test and inspection reports. Record as-left set points of adjustable devices.

3.6 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, if requested by Engineer, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Engineer, perform seven days of three-phase voltage recording at the outgoing section of each switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
   a. Adjust switchgear taps.

b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.
4. Report:
   a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove covers prior to the inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of the switchgear.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1^0C at 30^0C.
3. Record of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used and lists the results as follows:
   a. Description of equipment to be tested.
   b. Discrepancies.
   c. Temperature difference between the area of concern and the reference area.
   d. Probable cause of temperature difference.
   e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
   f. Identify load conditions at time of inspection.
   g. Provide photographs and thermograms of the deficient area.
4. Act on inspection results according to the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Department's operations permit. Retest until deficiencies are corrected.

3.8 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Department's maintenance personnel, as directed by the Engineer, to adjust, operate, and maintain the medium voltage switchgear for a minimum 8 hour training.

B. Engage a factory-authorized service representative to train Department's maintenance personnel, as directed by the Engineer to adjust, operate, and maintain Automatic Transfer Control system. This training may be combined with the training in Section 3.8.A.

C. Engage a factory-authorized service representative to train Department's maintenance personnel, as directed by the Engineer, on Electrical Safety and Lockout/Tagout Procedure for all electrical equipment furnished under the Contract, for a minimum 8 hour training.

END OF SECTION

SECTION 26 18 39 - MEDIUM VOLTAGE MOTOR STARTERS

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish and install the medium voltage motor starters as specified herein and as shown on the contract drawings.

B. Related Sections

1. Section 26 00 01 - General Electrical Provisions
2. Section 26 00 02 - Electrical Power System Studies
3. Section 26 00 03 - Basic Electrical Materials and Methods
4. Section 26 00 04 – Lighting
5. Section 26 00 05 – Miscellaneous Electrical Equipment
6. Section 26 13 26 – Medium Voltage Metal-Clad Switchgear
7. Section 40 90 05 – Supervisory Control and Data Acquisition Equipment
8. Section 43 25 13 – Pumping Equipment

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, SWITCHGEAR – 5KV.

1.3 REFERENCES

A. Medium voltage motor starters shall be designed, manufactured, assembled and tested in accordance with the following standards:

1. ANSI/NEMA ICS-3- 1993 (R2000)
2. UL 347 or equivalent CSA C22.2 No. 14

1.4 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Master drawing index
2. Front view elevation
3. Floor plan
4. Top view
5. Schematic diagram
6. Nameplate schedule
7. Component list
8. Conduit entry/exit locations
9. Assembly ratings including:
   a. Short-circuit rating
   b. Voltage
   c. Continuous current
   d. Basic impulse level
10. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
11. Cable terminal sizes
12. Descriptive bulletins
13. Product data sheets

B. The following additional information shall be submitted to the Engineer:

1. Busway connection between front and rear starter units and to switchgear sections
2. Connection details between close-coupled assemblies
3. Composite floor plan of close-coupled assemblies
4. Key interlock scheme drawing and sequence of operations

1.5 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Paragraph 1.04 above, and shall incorporate all changes made during the manufacturing process.
2. Wiring diagrams
3. Three certified copies factory test reports
4. Installation information, including equipment anchorage provisions
5. Seismic certification as specified.

1.6 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Provide Seismic tested equipment as follows:

1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the latest International Building Code (IBC).
2. The IP rating of the equipment shall be 1.5
3. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
   a. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
   b. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
   c. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.7 REGULATORY REQUIREMENTS

A. Equipment shall be provided with the following special labels UL All optionally specified features must be confirmed to meet above specified labeling requirements to insure label can be applied.

1.8 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions and in accordance with the provisions of Section 26 00 01. One (1) copy of the manufacturer's instructions shall be included with the equipment at time of shipment.

B. Medium voltage motor control center and switchgear sections shall be delivered in shipping splits that can be moved through the door openings shown on Plans and past obstructions in delivery path.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

1.10 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton

B. Schneider Electric

C. General Electric

D. Medium Voltage Starters, Medium Voltage Metal-Clad Switchgear and LV MCC shall all be supplied by the same manufacturer.

E. Request for Substitution:

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 RATINGS

A. Starters shall have an integrated interrupting rating with current limiting fuses of 25 kAIC.

B. Starter electrical connections shall be bolted connections.

C. Suitable for application on a power system having a short-circuit capacity of 25 kAIC.

The vacuum contactor shall have the following ratings:

7200V Max.	400 Amperes
Max. Interrupting Current (3 OPS)	8500 Amperes
Rated Current – Enclosed	400 Amperes
Short-Time Current	
30 Sec.	2400 A
1 Sec.	6000 A
8.7 ms (0.5 Cycle)	63 kA Peak
Mechanical Life	2.5 Million
Electrical Life	300,000
at rated current	
Impulse Withstand	60 kV (1.2 x 50 Micro Sec.)

2.3 CONSTRUCTION

A. Isolating switch and contactor assemblies, including current limiting fuses, shall be of the component-to-component design with a minimum amount of interconnecting cables. The isolating switch shall be easily removed from the enclosure by removing the pin securing the operating rod to the switch and then removing two bolts securing the removable portion of the switch. Line and load cable terminations shall be completely accessible from the front. The isolating switch shall be padlockable in the open position and shall be suitable for applying minimum of three padlocks.

B. The isolating switch shall be an externally operated, with a remote operator three-pole drawout type, such that in the open position it grounds and isolates the starter from the line connectors with an isolating shutter leaving no exposed high-voltage components. Integral mechanical interlocks shall prevent entry into the high-voltage areas while the starter is energized and shall block accidental opening or closing of the isolating switch when the door is open or the contactor is closed. The isolating switch handle shall have provisions for padlocking in the open position. The isolating switch shall have a mechanical blown fuse indicating device. The isolation switch shall be designed for a minimum of 10,000 operations.

C. Current limiting power fuses shall be provided with special fatigue proof elements that allow the elements to absorb the expansions and contractions created by the heating and cooling associated with severe cycling as is typical with motor starting. The fuses will include visible fuse condition indicators. The fuses shall incorporate special time/current characteristics for motor service allowing proper coordination with the contactor and overload relay for maximum motor protection. This coordination shall be such that under a low-fault condition the interrupting rating and dropout time of the contactor shall be properly coordinated with all possible fuse sizes to eliminate contactor racing. The power fuses shall be vertically mounted permitting easy inspection and replacement without starter disassembly.

D. The vacuum contactor shall be of bolted connection type and magnetically-held design, rated 400 amperes with single-break high-pressure type main contacts with weld-resistant alloy contact faces. The vacuum contactor contact wear shall be easily checked with the use of a “go/no-go” feeler gauge.

E. A built-in test circuit shall be included to permit checking of the starter control and pilot circuit, with the high voltage de-energized and isolated, and the contactor in its normal position or in the drawout position. The control circuit shall be capable of being energized through a polarized plug connector from an external 115-volt supply while in the test mode.

F. The low voltage control compartment shall be isolated and barriered from the high voltage area and located behind a separate low voltage access door. The low voltage compartment shall be painted white to increase visibility of components mounted inside the compartment.

G. Each starter cell shall contain a vertical and horizontal low voltage wireway.

2.4 BUS

A. When starters are grouped together in a lineup, the horizontal main bus shall be located in its own separate, 12-inch high enclosure and isolated from the starters. To allow for ease of maintenance or extension of lineups without disassembling starters, the main bus shall be front, top and side accessible.

B. Starters shall be connected by an insulated vertical bus.

C. All bus bars shall be copper tin-plated. Bus shall be rated for 1200A, at 7.2kV and below continuous current.

D. Provide a 1/4 x 2-inch ground bus throughout the entire lineup. Ground bus shall also be supplied in upper compartments of 2-high starters and be bus connected to the ground bus supplied in the lower compartments.

2.5 WIRING/TERMINATIONS

A. All control wire shall be UL/CSA approved.

B. Standard control wire shall be 14GA, stranded, tin-plated, red, dual-rated type XLPE (3173) 125 degrees C, SIS 90 degrees C.

C. Current transformer circuits shall utilize #12 wire with the same characteristics as above. Provide shorting blocks for all current transformers.

D. Provide “plug-in” terminal blocks, rated 600 V, 50 A with “clamping collar.”

E. Wire markers shall be a molded plastic “clip-sleeve” type.

F. “Clamping-collar” type terminals shall be used to terminate control wiring. Current transformer circuits shall be provided with ring-type terminals where applicable.

2.6 STARTERS

A. The starters shall be designed to accommodate motors of the size and type as shown on the drawings.

B. The starters shall be non-reversing to accommodate the following motor type:

1. Induction Motor Full-Voltage Start

C. The following equipment shall be provided for the starter.

2. Each induction motor full voltage starter shall include:
   a. Medium Voltage Section
      1) One – Fixed portion isolating switch with shutter mechanism
      2) One – Removable portion isolating switch with blown fuse indication
      3) Three – Clip-in Current-limiting power fuses
      4) One – Bolt-in three-pole main vacuum contactor assembly
      5) One – Control circuit transformer 750 VA @ 4.16 kV, Two – Control circuit primary current limiting fuses
      6) One – Control circuit secondary fuse
      7) One – Run-test circuit
      8) Four – Electrical interlocks
      9) One set of three-phase current transformers, for use with electronic motor protective relay and meter
      10) Three – Current transformers for bus differential relay protection
      11) One – Zero sequence ground fault current transformer where ground fault protection is specified
      12) One – Current transformer, furnished by the main pump manufacturer, for use with Pump and Motor Protection relay (PMPR). Coordinate and install in accordance with pump manufacturer's recommendations.
   b. Low Voltage Compartment and Door
      1) One – Motor Protection Relay and meter (MPR as specified in 2.7)
      2) One set – Interposing control relays as per plans
      3) One – Timing Relay, adjusted to stagger the pump starts as indicated on the Plans
      4) One – Set of control circuit terminal blocks
      5) Two – VT's, Open Delta,
      6) Isolation switch viewing window to verify switch position
      7) One – CT shorting terminal block
      8) One – Microprocessor metering package as specified in 2.7.

2.7 PROTECTIVE RELAYS AND METERING

A. Multifunctional, solid-state microprocessor-based relay and metering, complying with IEEE C37.90. Provide motor protective relay, SEL-710 or approved equal. The protection scheme shall include motor jammed, motor overload and overcurrent (50/51), under and over voltage (27/59), under current/power (37), phase balance (46), phase sequence (47) and over/under frequency (81), as a minimum.

B. Coordinate with the main pump manufacturer, obtain motor data and provide manufacturer recommended settings.

C. Auxiliary Devices

1. Provide test switches.
2. Provide disconnecting potential transformers, fused-type, of the quantity and ratings indicated on the contract drawings
3. Provide window-type current transformers of the quantity and current rating as indicated on the contract drawings. Current transformer accuracy shall be suitable for the connected burden
4. Provide Modbus TCP CAT 6 interface to SCADA
5. Provide time synchronization with other protective relays and SCADA. Provide coax interface to GPS clock as shown on IC Drawings.
6. Provide an auxiliary control power transformer of the quantity and kVA rating as indicated on the contract drawings

D. Coordinate with main pump manufacturer and install in the respective starter compartments, one current transformer, pump motor protection relay unit, and its display unit, which shall be furnished by the pump supplier, as noted in the Plans for the selected equipment. Display unit, Ethernet jack for the relay unit and reset pushbutton shall be installed on the door, and shall be accessible without opening the door.

2.8 SCADA AND REMOTE CONTROL STATION INTERFACE

A. Provide hardwired I/O interface and Modbus TCP interface to SCADA, as described in Section 26 13 26 – 2.10.

B. Provide time synchronization of motor protective relays with SCADA and other microprocessor based protective relays in the switchgear section, as shown on IC Drawings.

2.9 ENCLOSURES

A. Provide NEMA 1A gasketed enclosures for indoor applications where shown on the contract drawings. Outdoor enclosures shall be provided with space heaters and thermostats.. Control power shall be obtained from an internal control power transformer.

B. Enclosures for the medium voltage starters shall meet NEMA ICS-6 standards. Enclosure shall be NEMA 1, unless otherwise noted, completely front accessible, allowing for free-standing, against a wall, or back-to-back mounting.

C. Provide a auxiliary section to accommodate bus connection to the switchgear.

D. Structures shall be welded steel frame, formed steel doors and side sheets, flat steel top and rear covers.

E. Standard hardware shall be grade 5, plated zinc-dichromate.

2.10 NAMEPLATES

A. Nameplates shall be 2-inch high x 2-1/2 inch wide, laminated black with white core.

B. Unit nameplate and device marker lettering shall be 3/16-inch high.

2.11 FINISH

A. The finish for internal and external parts shall consist of a coat of ANSI 61 (gray) thermosetting, polyester, powder paint applied electrostatically to pre-cleaned phosphatized steel and aluminum surfaces.

2.12 ACCESSORIES

A. Provide a portable lifting device for transporting contactor outside its compartment.

B. Provide remote motor operator for the isolating switches

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

1. Wiring check
2. Sequence of control circuits
3. Dielectric Test (Hi Pot) per NEMA ICS 3 Part 2 at 2000 volts plus 2.25 times nominal voltage, for 60 seconds, phase-to-phase and phase-to-ground

B. The manufacturer shall provide three (3) certified copies of factory test reports.

C. Factory tests as outlined above shall be witnessed by the Department's representative. Provide transportation and lodging foe two (2) Department personnel, as designated by the Engineer, to witness the factory acceptance tests.

1. The manufacturer shall notify the Engineer, fourteen (14) days prior to the date the tests are to be performed.

3.2 FIELD QUALITY CONTROL

A. Engage the services of a testing agency and provide testing in accordance with Section 26 00 01 – 3.8.

B. Engage the services of a qualified factory-trained manufacturer's representative to provide startup of the equipment specified under this section.

C. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:

1. Megger bus
2. Ground test
3. Verify that all mechanical interlocks are functioning properly

D. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.3 TRAINING

A. The Contractor shall provide a training session for ten (10) Department representative(s) for 3 normal workday(s) at a job site location determined by the Engineer. This training may be combined with the training specified in Section 26 13 26.

B. The training session shall be conducted by a manufacturer's qualified representative and include instructions on assembly, starters and other major components.

3.4 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

C. Check all bolted connections to assure that they are in accordance with the manufacturer's recommended torque requirements.

3.5 FIELD ADJUSTMENTS

A. Program the motor protective relays in accordance with the recommendations documented by the coordination study, Section 26 00 02 or as directed by the Engineer.

3.6 FIELD TESTING

A. Sequence the control circuit to verify that the starter will start and run properly.

END OF SECTION

SECTION 26 24 19 - MOTOR CONTROL CENTER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Motor control center equipment shall be the items of equipment specified herein.

B. The manufacturer shall provide one set of any special tools, as applicable, required for the maintenance of the equipment, housed in a metal tool box.

C. Equipment furnished under this section shall be complete with anchor bolts and associated hardware required to anchor equipment to concrete. Anchor bolts and all hardware shall be galvanized steel.

D. For each specified item, a representative of the manufacturer shall check the installation and submit, to the Engineer, three (3) certified, signed statements, addressed to the Engineer, that the equipment has been properly installed and is in good working order.

E. Factory Acceptance Testing.

F. Related Sections

1.	Division 03	Concrete
2.	Division 23	Heating, Ventilating, and Air-Conditioning (HVAC)
3.	Section 26 00 01	General Electrical Provisions.
4.	Section 26 00 02	Electrical Power System Studies.
5.	Section 26 00 03	Basic Electrical Materials and Methods.
6.	Section 26 00 05	Miscellaneous Electrical Equipment
7.	Section 40 90 05	Supervisory Control Data Acquisition (SCADA)
8.	Section 41 22 13	Bridge Crane
9.	Section 43 25 13	Pumping Equipment
10.	Section 46 21 11	Mechanical Screens

G. Progress payments will be in accordance with Section 109 of the Standard Specifications.

H. Equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed,

spare parts have been delivered, Record Drawings have been approved and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. Payment for work specified under this Section shall be included in the Contract lump sum price for the Item, PUMP STATION MOTOR CONTROL CENTER.

1.2 REFERENCES

A. Codes and Standards referred to in this Section are:

1. NEMA ICS-1 General Standards for Industrial Control and Systems.
2. UL 845 Motor Control Centers
3. ISA Standards and Recommended Practices for Instrumentation and Control
4. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum.)
5. IEEE C37.20.7 for Arc-resistant MCC Testing and Verification

1.3 SUBMITTALS

A. Provide shop drawing and product data under provisions of Section 26 00 01.

B. Submittals of shop drawings and product data shall be particularly detailed and complete. Submittals shall be complete with the manufacturer's guarantee. Piecemeal submittals will be returned without review.

C. Submit Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Time-current characteristic curves for overcurrent protective devices

D. Submit Shop Drawings For MCC:

1. Include a tabulation of installed devices with features and ratings.
2. Include dimensioned plans and elevations, showing dimensions, shipping sections, and weights of each assembled section. Elevations shall show major components, features, and mimic bus diagram.
3. Include a plan view and cross section of equipment base showing clearances, manufacturer's recommended work space, and locations of penetrations for grounding and conduits. Show location of anchor bolts and leveling channels.
4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, and location and size of each field connection.
5. Locate accessory and spare equipment storage.
6. Include single-line diagram.
7. Include control power wiring diagrams.
8. Include copy of nameplate.
9. MCC Ratings:
   a. Voltage.

b. Continuous current.
c. Short-circuit current.

10. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting seismic restraints.
11. Overcurrent settings.
12. Interface data with monitoring or control network.
13. Wiring Diagrams: For each MCC section include the following:
    a. Power, signal, and control wiring.
    b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.
    c. Schematic control diagrams.
    d. Diagrams showing connections of component devices and equipment.
    e. Schematic diagrams showing connections to remote devices including connection details to the SCADA equipment.

E. Submittal information shall include bill of materials, one-line diagram, schematic diagrams, MCC front elevation views, MCC front of bucket views; point-to-point internal wiring diagrams, point-to-point field wiring diagrams, and other necessary diagrams and installation requirements for the motor starters, motor control center, and automatic transfer control system components and other components and systems that are interfaced to these systems.

F. The manufacturer of each specified item shall provide not less than four (4) hard-cover operation and maintenance manuals for the respective equipment item furnished. The manuals shall contain final, approved shop drawings and product data sheets (including any field additions or modifications), as well as recommended installation, testing, operation and maintenance procedures. Refer to Section 26 00 01 for further requirements.

G. Submit three (3) certified copies of MCC factory test reports.

H. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

1.4 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling shall be in accordance with the provisions of Section 26 00 01.

B. Motor control center and switchgear sections shall be delivered in shipping splits that can be moved past obstructions in delivery path.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCC and its components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 33 04 "Operation and Maintenance Manuals," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. Stamped and signed approved shop drawings and catalog cuts
4. Stamped and signed O&M Manuals
5. Stamped and signed record drawings

PART 2 - PRODUCTS:

2.1 MOTOR CONTROL CENTERS

A. Manufacturers

1. Eaton
2. Schneider Electric
3. Allen-Bradley
4. General Electric
5. LV MCC, Medium Voltage Metal-Clad Switchgear and Medium Voltage Motors Starters shall all be furnished by the same manufacturer.
6. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor’s responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
7. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
8. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

B. Coordination Study

1. Where coordination study specified in Section 26 00 02 recommends changes in types, classes, features or ratings of equipment or devices from those indicated, make written request for instruction. Obtain instructions from ENGINEER before ordering equipment or devices recommended to be changed.

C. Motor Control Centers

1. Wiring: NEMA ICS 3, Class I, Type B.
   a. Factory installed wiring shall include conductor labels which correspond to approved shop drawings. Each wire shall have a clear label at terminal strip and termination points.
2. MCC shall be Arc-Resistant, tested and verified in accordance with IEEE C37.20.7.
3. Short Circuit Rating: 65 kAIC
4. Enclosures: Surface-mounted cabinets as indicated. NEMA 250, Type 1 gasketed, unless otherwise indicated to meet environmental conditions at installed location.
   b. Compartments: Modular; individual doors have concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units require disconnect means in off position before door can be opened or closed, except by consciously operating permissive release device.
   c. Interchangeability: Compartments are constructed to remove units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in control center. Units requiring same size compartment are interchangeable, and compartments are constructed to permit ready rearrangement of units, such as replacing 3 single units with unit requiring 3 spaces, without cutting or welding.
   d. Wiring Spaces: Each vertical section of structure with horizontal and vertical wiring has spaces for wiring to each unit compartment in each section, with supports holding wiring in place.
5. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

D. Buses

1. Material: Tin plated copper.
2. Ampacity Ratings:
   a. As indicated on the drawings for horizontal buses.
   b. 300 amp min for vertical main buses or larger as required for installed units.
3. Neutral Buses: Full size in service entrance section only.
4. Equipment Ground Bus: Noninsulated, horizontal copper bus 2 by 1/4 in. (50 by 6 mm), min.
5. Horizontal Bus Arrangement: Main phase, neutral and ground buses extended with same capacity entire length of motor-control center, with provision for future extension at both ends by bolt holes and captive bus splice sections.
6. Short-Circuit Withstand Rating: Same as short-circuit current rating of section.

E.Functional Description

1. Description: Modular arrangement of motor controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center as indicated.
2. Motor-Controller Units: Combination controller units of types and with features, ratings, and circuit assignments indicated.
   a. Units with full-voltage, across-the-line, magnetic controllers up to and including Size 3 are installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   b. Units have short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center section.
   c. Units in motor-control centers with Type B wiring are equipped with pull-apart terminal strips or drawout terminal boards for external control connections.
3. Overcurrent Protective Devices: Types of devices with features, ratings, and circuit assignments indicated. Individual feeder-tap units through 225-A rating shall be installed on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
4. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.
5. Spare Units: Type, size, and ratings as indicated, and installed in compartments indicated “spare”.

F. Magnetic Motor Controllers

1. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across-the-line, unless otherwise indicated.
2. Control Circuit: 120V; obtained from integral control power transformer, unless otherwise indicated. Include control power transformer with adequate capacity to operate connected pilot, indicating and control devices, plus 100% spare capacity.
3. Controller shall be equipped with a transmitter for providing motor current configured as a 4-20mA signal for the controllers shown on the drawings.
4. Combinational Controller: Factory-assembled combination controller and disconnect switch with or without overcurrent protection as indicated.
5. Circuit-Breaker Disconnect: NEMA AB 1, motor-circuit protector with field-adjustable short-circuit trip coordinated with motor locked-rotor amperes.
6. Overload Relay:
   a. Provide NEMA Class 20 heaters or sensors in each phase matched to nameplate full load current of specific motor to which connected with appropriate adjustment for duty cycle. Solid state overloads not acceptable.
   b. Enhanced Protection Overload Relay: Provide overload relays with NEMA Class 10 or better tripping characteristics for submersible equipment or where indicated. Select to protect motor against voltage unbalance and single phasing.
   c. For submersible equipment controllers, also provide jam, phase unbalance, phase sequence and under current/power protection.
7. When power factor correction capacitors are indicated provide termination lugs on line side of overload relays.

8. Time Delay Restart Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection.
   a. Provide in starter enclosure for Size 2 and larger starters.
   b. Delay initial motor start.
      1) Delay motor restart due to starter dropout caused by undervoltage or starter coil circuit interruption for maintained control circuits.
      2) Adjustable on delay from 0.15 to 30.0 sec set at 10.0 sec.
      3) Connect control relay in motor starter coil circuit.
      4) Coordinate control relay section with motor starter to cause motor starter to drop out at voltage slightly higher than dropout voltage of starter and have dropout time slightly faster than motor starter to ensure if motor starter drops out, relay will drop out.

G. Feeder Overcurrent Protection

1. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
   a. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
   b. Application Listing: Appropriate for application, including Type HACR for heating, air-conditioning, and refrigeration equipment.
   c. Circuit Breakers, 200A and Larger: Trip units interchangeable within frame size.
   d. Circuit Breakers, 400A and Larger: Field-adjustable, instantaneous, short-time, long-time and continuous-current settings.
   e. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
   f. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
   g. Shunt Trip: Where indicated or required for ground fault protection trip.

H. Micro Processor Based Metering Units

1. Each incoming line shall have microprocessor based electronic metering unit with digital readout and key pad. Metering unit shall monitor phase amperes, phase-to-phase voltages, and phase-to-neutral voltages with one percent accuracy. Metering system shall also monitor and indicate megawatts, megavars, power factor, megawatt demand and frequency. In addition, overvoltage/undervoltage, phase loss/ unbalance/reversal protective functions shall also be available and user programmable. Furnish two NO/NC alarms and two NO/NC trip contacts. Fused potential transformers shall be included. Current transformers shall be as shown. Metering units shall be equipped with data communications modules capable of communication with the SCADA panel using Modbus TCP protocol; data to be monitored shall be as shown on the Drawings. Coordinate with SCADA panel supplier through the Contractor to determine protocol type. Metering units shall be door mounted. Contractor shall transmit signals to the SCADA system from the metering units for the functions as described in this Section and as shown on the drawings.

I. Surge Protection Device on Main Circuit Breakers

1. SPD and connecting breaker shall be service entrance rated and provided by motor control center manufacturer located external to the motor control center.
2. See Section 26 00 05 for external surge protection device requirements for MCC.
3. IEEE C62.41, selected to meet requirements for category C3.
4. Protection modes and UL 1449 clamping voltages coordinated with circuit system and circuit voltage.
5. Factory mounted with UL listed and labeled mounting device.
6. 200 kA per phase surge current capacity minimum.
7. Dedicated flange mounted disconnect in common MCC bucket.
8. Door mounted diagnostic lights.
9. Audible alarm, with silencing switch, to indicate when protection has failed. Switch shall be accessible from outside of bucket and not require bucket door to be opened to access.
10. Replaceable modular design.
11. Data communications module capable of communication with the SCADA panel using Modbus TCP protocol. Data to be monitored shall be as shown on the Drawings.
12. Mounted next to main incoming device in MCC.
13. One form C contact to indicate suppressor is operational
14. Minimum 10 year warranty.

J. External Hard Wired Signals

1. Pump Motor Starter Buckets
   a. Provide dry contact for remote indication of motor overload.
   b. Provide dry contact for remote indication of selector switch in Auto.
   c. Provide dry contact for remote indication of selector switch in Off.
   d. Provide dry contact for remote indication of circuit breaker open.
   e. Provide dry contact for remote indication of pump running.
   f. Provide dry contact for remote indication of pump moisture.
   g. Provide dry contact for remote indication of pump overtemp.
   h. Provide isolated 4-20mA signal for remote indication of motor amps.
   i. Ability to accept call signal from SCADA.
   j. Ability to accept call signal from float switch
   k. Ability to accept motor protection relay override signal from SCADA.
   l. Ability to accept and send signals to remote control stations on shown on Drawings.
2. Main Breakers
   m. Provide dry contact for remote indication of MCC-1 main breaker open.
   n. Provide dry contact for remote indication of MCC-1 main breaker tripped.
   o. Provide dry contact for remote indication of MCC-1 ground fault.
   p. Provide dry contact for remote indication of MCC-2 main breaker open.
   q. Provide dry contact for remote indication of MCC-2 main breaker tripped.
   r. Provide dry contact for remote indication of MCC-2 ground fault.
   s. Provide dry contact for remote indication of MCC Tie breaker closed.

K. Open Transition Automatic Transfer Control System (ATCS)

1. Provide an automatic transfer control system for control of three circuit breakers, Main1, Tie and Main2. The logic of the transfer control system functions shall be provided via a microprocessor. The set points shall be field adjustable without the use of special tools
2. The transfer control system shall be provided with a local display. The display shall show the status of the system as it is operating. When timers are functioning, the display shall show the timer counting down. All time delays shall be capable of being set from the front of the display using a timer setting screen
3. The transfer control system includes the following features:
   a. Time delay to close Tie on loss of Source 1, adjustable.
   b. Time delay to close Tie on loss of Source 2, adjustable.
   c. Time delay to open Tie and transfer load to Source 1, adjustable.
   d. Time delay to open Tie and transfer load to Source 2, adjustable.
   e. Time delay neutral (main and tie open), adjustable.
   f. The local system display shall show the following: Main- Tie- Main one line diagram; main and tie breaker status (open, closed, tripped, out of cell); readout marked “Source 1” and “Source 2” to indicate that respective source voltages are available; automatic/manual mode select pushbutton; pushbuttons for manual breaker control; and alarm information (loss of source, breaker trip).
4. Sequence of Operation – Automatic Mode
   a. Under normal conditions, the main breakers are closed and the tie breaker is open.
   b. Upon phase loss or loss of phase-to-phase voltage of either utility source to between 80% and 100% of nominal, and after a time delay, adjustable from 1 to 60 seconds to override momentary dips and outages the transfer control system shall open the affected main breaker and close the tie breaker.
   c. When normal voltage has been restored after a time delay, adjustable from 10 to 600 seconds (to ensure the integrity of the source), the transfer control system shall open the tie breaker. The transfer control system shall have an adjustable neutral position timer (0-10 seconds) to allow voltage to decay sufficiently before the affected main breaker is then closed (open transition retransfer).
   d. If Source 2 should fail while carrying the load, transfer to Source 1 shall be made instantaneously upon restoration of Source 1 to satisfactory conditions.
   e. If both sources should fail simultaneously, no action shall be taken.
   f. If the main or tie breakers trip due to a fault, the transfer control system shall be reset to manual mode and manual operation of that breaker shall be prevented until its overcurrent trip switch is reset.
5. Sequence of Operation – Manual Mode
   a. While in manual mode, breakers shall be capable of being opened and closed using control switches or pushbuttons on the transfer control system display. Electrical interlocking shall be provided to prevent the closing of both mains and the tie simultaneously.
6. Provide a control power transformer for each source with control power transfer scheme
7. Provide electrically operated main and tie circuit breakers
8. Provide a programmable logic controller with 24 volts dc ride-through power supply
9. Provide an industrial display panel

L. Accessories

1. Provide main breaker with auxiliary contacts and alarm lockout contacts to provide circuit breaker open and circuit breaker trip status.
2. Factory install in controller enclosure, unless otherwise indicated.
   a. Low Flow Pumps: “Pump Run”, “Pump Call”, “Manual Operation”, and “Off” Pilot Lights, LED type, push-to-test: NEMA ICS 2, heavy-duty type. Front of bucket mounted motor protection relay provided by pump manufacturer, install such that bucket does not need to be opened to access relay. If said relay does not have a means for reset, contractor shall provide a reset pushbutton on front of bucket.
   b. Manual overload reset button on all motor starter buckets.
   c. Non-resettable pump run timer indicating total run time in hours.
   d. Non-resettable pump start counter indicating total number of starts.
3. Furnish the following devices when indicated on Drawings.
   a. Push-Button Stations and Selector Switches: NEMA ICS 2, heavy-duty type.
   b. Stop and Lockout Push-Button Station: Momentary-break push-button station with factory-applied has arranged so padlock can be used to lock push button in depressed position with control circuit open.
   c. Control Relays: Auxiliary and adjustable time-delay relays.
   d. Elapsed Time Meters: Heavy duty with digital readout in hours.

M. Nameplates

1. Factory install for each bucket and each individual device. Nameplates shall include equipment description populated from drawings. Use a minimum of 1/2 inch high lettering on 1-1/2 inch high label. Nameplates shall be plastic laminate securing fastened to equipment with screws. Use black lettering on white field.
2. Factory installed nameplate describing technical ratings of MCC including short circuit current rating. Nameplate to be located outside of the gear on front face of incoming section.
3. Mimic bus showing Main1-Tie-Main2 Automatic Transfer Control System.

N. Fabrication

1. Indoor enclosure: Steel.
2. Finish: Manufacturer’s standard gray exterior finish over rush-inhibiting primer on phosphatizing-treated metal surfaces. Interior finish shall be white.

2.2 QUALITY ASSURANCE

A. The motor control center furnished under this Section shall be fully tested and documented by certified factory test reports, in accordance with Section 26 00 01 and as specified herein.

B. As a minimum, the following tests shall be conducted:

1. The following factory standard tests shall be performed on the circuit breaker element (main breakers only) provided under this section. All tests shall be in accordance with the latest version of ANSI standards.
   a. One-minute insulation-resistance test on each pole, phase-to-phase and phase-to-ground per ANSI standards.

b. Final inspections and quality checks.

2. The following production test shall be performed on each breaker housing:
   a. Operation of wiring, relays and other devices verified by operational sequence test.
   b. Final inspections and quality checks.
3. MCC Automatic Transfer Control system shall be simulated for correct operation on loss of voltage, under/over-voltage, overcurrent loss of phase, phase imbalance and under/over-frequency.
4. Verification of circuit breaker interlocks.
5. Verification of motor starter circuits and interlocks.
6. Energize contactors using an auxiliary source.
7. Verification of meter readouts through application of current and voltage to each analog input.
8. The manufacturer shall provide three (3) certified copies of factory test reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify location and layout of Motor Control Centers equipment.

B. Verify that electrical power is available and of correct characteristics.

3.2 PREPARATION

A. Install concrete bases after dimensions of equipment are confirmed by equipment manufacturers.

3.3 INSTALLATION

A. Install system and components in accordance with manufacturer's specifications.

B. The installer shall provide all labor and perform all work to install and make operable all mechanical and electrical equipment necessary to assure safe and reliable operation.

3.4 FIELD QUALITY CONTROL

A. Representative of the Manufacturer

1. The services of a qualified representative of the manufacturer shall be provided to instruct on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct operating personnel in its operation and maintenance. This service shall include all equipment provided in this Section. Include:
   a. Two mandays for Installation Services for Motor Control Center.
   b. One manday for Instructional Services for Motor Control Center.

2. The start-up services for the following equipment shall be coordinated with the Department and it shall be notified at least two weeks in advance:
   a. Motor Control Center.
3. Test in accordance with Section 26 00 01.

3.5 ADJUSTMENTS

A. Motor Control Centers

1. Set field-adjustable pick-up time-sensitivity ranges in accordance with Section 26 00 02.

END OF THIS SECTION

DIVISION 31
EARTHWORK

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SECTION 31 23 00 - EARTHWORK FOR STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Earthwork - excavation, backfilling, compaction, disposal of waste and surplus materials, and other Earthwork related work.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 31 63 29 - Temporary Excavation Support.

1.2 METHOD OF MEASUREMENT

A. The work specified herein will be measured for payment in Cubic Yards (CU YD) in place. The volume measured for payment will be limited to the dimensions agreed upon with the Engineer before construction.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract unit price per Cubic Yards (CU YD) for STRUCTURE EXCAVATION, ROCK EXCAVATION FOR STRUCTURES or GRANULAR BACKFILL FOR STRUCTURES, which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 DEFINITIONS

A. Excavation:

1. Consists of removal of material encountered to subgrade elevations required or indicated.
2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.

B. Foundations: Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

C. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

D. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

E. Unauthorized Excavation:

1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
   a. Unauthorized excavation, as well as associated remedial work as directed by Engineer, shall be at Contractor's expense.
2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Engineer.

1.5 SUBMITTALS

A. Samples:

1. Coordinate samples and testing for approval of off-site materials with the Engineer.
2. Test reports.

1.6 PROJECT CONDITIONS

A. Salvageable Items: Carefully remove items to be salvaged, and deliver to the Department as directed by the Engineer.

B. Dispose of waste materials, legally, off site.

1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill and Backfill:

1. Selected material approved by Engineer from site excavation or from off site borrow.
2. Structural Fill:
   a. Uniform granular soil.
   b. Free of organic matter, frozen material and debris.
   c. Granular soil:
      1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM or SC.
3. Non-Structural Fill:
   a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
   b. Liquid limit: Less than 45.
   c. Maximum plasticity index: 20.

B. Granular Fill Under Building Floor Slabs-On-Grade, and Electrical Equipment Pads:

1. Clean, granular material.
2. Less than 5 PCT fines passing the No. 200 sieve.
3. ASTM C33 gradation size No. 67, 3/4 IN to No. 4 or other material acceptable to Engineer.

PART 3 - EXECUTION

3.1 PROTECTION

A. Erosion Control:

1. See Standard Specifications for Road and Bridge Construction.

B. Protect existing surface and subsurface features on-site and adjacent to site in accordance with Standard Specifications for Road and Bridge Construction.

3.2 ROCK EXCAVATION

A. Rock Excavation: In accordance with Standard Specifications for Road and Bridge Construction, Section 502, with the following exceptions.

B. Blasting with any type of explosive is prohibited.

3.3 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Provide dewatering system necessary to successfully complete compaction and construction requirements.

C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Engineer.

D. Stabilize subgrade with well graded granular materials as directed by Engineer.

E. Assure by results of testing that compaction densities comply with the following requirements:

1. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside of structures under foundations, under equipment support pads, under slabs-on- grade and scarified existing subgrade under fill material	95 PCT per ASTM D1557	-2 to +3 PCT of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	95 PCT per ASTM D1557	-2 to +3 PCT of optimum
Behind and around site retaining walls	95 PCT per ASTM D698	-2 to +3 PCT of optimum

2. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	95 PCT per ASTM D1557	-2 to +3 PCT of optimum
Granular fill under building floor slabs-on-grade	60 PCT relative density per ASTM D4253 and ASTM D4254	

3.4 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:

1. In general, work includes, but is not necessarily limited to, excavation for structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
2. Obtain fill and backfill material necessary to produce grades required.
   a. Materials and source to be approved by Engineer.
   b. Excavated material approved by Engineer may also be used for fill and backfill.
3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:

1. General:
   a. Do not commence excavation for foundations for structures until Engineer approves:
      1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
      2) Density and moisture content of site area compacted fill material meets requirements of specifications.
      3) Installation of Temporary Excavation Support System, if applicable.
   b. Engineer grants approval to begin excavations.
2. Dimensions:
   a. Excavate to elevations and dimensions indicated or specified.
   b. Allow additional space as required for construction operations and inspection of foundations.
   c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
   d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.

a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Engineer.
b. Remove unsuitable subgrade soils located below foundations. The bottom of the overexcavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
    1) Distance equal to depth of overexcavation below bottom of foundations.
    2) 5 FT.
    3) As directed by Engineer.
c. When excavation has reached required subgrade elevations, notify Engineer, who will make an inspection of conditions.
    1) If Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.

4. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
    a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
    b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 6 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
    c. Do not carry excavations lower than shown for foundations except as directed by Engineer.
    d. If any part of excavations is carried below required depth without authorization, notify Engineer and correct unauthorized excavation as directed. Corrections may include:
        1) Under soil supported footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
            a) Concrete fill may be used to bring elevations to proper position.
        2) In locations other than those above, including slabs on grade and pile supported foundations, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.
        3) No extra compensation will be made to Contractor for correcting unauthorized excavations.
5. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
6. Notify Engineer as soon as excavation is completed in order that subgrades may be inspected.
    a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.

b. Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.

7. Dewatering:
   a. See Section 31 63 29 for dewatering requirements specific to the Temporary Excavation Retention System.
   b. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade below foundations and fill material, to allow foundations and fill material to be placed in the dry, and to maintain a stable excavation side slope.
   c. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
   d. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
   e. Employ dewatering specialist for selecting and operating dewatering system.
   f. Keep dewatering system in operation until dead load of structure exceeds possible buoyant uplift force on structure.
   g. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
      1) Install groundwater monitoring wells as necessary.
   h. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
8. Subgrade stabilization:
   a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Engineer.
   b. Provide compaction density of replacement material as stated in this Specification Section.
   c. Loose, wet, or soft materials, when approved by Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
   d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
   e. Remove and replace frozen materials as directed by Engineer.
   f. Method of stabilization shall be performed as directed by Engineer.
   g. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Engineer.
9. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.

a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DEGF before structure is completed and heated to a temperature of at least 50 DEGF.

10. Protection of structures:
    a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
    b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
11. Shoring:
    a. Shore, slope, or brace excavations as required to prevent them from collapsing.
    b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
    c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
12. Drainage:
    a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
    b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
    c. Provide pumping required to keep excavated spaces clear of water during construction.
    d. Should any water be encountered in the excavation, notify Engineer.
    e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
13. Frost protection:
    a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
    b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
    c. Protect excavation from frost if placing of concrete or fill is delayed.
    d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project.
    e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.

C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:

1. General:
    a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Engineer and scarified to a depth of 6 IN and compacted to density specified herein.

b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 PCT.
c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Engineer as being free of undesirable material and compacted to specified density.

2. Obtain approval of fill and backfill material and source from Engineer prior to placing the material.
3. Granular fill under floor slabs-on-grade at EL 624.83: Place all floor slabs-on-grade on a minimum of 6 IN of granular fill unless otherwise indicated.
4. Fill and backfill placement:
   a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Engineer.
   b. Place fill and backfill material in thin lifts as necessary to obtain required compaction density.
   c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
   d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
      1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum.
      2) Contractor is responsible for method of compaction so as not to damage wall.
   e. Use hand operated equipment for filling and backfilling next to walls.
   f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
   g. Use vibratory equipment to compact granular material; do not use water.
5. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.

D. Filling and Backfilling Outside of Structures.

1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
2. Provide material as approved by Engineer for filling and backfilling outside of structures.
3. Fill and backfill placement:
   a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Engineer.
   b. Place fill and backfill material in thin lifts as necessary to obtain required compaction density.
   c. Compact material with equipment of proper type and size to obtain density specified.
   d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
      1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum.
      2) Contractor is responsible for method of compaction so as not to damage wall.

e. Use only hand operated equipment for filling and backfilling next to walls and retaining walls.
f. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
g. Use vibratory equipment for compacting granular material; do not use water.

4. Backfilling against walls:
   a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.
   b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
   c. Backfilling for pump station:
      1) Do not place backfill against walls below EL 585.00 until all concrete walls, struts and beams below EL 589.00 are in place and have reached its 28- day required compressive strength.
      2) Do not place backfill against walls below EL 603.00 until all concrete walls, struts and beams below EL 599.75 are in place and have reached its 28- day required compressive strength.
      3) Do not place backfill against walls below EL 624.83 until all concrete walls, struts and beams below EL 624.83 are in place and have reached its 28- day required compressive strength.
   d. Backfilling for all other structures:
      1) Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
      2) See Contract Drawings for specific exceptions.
   e. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.

3.5 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA standards 29 CFR Part 1926.650 Subpart P, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. Inspections: By Engineer in accordance with IDOT Construction Manual and IDOT standard procedures.

END OF SECTION

SECTION 31 51 00 - ROCK ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Rock anchors.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 31 63 29 - Temporary Excavation Retention System.

C. All anchors indicated on the Drawings or specified to be rock anchors obtaining their required tension load carrying capacity from embedment into rock.

1.2 METHOD OF MEASUREMENT

A. The work specified herein will be measured for payment for each ROCK ANCHOR in place. The count measured for payment will be limited to the dimensions agreed upon by the Engineer before construction.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract unit price per each for ROCK ANCHORS, which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 QUALITY ASSURANCE

A. Referenced Standards:

1. American Institute of Steel Construction (AISC):
   a. 325, Manual of Steel Construction.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A311, Standard Specification for Cold-Drawn, Stress-Relieved Carbon Steel Bars Subject to Mechanical Property Requirements.
   c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
   d. A572, Standard Specification for High-Strength Low-Alloy Columbium- Vanadium Structural Steel.
   e. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. A722, Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete.
   g. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.

h. C33, Standard Specification for Concrete Aggregates.
i. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
j. C150, Standard Specification for Portland Cement.

3. Post-Tensioning Institute (PTI):
   a. Post-Tensioning Manual:
      1) Recommendations for Prestressed Rock and Soil Anchors, 4th edition, PTI DC35.1-04.

B. Qualifications:

1. Anchor installer to have a minimum of five (5) years of experience in the installation and construction of the type of anchors shown on the Drawings and required by the Specification Sections.

1.5 DEFINITIONS

A. Anchor Bond Length: That length of anchor which is bonded to a passive subgrade zone and which transmits the required anchor tension load to the structure or subgrade.

B. Anchor Embedment Length: That portion of the total length of anchor extending into and surrounded by subgrade rock material.

C. Production Anchors: Anchors indicated on Drawings or otherwise required for support of structural members.

D. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.6 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Manufacturer and type of proposed anchor along with proposed anchor corrosion protection.
   b. Proposed sizes and types of steel anchor or baseplates.
   c. Shop Drawings showing all bracing members and their connections.
   d. Manufacturer and type of proposed epoxy resin.
   e. Manufacturer and type of proposed fast setting leveling grout.
   f. Concrete grout mix design.

B. Qualifications:

1. Submit record of three (3) of Installer's past successful installations of required type of anchor under similar soil conditions.

C. Informational Submittals:

1. Submit results of all anchor load tests for Engineer information.
2. Submit strength test results of concrete grout placed in the field.
3. Submit anchor installation report for all in place production anchors.
   a. Submittal is for information only.

1.7 PROJECT CONDITIONS

A. Do not begin anchor installation until the earthwork in the area where anchors are to be installed has been completed as shown on the Drawings and indicated in this Specification Section.

B. Coordinate anchor installation with all other work including Temporary Excavation Support, dewatering and excavation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rock Anchors:
   a. Dywidag threadbar reinforcing steel as manufactured by Dywidag Systems International, USA, Inc.
   b. Williams All-Thread Bars as manufactured by Williams Form Engineering Corp.
2. Fast setting leveling grout under steel anchor or base plates:
   a. Super Por-Rok as manufactured by CGM, Inc.
3. Polyester or epoxy resin grout for bonding anchors to subgrade:
   a. FASLOC resin cartridges as manufactured by Dywidag-Systems International, USA, Inc.

B. Request for Substitution:

1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 ANCHOR CAPACITY

A. Allowable working tension load carrying capacity for each required production anchor: As stated on Drawings.

2.3 MATERIALS

A. Rock Anchors:

1. 1 IN DIA threadbar prestressing steel anchors conforming to ASTM A722.
   a. Minimum ultimate tensile stress: 150 ksi.

B. Steel Anchor or Baseplates: ASTM A36 or ASTM A572.

C. Washers Under Anchor Locking Nuts:

1. Beveled washers: Steel or malleable iron of sufficient strength to prevent gouging of washer while tightening locking nut.
2. Flat washers: ASTM A325.

D. Fast setting leveling grout under steel anchor or baseplates: Minimum 28-day compressive strength to be 5000 PSI.

E. Cement anchor grout for corrosion-protecting and bonding anchors to subgrade:

1. Cement: ASTM C150, Type I, II, or III.
2. Aggregates:
   a. ASTM C33 well graded from fine to coarse.
   b. Aggregates to be natural not manufactured.
3. Water: Potable, clean, free of oils, acids, and organic matter.
4. Water content to be minimum necessary for proper pumping of grout with a maximum water cement ratio by weight of 0.45.
5. Minimum 28-day compressive strength to be 5,000 PSI with a higher 28-day compressive strength provided if required to allow anchors to be post tensioned to specified tension loads.
6. Do not use expansive agents or admixtures in the grout mix.

F. Prior to beginning installation of anchors, submit the proposed cement grout mix design to Engineer for review.

1. Mix design to contain the following information:
   a. Sieve analysis and source of aggregates.
   b. Test for aggregate organic impurities.
   c. Proportioning of all materials.
   d. Type of cement along with mill certificate for the cement.
   e. One (1) seven (7) day and two (2) 28-day compression test results using 6 IN DIA by 12 IN high cylinders for testing.

PART 3 - EXECUTION

3.1 LINES AND LEVELS

A. Complete necessary excavation and furnish all lines and levels necessary for completion of anchor installation.

3.2 DETERMINATION OF ANCHOR LENGTH(S) TO BE INSTALLED

A. Perform no less than two (2) load tests on anchors to determine required anchor bond length and embedment length into subgrade necessary to provide required allowable working tension load carrying capacity.

1. Perform load tests prior to installing production anchors.
   a. Install test anchors at locations with anchor bond length and embedment length into subgrade all as determined and directed by Engineer.
2. All components and details of the test anchors to be the same as proposed and required for use in production anchors.
3. When approved, test anchors may be placed at locations required for production anchors.
   a. If test anchors are placed at these locations and for any reason are deemed unacceptable, install additional anchor or anchors adjacent to the inadequate anchor as directed by Engineer.
   b. Provide additional structural members as required to transfer load due to the location of an additional anchor or anchors and as directed by Engineer.
   c. Additional anchors and structural members to be provided and installed at no additional expense to the Contract.

B. Entire anchor load testing program to be under the direction and supervision of the Engineer.

1. When establishing anchor bond length and anchor embedment length into subgrade for test anchors, take into account the reduced tension capacity of an anchor due to "group action" caused by the close proximity to the locations of adjacent production anchors.
2. Apparatus for load testing anchors to be designed such that the load-carrying capacity of the anchor and the subgrade material surrounding the anchor are tested.
3. Contractor to design test anchor setup.
   a. Entire apparatus for load testing anchors to be supplied by Contractor.

C. Load test anchors in accordance with the PTI "Recommendations for Prestressed Rock and Soil Anchors."

1. Provide a calibration chart not more than 20 days old for the hydraulic jack, pump and pressure gauge used for the load tests. Calibrate the hydraulic jack, pump and pressure gauge as a system.
2. Entire load test setup to have adequate capacity for testing anchors to twice their specified allowable working tension load carrying capacity.
3. Provide a dial gauge to measure anchor movement during load testing.

4. Do not begin load tests until material used to bond anchors to subgrade has cured sufficiently to be capable of transferring the required test loads from the anchor to the subgrade.

D. Load test anchors to a minimum of twice the specified allowable working tension load carrying capacity as stated in this Specification Section.

E. Criteria for establishing failure of test anchors will be as determined by Engineer.

F. In the event of failure of test anchor apparatus setup, repeat load test at no additional cost to the Contract.

G. Based on the results of the anchor load tests, the anchor bond length and anchor embedment length into subgrade for production anchors to be installed at required locations to be as directed by the Engineer.

1. Send anchor load test results to Engineer for information.

H. If, during the installation of the production anchors, subgrade conditions are found to be different from those encountered during installation of the test anchors, or if production anchors are not capable of being post tensioned to the required loads as specified herein, revise the anchor bond length and/or the anchor embedment length into subgrade for the anchor being installed as directed by the Engineer.

1. If anchor is found to be not capable of being post tensioned to the required loads, install additional anchor or anchors as directed by Engineer with anchor bond length and embedment length as directed by Engineer.
2. Install additional structural members required by placement of additional anchor or anchors as directed by Engineer.
   a. Allow Engineer to witness installation of all production anchors.

3.3 ADDITIONAL ANCHOR LOAD TESTS

A. In addition to anchor load test requirements for Base Bid, Engineer may require installation and testing of additional test anchors loaded and tested in accordance with requirements of this Specification Section.

3.4 ANCHOR INSTALLATION AND DETAIL REQUIREMENTS

A. Equipment:

1. Drilling equipment shall be adequate for providing the required drill holes in the subgrade encountered.
2. All drilling is to be done by rotary or rotary-percussion drilling methods.
3. Grouting equipment to be capable of continuous mechanical mixing that will produce a uniform and thoroughly mixed cement grout at the required pressures.
4. Post tensioning of anchors to be accomplished by use of a hydraulic jack and pump properly calibrated, capable of applying the required tension loads and including appropriate gauges to indicate the load applied and to measure anchor elongation and movements.

B. Anchor Corrosion Protection:

1. All installed anchors for their entire length shall be covered with a gas-tight, corrugated polyvinyl chloride (PVC) or corrugated high-density polyethylene (HDPE) sheathing to prevent corrosive substances reaching the anchor steel.
2. A PVC or HDPE seal end cap to be placed over the bottom end of each anchor along with a gas-tight PVC or HDPE sealing cap placed over the anchor nut at each anchor.
3. PVC or HDPE required protection for anchors to be as standard with anchor manufacturer subject to review and approval by Engineer.

C. Anchor Placement:

1. Before anchor placement, each anchor to be thoroughly cleaned to permit adequate bonding of the anchor to the bonding material.
2. Do not install any anchors which are bent, cracked, of insufficient length, of reduced cross section due to any reason, or damaged in any way which would decrease the tension load carrying capacity of the anchor.
3. Install anchors at the indicated locations, to the embedment length as directed by the Engineer and at the indicated angle of inclination.
   a. Where the angle of inclination is not shown on the Drawings, an anchor shown horizontally shall be placed at 90 DEG with true vertical and an anchor shown vertically shall be placed at 90 DEG with true horizontal.
   b. A tolerance of ±3 DEG will be allowed on the indicated or specified angle of inclination.
4. All anchors to be continuous full length without splices.
5. Provide a washer under the anchor locking nut.
   a. Washer to be beveled where anchor is not 90 DEG to anchor plate.
6. Locking nuts shall be hexagonal head of the heavy duty type, conforming to the requirements of or in accordance with the manufacturer's specification for special nuts to be used with anchors supplied.
   a. Nuts to be capable of developing an ultimate strength of not less than 125 PCT of the minimum yield strength of the anchor to which it is attached.

D. Epoxy Resin Grout for Bonding Anchors to Subgrade:

1. The epoxy resin grout to be packaged in cartridge form with cartridges placed in the drill hole prior to placement of the anchor.
2. Install sufficient number of cartridges into the drill hole so that the entire embedded length and circumference of anchor is entirely coated with the epoxy resin.
3. Use fast setting resin for required anchor bond length and a slow setting resin for remainder of embedment length to accommodate stressing and to provide corrosion protection.
4. Install anchors through the resin cartridges to full length of required embedment in accordance with the anchor manufacturer's instructions.
5. Do not post tension anchors until epoxy resin has cured sufficiently to be capable of transferring the required post tensioning loads from the anchor to the adjacent subgrade material.

E. Cement Grout for Coating and Bonding Anchors to Subgrade:

1. Place grout continuously from bottom of drill hole to top of drill hole using tremie method until grout overflows top of hole.
   a. Place grout in such a manner to ensure that grout completely fills the drill hole and completely coats the anchor.
2. The entire required anchor bond length to be pressure grouted using sufficient pressure to allow the required post tensioned loads to be placed on the anchors.
   a. Do not place required post tensioning loads on anchors until cement grout has obtained sufficient strength to be capable of transferring the post tensioning loads from the anchor to the adjacent subgrade material.
3. The drill holes for soil anchors to be steel encased as required to prevent the intrusion of soil, water or any other material into the holes that would prevent the required bonding of the anchors to the subgrade.
   a. Withdraw steel casing slowly during grout placement in such a manner that grout completely fills the bore hole and completely coats the anchor.
4. Make three (3) 6 IN DIA x 12 IN high cement grout test cylinders for each consecutive 10 production anchors installed.
   a. Make cylinders in accordance with ASTM C31.
   b. Test one (1) cylinder at seven (7) days and two (2) cylinders at 28 days.
      1) Perform tests in accordance with ASTM C39.
   c. Send test results indicating production anchors they represent to Engineer.

F. Steel Anchor or Baseplates with Leveling Grout:

1. Provide anchor or baseplates of sufficient size and thickness to be capable of transferring the required post tensioning loads to the anchors without exceeding the specified allowable bearing stress on the leveling grout when such grout is required beneath the anchor or baseplate, and without exceeding the allowable bending stress for the steel plate as stated in the AISC 325.
2. When indicated on the Drawings or otherwise required, fully bed all anchor or baseplates on a minimum 1 IN thick layer of leveling grout.
   a. Leveling grout to be a fast-setting cement grout.
3. Required post tensioning anchor loads to not impose a bearing stress on the leveling grout which exceeds 0.3 times the compressive strength of the grout at the time of post tensioning.
   a. Minimum compressive strength of leveling grout at time of post tensioning to be 3,000 PSI.

G. Application, Measurement, and Magnitude of Post Tensioning Forces Required for Production Anchors:

1. All production anchors indicated on Drawings or specified (except load test anchors) to be post tensioned to 150 PCT of the required allowable working tension load carrying capacity indicated for each production anchor as stated in this Specification Section.
2. Maintain this 150 PCT load on each production anchor for a minimum period of 5 minutes.
   a. Measure anchor movement by dial gauge during the application of the 150 PCT load and while maintaining this load for the minimum 5 minute period.
   b. If during the 5 minute period, the anchor movement is less than 0.03 IN, the

c. 150 PCT load can be reduced and the production anchor locked-off at the required post tensioning force stated below.
d. If the anchor movement is greater than 0.03 IN during the 5 minute period, then the 150 PCT load to be maintained until the anchor movement decreases to an acceptable value as determined by the Engineer.

3. When approval to do so is obtained from the Engineer, reduce the 150 PCT load at each production anchor to a post tensioning force which will remain permanently in each production anchor equal to 110 PCT of the required allowable working tension load carrying capacity giving full consideration to all possible losses of the applied post tensioning force.
4. Allow the installation and post tensioning of all production anchors to be witnessed and approved by the Engineer.
5. All anchors to be post tensioned by means of a hydraulic jack.
   a. Post tensioning forces to be determined by both of the following methods:
   b. Measurement of anchor elongation.
      1) Required anchor elongation to be determined from average load elongation curves for type and size of anchors being installed.
   c. Observation of post tensioning force indicated on a calibrated gauge attached to the hydraulic jack applying the post tensioning force.
      1) Discrepancies of more than 5 PCT between elongation and gauge reading to be investigated and remedied.
      2) Movement of the structural system during the application of the post tensioning forces to be taken into account.

3.5 ROCK ANCHORS

A. Place each rock anchor in a minimum 5 IN DIA drill hole.

1. Each drill hole to be pressure tested to determine water leakage before anchor or bonding material can be installed.
2. When water leakage is determined by Engineer to be excessive, completely fill drill hole with consolidation cement grout.
3. Allow grout to harden and then re-drill hole to original diameter.
4. Recheck for water leakage.
5. Repeat consolidation grouting, re-drilling and leakage testing until Engineer approves drill hole for water tightness.
6. Consolidation cement grout to have a 5,000 PSI minimum 28-day compressive strength.
7. Allow Engineer to witness the drilling of all drill holes.

B. Completely coat and bond all rock anchors to rock subgrade with resin grout for entire anchor embedment length.

1. See this Specification Section for resin grout requirements.
2. Prior to placing resin grout cartridges in drill holes, ensure that drill holes are free of water, loose rock particles or any other item that might weaken the bonding of the anchor to the rock subgrade.
3. Clean drill holes as necessary.

C. Completely coat and bond all rock anchors to rock subgrade with cement grout for entire anchor embedment length.

1. Prior to placing anchor and grout in drill hole, ensure that hole is free of water, loose rock particles or any other item that might weaken the bonding of the anchor to the rock subgrade.
2. Clean drill holes as necessary.
3. See this Specification Section for concrete grout requirements.

3.6 ANCHOR REPORT

A. During the installation of the production anchors, provide an anchor report for each production anchor installed recording for each anchor the following information:

1. Anchor type, manufacturer, diameter and length.
2. Total anchor embedment length into rock.
3. Anchor drill hole diameter.
4. Whether or not consolidation grouting or temporary steel casing was required for drill hole.
5. Anchor bond length.
6. Quantity of resin grout placed in drill hole.
7. Quantity of cement grout placed in drill hole.
8. Hydraulic jacking force reading at 150 PCT of required allowable working tension load carrying capacity with all accompanying anchor movement measurements.
9. Hydraulic jacking force reading at 110 PCT of required allowable working tension load carrying capacity.

3.7 FIELD QUALITY CONTROL

A. Coordinate with Engineer who will provide the following Testing and Inspection:

1. Observe and direct anchor load testing program.
2. Establish test criteria for failure of test anchors.
3. Revise anchor bond length and/or the anchor embedment length into rock as required by changed field conditions.
4. Witness drilling of all drill holes.
5. Witness installation of all production anchors.

END OF SECTION

SECTION 31 63 29 – TEMPORARY EXCAVATION RETENTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The work specified in this Section includes requirements of the primary temporary excavation retention system (TERS) for construction of the proposed pump station and secondary connection to existing pump station.

B. Design, furnish, install, and maintain temporary excavation retention systems as required to provide lateral support, prevent loss of ground, limit soil movements to the Threshold Value, and protect the following from damage: existing pump station, I-290 embankment and appurtenant features, I-290 Bridge over Des Plaines River, adjacent underground utilities and any other features located within a distance equal to two times the greatest depth of the excavation.

C. The location, configuration, design, construction, and maintenance of the excavation retention system(s) shall be the sole responsibility of the Contractor. Development and implementation of quality control and assurance programs are the responsibility of the contractor, subject to review by the Engineer. The Contractor shall be responsible for sizing the excavations subject to review by the Engineer.

D. Temporary excavation retention system to be used for the primary excavation on this project shall be watertight to the level as defined in Section 1.5.A.6. Secant drilled shafts with multiple levels of internal bracing or similar types of watertight systems such as diaphragm walls, etc. are considered acceptable. Sheet piling will not be permitted.

E. Systems for the secondary excavation will require a two-stage approach with initial support consisting of either jet grout, slurry replacement with lean concrete, grouted spiling, or ground freezing. The second stage would consist of steel liner plate, shotcrete and ribs, or a jacked steel casing. Alternative systems may be accepted at the discretion of the engineer.

F. Construction of temporary excavation retention system(s) shall not disturb existing structures or the completed proposed structures. Should damage to adjacent structures occur during construction the Contractor, at no additional cost to the Contract, shall repair damage to said structures.

G. The Contractor shall be responsible for all quality control and quality assurance measures required to ensure the temporary excavation retention system is constructed to an adequate quality level to be suitable for its intended purpose.

H. The Contractor shall bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the temporary excavation retention system(s). The Contractor

shall pay for all claims, costs and damages that arise as a result of the work performed at no additional cost to the Contract.

I. If, in the judgment of the Engineer, the performance of the excavation retention system exceeds the Limiting values, the Engineer will instruct the Contractor to stop work and implement remedial measures to arrest further movements. The Contractor shall take immediate steps to implement the remedial measures at no additional cost to the Contract.

J. Temporary excavation retention system(s) shall be designed and installed in accordance with all OSHA excavation safety standards.

K. The acceptance of submittals is not to be construed as a complete check, and indicates only that the design, general method of construction, materials, detailing and other information provided appear to meet the Contract Documents. Acceptance will not relieve the Contractor of the responsibility for any errors that exist, as the Contractor is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work design, dimensions, all design extensions, such as the design of adequate connections and details, etc., and the satisfactory construction of all work.

L. Removal and disposal of temporary excavation retention system wall shall be performed as shown on the Drawings.

M. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.

1.2 METHOD OF MEASUREMENT

A. The final depth of excavation will be measured at alternating secondary drilled shafts (or other alternate system component) and averaged by the total number of measurements. The circumference shall be measured as the temporary excavation retention system centerline circumference. The exposed primary elements will be paid in square feet computed by multiplying the average final depth of excavation by the temporary excavation retention system centerline circumference. Secondary temporary excavation retention system elements and temporary excavation retention system wall removal work, as shown on the Drawings, will not be measured for payment.

B. Measurement for GROUT CURTAIN WALL below the temporary excavation retention system primary elements (if required) shall be measured per cubic foot of actual grout mixed and pumped into the rock.

1.3 BASIS OF PAYMENT

A. The work specified herein for the temporary excavation retention system shall be paid for at the contract unit price per square foot for TEMPORARY EXCAVATION RETENTION SYSTEM (SPECIAL), which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work. Any temporary excavation retention system wall removal and disposal required to clear retaining walls,

utilities, piping, duct bank, and as shown on the Drawings shall be considered incidental work.

B. The work specified herein for the grout curtain wall shall be paid for at the contract unit price per cubic foot for GROUT CURTAIN WALL (if required), which price shall be payment in full for all material, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 QUALITY CONTROL AND QUALITY ASSURANCE

A. Referenced Specifications, Codes and Standards:

1. Quality Control and Quality Assurance shall follow IDOT Standard Specifications appropriate to the elements selected by the Contractor's Designer for the TERS. For any elements not covered by these Specifications, the Contractor shall propose appropriate QC/QA methods subject to approval by the Engineer.

B. Temporary Excavation Retention System Designer's Qualifications:

1. Not less than five years of experience in the design of similar types of systems of at least 30 feet deep in urban areas of comparable type, size, and complexity as this project.
2. Completed not less than three successful temporary excavation retention system projects of comparable type, size, and complexity as this project within the last five years.

C. Temporary Excavation Retention System Installer's Qualifications:

1. Not less than five years of experience in the installation of selected type of temporary excavation retention systems at least 50 feet deep in urban areas of comparable type, size, and complexity as this project.
2. Completed not less than three successful temporary excavation retention system projects of comparable type, size, and complexity as this project within the last five years.

D. Install all Temporary Excavation Retention System under the supervision of a supervisor having the following qualifications:

1. Not less than five years of experience in installation of selected type of temporary excavation retention system at least 50 feet deep in urban areas of comparable type, size, and complexity as this project.
2. Completed not less than three successful temporary excavation retention system projects of comparable type, size, and complexity as this project within the last five years.

1.5 DESIGN CRITERIA

A. Design of temporary excavation retention system shall meet the following minimum requirements:

1. Support systems shall be designed for earth pressures, hydrostatic pressure, adjacent structures, equipment, traffic, uneven topography, temporary stockpiles, construction loads, and other surcharge loads.
2. Design internal bracing to provide sufficient reaction to maintain stability.
3. Limit movement of ground adjacent to the excavation retention system to be within the Threshold ground deformation specified in the approved Instrumentation and Monitoring Plan.
4. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements, provide bottom stability and control groundwater. A minimum penetration of the deeper of five (5) feet below the bottom of excavation or ten (10) feet below top of Rock as defined in IDOT Standard Specification section 516.09 shall be provided.
5. Design of temporary excavation support system shall withstand an additional one (1) foot of excavation below proposed bottom of excavation without redesign.
6. System shall be sufficiently watertight to limit groundwater leakage to no more than 0.01 gpm/sf or more stringent requirements as determined by the contractor.
7. Design of the TERS shall include contingency provision(s) for installation of a supplemental grouting curtain below the bottom of the primary TERS wall.

1.6 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 at least eight (8) weeks prior to the installation of any temporary excavation retention.

1. Qualifications of Contractor's temporary excavation retention system designer.
2. Submit a Temporary Excavation Retention Plan signed and sealed by a Structural Engineer licensed and registered in the State of Illinois at least eight weeks prior to start of the construction. Submit design calculations for review by the Engineer and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:
   a. The layout, depths, and extent of different types of vertical and lateral support elements relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal of the support elements. Indicate sizes, shapes, and material specifications for all support elements.
   b. Requirements of dewatering and depressurization elevation levels during the construction. Provide details of working slab, subdrains and sump construction where applicable.
   c. Minimum lateral distance from the edge of the excavation retention system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.
   d. Details of materials handling, stockpiling, and disposal sites for excavated materials.
   e. List of equipment used for installing the excavation retention systems.
   f. Provide an estimate via 2D analysis or other methods of anticipated lateral and vertical deformation of the excavation retention systems at each excavation stage.

g. Pump test procedure for validating TERS cutoff of groundwater prior to excavation.
h. Plan for contingency grout curtain installation.
i. Plan for support of connection between Proposed and Existing pump station including ground modification necessary to provide for a groundwater-tight seal.
j. Quality Control and Quality Assurance required during installation.
k. Plans for environmental controls.

3. Submit an Instrumentation and Monitoring Plan specific to the elements of the Temporary Excavation Retention Plan. The plan shall include the following items as a minimum:
   a. Type and location of survey monitoring points on excavation retention system.
   b. Type and location of monitoring points adjacent to the excavation (existing pump station, I-290 embankment & bridge, etc.)
   c. Type and location of combined inclinometer/piezometers adjacent to the excavation. A minimum of 3 will be required.
   d. Frequency of monitoring and reporting. At a minimum, daily readings shall be taken during construction and until movement has stabilized
   e. Reporting procedure for movements in excess of Threshold and Limiting values.
4. Submit a Construction Contingency Plan specifying the methods and procedures to maintain excavation retention system stability if the Threshold and or Limiting values movement of the adjacent ground and/or structures is exceeded.
5. For excavation retention systems left in place, submit the following as-built information prior to backfilling and covering the excavation retention systems:
   a. Survey locations of the temporary excavation retention system, including coordinates of the ends and points of change in direction.
   b. Elevations of top and bottom of the excavation retention systems left in place.

1.7 GROUND CONDITIONS

A. The work will be performed in an area where subsurface conditions have been investigated for the purpose of developing assumptions about ground conditions. A Geotechnical Investigation Report has been prepared based on this information.

B. The primary objective of the Geotechnical Investigation Report is to present the results of geotechnical investigations conducted for the project in a factual manner. These results include descriptions of field and laboratory investigations performed and procedures used, background physiography, regional geology information, and summaries of site subsurface conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials selected for the TERS by the Contractor's Designer such as concrete, cement, reinforcing steel, structural steel, grout, etc. shall comply with applicable IDOT Standard Specifications, with any modifications clearly identified by the designer

B. Other materials as selected by the designer of the TERS shall be in accordance with published industry or manufacturer standards where no applicable IDOT Standard Specification exists.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Installation of the temporary excavation retention system shall not commence until the Engineer has reviewed the related earth excavation and dewatering submittals with all Engineer's comments satisfactorily addressed.

B. Install excavation retention system in accordance with the Contractor's Temporary Excavation Retention Plan.

C. Carry out program of temporary excavation retention in such a manner as to prevent undermining or disturbing foundations of existing structures of work ongoing or previously completed.

D. Perform preparatory work to discover, protect, maintain and restore, or remove utilities, foundations or other facilities located within a horizontal distance two times the greatest depth of excavation of the proposed temporary excavation retention system.

E. Provide a baseline location survey of adjacent structures and features, including but not limited to existing pump station, I-290 embankment and appurtenant features, I-290 Bridge over Des Plaines River, and any other features located within a distance equal to the largest dimension of the excavation.

F. Conduct pre-excavation as necessary to remove obstructions and identify existing utilities along the alignment of the excavation retention system that will interfere with installation.

G. Notify Utility if existing utilities interfere with the temporary excavation retention system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at no additional cost to Contract.

H. The Contractor shall provide fully equipped rig(s) and appropriate tools in full-time operation at the site during the work, and shall mobilize additional equipment, if necessary, to complete the work on schedule.

I. If unstable ground is encountered, take measures to retain the material in place and prevent loss of ground or movements that might cause damage to adjacent structures or utilities.

J. Excavation shall not proceed more than two (2) feet below each bracing level, until that bracing level has been completely installed and achieved required design strength.

K. The Contractor shall provide ongoing monitoring of the excavation retention system and adjacent structures. In event(s) the measured movements exceeding the Threshold or Limiting values, the Contractor shall take immediate steps to implement the Construction Contingency Plan to arrest further movement.

3.2 SECANT DRILLED SHAFTS

A. Install all secant drilled shafts in accordance with IDOT Standard Specification Section 516, except as modified herein before starting excavation. Install secants to the greater of the design tip elevation determined by the Contractor as shown on his reviewed Temporary Excavation Retention Plan or ten (10) feet below top of rock as encountered in the field. If the Contractor elects to use slurry installation methods, it shall be conducted in a method to prevent loss of ground around the hole.

B. The Contractor shall have equipment on-site able to advance each drilled hole for installation of the secant drilled shafts, through sand below the water table, cobbles, boulders, weathered and sound bedrock.

C. Provide adequate means to ensure secant drilled shafts shall be installed within no less than 1:100 of vertical alignment; diameter of secant pile installed shall overlap sufficiently at actual installation tolerance to provide water cutoff meeting design criteria.

D. Each secant drilled shaft shall be concreted in its drilled hole within the same day drilling is completed to the tip elevation. Concrete shall be placed via tremie or other suitable method to prevent segregation.

3.3 INTERNAL LATERAL WALL BRACING (WALES AND STRUTS)

A. Use wales and struts as necessary to provide lateral support of the excavation retention walls. Include web stiffeners, plates, brackets, or angles as required to prevent rotation, crippling or buckling of connections and points of bearing between structural steel members. Allow for eccentricities due to fabrication and assembly. Consider effects of temperature changes.

B. Install and maintain all support members in continuous tight contact with each other and with the wall being supported.

C. Coordinate locations of all bracing and components thereof for temporary lateral excavation retention with locations of permanent structures.

D. Control rate of excavation and installation of support members to minimize movement of adjacent ground surface.

Excavation shall proceed in accordance with the detailed sequence submitted by the Contractor and reviewed by the Engineer. It shall be the responsibility of the Contractor to schedule and sequence the work accordingly.

3.4 CONNECTION TO EXISTING PUMP STATION

The excavation support for connection to the existing pump station must provide for initial ground improvement and water control in advance of excavation or any large scale penetration of the primary temporary excavation retention system.

A. The Contractor's Designer shall clearly indicate any special detailing requirements of the primary TERS reinforcing in the connection zone.

B. The following types of initial ground improvement are considered acceptable, the contractor can propose alternate types subject to approval at the discretion of the engineer.

1. Jet Grout.
   a. The Contractor shall determine the diameter and spacing of jet grout columns, mix design and all other required elements of the work.
   b. Specialized quality control & assurance measures required for jet grout will be incorporated into overall contractor plan.
   c. The contractor shall specifically address measures to prevent damage to the existing structure during jet grout operations.
2. Slurry replacement.
   a. Slurry replacement shall be in general accordance with Concrete Diaphragm Wall requirements.
3. Grouted Spiling with horizontal drains.
   a. Steel spiling must provide a canopy extending above and to at least the springline of the secondary excavation perimeter.
   b. The steel spiling shall be embedded a minimum of 3" into the existing pump station wall.
   c. Horizontal drains or similar measures shall be used to depressurize the secondary area in advance of excavation.
4. Ground Freezing
   a. The Contractor shall determine the length and spacing of ground freezing elements, required affected zone, and all other required elements of the work.
   b. Specialized quality control & assurance measures required for ground freezing will be incorporated into overall contractor plan.
   c. The contractor shall specifically address measures to prevent damage to the existing structure during ground freezing operations.

C. The following types of final ground support are considered acceptable, the contractor can propose alternate types subject to approval at the discretion of the engineer.

1. Steel Liner Plate
   a. The Contractor shall determine the required type, gauge, grade and all other required elements of the liner plate utilized.
   b. The contractor's design shall address face support.
   c. The design shall include provision for backfilling voids behind the liner plate via grouting or other methods.
2. Shotcrete and Ribs

a. The Contractor shall determine the required type, size, grade and all other required elements of the ribs utilized.
b. The Contractor shall determine the required shotcrete compressive strength, thickness, reinforcing, mix design and all other required properties.
c. The contractor's design shall address face support.

3. Jacked Steel Casing
   a. The Contractor shall determine the required diameter, thickness, grade and all other required elements of the casing utilized.
   b. The Contractor shall determine the required jacking force and thrust block requirements. Reacting against the partially completed pump station will not be permitted.
   c. The contractor shall backfill any void between the second stage ground support and the final carrier pipe with controlled low strength material. The contractor shall adequately secure the pipe to prevent flotation during backfill.

3.5 GROUNDWATER CONTROL

A. Design, install, operate, and maintain a groundwater control system inside the temporary excavation retention system to provide stable, dry subgrade for the execution of the work and subsequent operations. Lower groundwater levels in advance of excavation utilizing wells, wellpoints, or similar methods. Provide drainage blankets, filter fabric, trench drains, and/or sumps as required to collect groundwater inflows at the bottom of excavation.

B. Prior to commencing excavation, perform a pump test inside the TERS to confirm the adequacy of the groundwater cutoff per the design criteria. Pump test must demonstrate ability to lower the water table and maintain for a minimum of 24 hours. If this pump test does not indicate satisfactory performance of the TERS, advise the Engineer of any changes or remedial measures required to accommodate field conditions and, upon completion, perform an additional pump test to confirm successful implementation.

C. If the Engineer agrees to the need for a grout curtain in the rock mass underneath the TERS, provide a plan for installation of this grout curtain, including but not limited to:

D. Spacing of primary holes and criteria for when installation of secondary and tertiary holes is required.

E. Anticipated diameter and depth of each type of hole

F. Grout mix selection

G. Injection pressure and refusal criteria

H. Pre- and post-grouting packer testing locations (minimum of 4) to confirm reduction in rock permeability achieved.

I. Furnish piezometers for monitoring dewatering operations in accordance with approved Instrumentation and Monitoring Plan.

J. Open pumping from sumps shall not result in boils, softening of the ground, or loss of fines.

K. Groundwater control operations shall be executed and maintained 24 hours a day, 7 days a week. Qualified personnel shall be on-site or on-call at all times to monitor system operations and to perform maintenance as necessary to keep the system in operation. Maintain temporary drainage facilities of adequate size, with standby pumps and adequate back-up power for emergency use, to collect and dispose of water which enters excavation.

L. Review available utility drawings and locate conduits and underground utilities in all areas where groundwater control wells are to be drilled and installed. Notify local authorities prior to any drilling and place wells to avoid interference with the existing conduits and utilities. Repair damage to existing structures and utilities resulting from groundwater control installations at no additional cost to the Contract.

M. Maintain existing surface drainage conditions in all areas affected by excavations.

N. Dispose of all water removed for groundwater control and removed from excavations in accordance with the Standard Specifications. Dispose of contaminated groundwater in accordance with Federal and local authority regulations.

3.6 DISPOSAL OF EXCAVATED MATERIALS

A. Remove and dispose of all excavated materials in accordance with the Standard Specifications.

B. Dispose of contaminated soils in accordance with the Standard Specifications and Federal and Local authority regulations.

C. Temporary stockpiling, if allowed, shall not exceed the safe height limitation in accordance with shop drawings.

3.7 INSTRUMENTATION AND MONITORING

A. Threshold and limiting values

1. Definitions:
   a. Threshold Value: Value of instrumentation readings at which the Engineer assesses the necessity of altering methods, rate, or sequence of construction.
   b. Limiting Value: Value of instrumentation readings at which the Engineer can order the Contractor to cease construction operations, make site and affected properties secure, and take necessary and agreed upon measures to mitigate unacceptable movements and to assure the safety of the work and the public.

B. The project maximum Threshold and Limiting Values are specified in Table 1, the Contractor may elect to use more stringent criteria if deemed necessary by their selected means & methods. The Contractor's Instrumentation and Monitoring plan shall provide for immediate verbal notification, and in writing within 24-hours, when the Threshold and

Limiting levels are reached. Work shall immediately cease following a Limiting level exceedance, until further notice is provided by Engineer, at no additional cost to Contract.

TABLE 1

Instrument	Threshold Value	Limiting Value
Inclinometers[1]	0.75 in.	1.25 in.
Ground Monitoring Point[2]	1.0 in.	2.0 in.
Structural Monitoring Point[1]	0.50 in.	1.0 in.
Structural Monitoring Point[2]	0.50 in.	1.0 in.
Utility Monitoring Point[2]	1.0 in.	2.0 in.
Piezometer[3]	3 ft.	5 ft.

1: Values are cumulative lateral displacement
2: Values are vertical displacement
3: Water level drop from baseline value OR current Des Plaines River elevation, whichever is lower

3.8 EMERGENCY MEASURES

A. Whenever there is a condition that is likely to endanger the stability of the excavation or adjacent structures, the contractor shall operate with a full crew 24 hours a day, including weekends and holidays, without intermission, until conditions no longer jeopardize the stability of the work. Emergency operations that cannot be traced to unforeseen ground conditions will be conducted at no further cost to the Contract.

3.9 REMOVAL OF EXCAVATION RETENTION SYSTEM

A. Excavation retention system shall be removed as shown on the Drawings.

B. The Contractor shall take all precautions against excessive vibrations or damage to adjacent structures. The Contractor shall be solely responsible for any damages caused directly or indirectly to structures, sewer and other utilities, and shall repair any such damage occurring due to his operations to the satisfaction of the Engineer at no additional cost to the Contract.

1. All voids created by the removal of the retention system shall be backfilled with compacted structural fill, lean concrete, or flowable fill, as approved by the Engineer.
2. The retention system removed from the excavation shall remain the property of the Contractor and shall be removed from the site for disposal.

3.10 RESTORATION

A. Furnish, compact, and backfill all excavations in accordance with the Standard Specifications and as shown on the Drawings.

B. Prepare the bottom of shaft excavations as a foundation for installing pipe and structures as approved by the Engineer.

C. Restore the work area disturbed by construction activities, and repair any damage caused to existing utilities, to its original, or better, condition.

D. Remove and dispose of all trailers, temporary utilities, drainage facilities, temporary fencing, waste materials and surplus materials, and other site development facilities provided by the Contractor following backfilling of the excavation.

END OF SECTION

SECTION 31 73 14 - TUNNEL, CASING AND SHAFT GROUTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The minimum requirements for grouting in tunnels, steel casings, and shafts in order to complete the Project.

B. The Contractor shall be responsible for all phases of the control of the quality and workmanship.

C. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary for the provision of grout holes, installing pipe necessary for grouting, connections to grout holes, grouting, and monitoring of the grouting pressures.

D. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the contract lump sum price for the Item, PUMP STATION GENERAL WORK.

1.3 DEFINITIONS

A. Contact Grouting is the injection of fluid, non-shrink, rapid-setting grout to fill voids and/or leaks between the initial ground support/excavated surface.

B. Additives are any natural or chemical product added to the grout mix to reduce admixture bleed water, lower mix viscosity and cohesion, and enhance penetrability.

C. Backfill Grouting is grouting to fill the annular space between the carrier pipe and the initial ground support (including casings constructed by tunneling and trenching).

D. Cut-off Grouting is the filling of voids, fissures, etc. in soil or rock by injecting grout under pressure to fill voids and reduce ground water inflow.

E. Stabilization Grouting is the treatment of the ground through grouting in order to improve the stability of the excavation either in the tunnel or at a shaft.

F. Check Grouting is grouting to verify the completeness of backfill grouting or contact grouting.

G. Fluidifier is a compound possessing such characteristics that it will tend to hold the solid constituents of the grout in colloidal suspension.

H. Tunnel and Shaft Grouting refers to all grouting types; backfill grouting, contact grouting, check grouting, stabilization grouting, and cut-off grouting needed to complete the work identified under this contract.

1.4 QUALITY ASSURANCE

A. Reference Standards:

1. American Concrete Institute (ACI):
   a. 523.1, Guide for Cast-in-Place Low Density Cellular Concrete.
2. American Petroleum Institute (API):
   a. Spec 13A, Specification for Drilling-Fluid Materials.
3. ASTM International (ASTM):
   a. C31, Compressive Strength of Cylindrical Concrete Specimens.
   b. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   c. C144, Standard Specification for Masonry Mortar.
   d. C150, Standard Specification for Portland Cement.
   e. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   f. C494, Standard Specification for Chemical; Admixture for Concrete.
   g. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   h. C796, Standard Test Method for Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.
   i. C869, Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.
   j. C937, Grout Fluidifier for Pre-Placed Aggregate Concrete.
   k. C1017, Chemical Admixture for use in Producing Flowing Concrete.
   l. D93, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester.
   m. D1042, Standard Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.
   n. D2196, Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational (Brookfield type) Viscometer.
   o. D2369, Standard Test Method for Volatile Content of Coatings.
   p. D3574, Standard Test Methods for Flexible Cellular Materials Slab, Bonded, and Molded Urethane Foams.

B. Grouting shall be considered as specialized work that requires specialized training, experience, equipment, and procedures. The Contractor may propose to self-perform the grouting provided that they can demonstrate sufficient qualifications, experience, and capabilities to the Engineer. However, Contractor shall use the services of a specialty grouting contractor if the Contractor does not have satisfactory credentials. Contractor shall submit the qualifications, experience, equipment, and procedures proposed for grouting to the Engineer.

C. The grouting program shall be performed under the supervision of a grouting supervisor(s) having a minimum of five (5) years specific experience in similar grouting operations and similar projects using similar grouting materials. The grouting supervisor(s)

shall be present on site at all times during grouting operations. The supervisor shall be knowledgeable in all aspects of grouting as currently practiced, including drilling of grout holes, grout formulation, properties of admixtures, mixing methods, grout pumping, and grout injection.

D. All drilling and grouting activities shall be documented. Prepare and maintain legible records of the work, copies of which shall be submitted to the Engineer as specified herein.

E. Site trials for each mix and delivery system shall be carried out prior to the commencement of tunneling to demonstrate that the proposed system works with the adopted equipment. The trials shall demonstrate the properties of each grout mix and its suitability for the ground conditions.

F. Rejection criteria for aged grout will be strictly enforced by the Engineer. Grout that is not placed within two hours of the time of mixing or has begun to set shall be rejected and not used.

G. Backfill, check, and contact grouts shall remain effective for the 100 year design life of the tunnels and shafts. The grouts shall not degrade, shrink, or lose strength to an extent that the tunnel would become damaged or become unserviceable as a result.

1.5 SUBMITTALS

A. See Section 01 33 00 for requirements for the administration of the submittal process.

B. Prior to shipping equipment and at least 30 days prior to grouting, submit to the Engineer a description of materials, grout mix, equipment and operating procedures for the following grouting operations: Contact grouting, Cut-off grouting, Backfill grouting, Check grouting, and Stabilization grouting. The description shall include sketches as appropriate, indicating the type and location of mixing equipment, pumps, injection point, venting method, direction of flow, maximum allowable pressure, pressure measurement, blocking to prevent flotation, grout volumes, volume measurement, grouting sequence, and schedule.

C. Submit documentation indicating the experience and qualifications of the grouting supervisor(s), demonstrating that each supervisor meets the requirement specified herein.

D. Submit a grout mix selection meeting Section 1024 of the Standard Specifications at least 30 days prior to grouting, including:

1. Grout type and designation.
2. Grout mix constituents and proportions, including materials by weight and volume.
3. Grout densities and viscosities, including wet density at point of placement.
4. Initial set time of the grout.
5. Bleeding, shrinkage/expansion.
6. Compressive strength.

E. Maintain daily logs of grouting operations.

1. The Contractor shall submit records of grouting to the Engineer for information. The records shall include the following information:
   a. Hole name, collar station, face station, date.
   b. Hole length, location and orientation, diameter, method of drilling.
   c. Details of mixes including any admixtures.
   d. Details of each batch of grout injected including mix, start time, start pressure, stop time, stop pressure, rate of pumping and volume injected including estimated wastage.
   e. Details of any interruptions, leakages and any equipment malfunctions.
   f. Name of grouting supervisor.
   g. Any other data required by the Engineer.
2. Each record shall be submitted to the Engineer within 24 HRS of the grouting being performed.
3. The Contractor shall furnish all necessary assistance and cooperation toward the development of these records at no additional cost to the Contract.

F. Certifications of calibration of pressure gauges and flow meters.

1.6 PROJECT CONDITIONS

A. Coordinate the grouting operations with all other work to be performed under this Contract.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle all materials as prescribed by the manufacturers of these materials and in accordance with their respective ASTM standards in original, unopened containers with the manufacturer's name, product labels, product identification, and as detailed on the accepted data sheets. Protect materials from mechanical and environmental damage. Maintain sufficient amounts of required materials on hand to assure continuous grouting operations.

B. Furnish cement/grout mix in sacks or in bulk. Use material in chronological order of delivery. If furnished in bulk, provide accurate weighing devices to properly measure cement weight.

C. Assure that cement/lime is free from lumps or foreign matter. Screen all cement/lime through a Number 100 mesh to remove any lumps or foreign matter before adding it to the mixer.

D. Fly ash, if used, shall be packaged and stored in accordance with their respective ASTM standards.

1.8 PERFORMANCE REQUIREMENTS

A. Establish grout mixes, methods, and criteria, if such criteria is not specified herein, that the grouting operations will meet, in accordance with these Specifications. The grouting system shall have sufficient gauges, monitoring devices, and tests to determine the

effectiveness of the grouting operation. The Contractor shall modify the grouting operation should the grouting not perform as proposed at no additional cost to the Contract.

PART 2 - PRODUCTS

2.1 GENERAL

A. All equipment and materials furnished and installed under this Section shall be suitable for the conditions of service to which they will be subject and equal to the best of their respective classes. Grade and quality shall meet the applicable specifications and standards.

B. Contact Grout Materials:

1. A suitable grout mix shall be proposed for each set of ground conditions to be encountered along the tunnel drive. Cement grout shall consist of Portland cement, fluidifier, and water in the proportions specified herein or as reviewed by the Engineer. Sand may be added to the grout mix in instances of very high grout takes as authorized by the Engineer, but in no case shall the grout mix contain more than three parts sand to one part cement by weight.
2. Grouts shall be sufficiently fluid as to ensure that they flow freely under pressure into all of the space to be filled. The addition of sand shall require additional fluidifier to be added to the grout mix. Grout mix (water-cement) ratios shall be expressed in cubic feet of water per cubic foot of cement (94 LBS bag). The range of water-cement ratios shall be between 1:1 and 0.75:1 by volume.
3. The water-cement ratio shall be varied to meet the characteristics of the voids as they are discovered during the contact grouting operation.
4. The grout shall contain a fluidifier (expansive agent) in the proportion of 1 PCT by weight of cementitious material or as recommended by the manufacturer.
5. Grouts shall be capable of resisting washout by groundwater and of supporting construction loads.
6. Contact grout to develop an unconfined compressive strength not less than 500 PSI at 28-days, compatible with pumping and placing requirements.
7. Do not use materials including admixtures that are toxic or cause any hazard to workers or the environment.
8. Unless specified otherwise, use ordinary Portland cement or micro-fine cement conforming to ASTM C150, Type II. Do not use cement that has become wet in storage or is more than 5 weeks old in site storage.
9. Lime shall conform to ASTM C207.
10. Assure that cement/lime is free from lumps or foreign matter. Screen cement/lime to remove lumps or foreign matter before introducing it to the mixer.
11. Use fresh and potable water for grout mix.
12. Admixtures shall conform to ASTM C494, shall be compatible with other grout materials, and shall not promote steel corrosion.
13. Fly Ash shall conform to ASTM C618, Class F.

C. Backfill Grout:

1. Low Density Cellular Grout:
   a. Low density cellular concrete mix shall be designed in accordance with the requirements of this section and ACI 523.1.
   b. Conduct backfill grouting taking into account the effects of fluid pressure on carrier pipe during backfill operations using a minimum factor of safety of 2.0.
   c. Minimum 7-day and 28-day compressive strength shall be 500 PSI and 600 PSI, respectively.
   d. Unless otherwise specified, each cellular concrete mix shall be designed and controlled within the following limits:
      1) At the point of placement, the wet density unit weight of the cellular concrete shall be not less than 50 PCF and shall be within 5 PCF of the density of the approved cellular concrete mix.
      2) Preformed foam shall be generated by combining controlled quantities of air, water, and foaming agent under pressure.
      3) Foam shall retain its stability until the cement sets to form a self-supporting matrix.
      4) The concentration of foam agent shall be in accordance with the manufacturer's written recommendations.
      5) Cement shall conform to the requirements of ASTM C150.
      6) Use fresh and potable water for grout mix.
      7) Water temperature shall not exceed 80 DEGF.
      8) No calcium chloride or admixture containing chloride other than impurities from admixture ingredients shall be acceptable.
      9) Admixtures may only be used when specifically approved by the foaming agent supplier in writing.
      10) Foaming agent shall comply with ASTM C869 when tested in accordance with ASTM C796. The type and manufacturer shall be:
         a) Mearl Geofoam Liquid Concentrate manufactured by The Mearl Corporation.
         b) Foam Liquid Concentrate manufactured by Cellufoam Concrete Systems.
2. Sand-Cement Grout:
   a. Backfill grout shall be a mix of sand, cement, and water, and other additives required to completely fill the annular space and therefore be compatible with pumping and placement requirements to do so.
   b. Conduct backfill grouting taking into account the effects of fluid pressure on carrier pipe during backfill operations using a minimum factor of safety of 2.0.
   c. Use fresh and potable water for grout mix.
   d. Cement grout shall consist of Portland cement, fluidifier, and water in the proportions specified herein or as reviewed by the Engineer. In no case shall the grout mix contain more than three parts sand to one part cement by weight.
   e. Grout shall be sufficiently fluid as to ensure that it flows freely under pressure into all of the space to be filled. The addition of sand shall require additional fluidifier to be added to the grout mix. Grout mix (water-cement) ratios shall be expressed in cubic feet of water per cubic foot of cement (94 LBS bag). The range of water-cement ratios shall be between 1:1 and 0.75:1 by volume.
   f. The water-cement ratio shall be varied to meet the requirement to completely fill the annular space.

g. The grout shall contain a fluidifier (expansive agent) in the proportion of 1 PCT by weight of cementitious material or as recommended by the manufacturer.
h. Grout to develop an unconfined compressive strength not less than 600 PSI at 28 days, compatible with pumping and placing requirements.
i. Do not use materials including admixtures that are toxic or cause any hazard to workers or the environment.
j. Unless specified otherwise, use ordinary Portland cement or micro-fine cement conforming to ASTM C150, Type II. Do not use cement that has become wet in storage or is more than 5 weeks old in site storage.
k. Lime shall conform to ASTM C207.
l. Assure that cement/lime is free from lumps or foreign matter. Screen cement/lime to remove lumps or foreign matter before introducing it to the mixer.
m. Admixtures shall conform to ASTM C494, shall be compatible with other grout materials, and shall not promote steel corrosion.
n. Fly Ash shall conform to ASTM C618, Class F.

D. Do not include toxic or poisonous substances in any grout mix or otherwise inject such substances underground.

E. All grout mixes shall be readily pumpable.

F. Employ and pay for the services of a commercial testing laboratory, acceptable to the Engineer, to prepare and test the grout mix design. Develop one or more mixes based on the following criteria as applicable:

1. Size of the annular void between the carrier pipe and the casing pipe, or the size of the void between the initial tunnel support or structure and the surrounding soil/rock.
2. Absence or presence of ground water.
3. Adequate retardation/acceleration.
4. Non-shrink characteristics.
5. Pumping distances.

G. Prepare mixes that satisfy the required application. Materials used in any grout mix shall meet the following standards:

1. Cement: ASTM C150.
2. Fly Ash: ASTM C618, Class F.
3. Use fresh and potable water for grout mix.
4. Sand for sand-cement grout shall conform to ASTM C144, except all sand shall pass a Number 8 screen and less than 5 PCT shall be finer than a Number 200 screen.
5. One (1) part cement to not more than six (6) parts of sand.

H. Fluidifier shall meet the requirements of ASTM C937, shall contain a shrinkage compensator, and shall be of calcium lingo-sulfonate or sodium lingo-sulfonate composition. Bentonite or other clay-like substances will not be acceptable as fluidifiers. The fluidifier shall be compatible with the cement and water used in the grouting procedure. Fluidifier shall be furnished in moisture resistant paper sacks shipped in sealed containers and shall be handled and stored so as to avoid absorption of moisture, damage, or waste. Material which has become caked due to moisture absorption shall not be used.

I. Use admixtures meeting ASTM C494 and ASTM C1017 as required to improve pumpability, to control time to set, to hold sand in suspension, and the reduce segregation and bleeding. Anti-washout admixture shall be used for grout placed in wet conditions. Ensure that admixtures used in a mix are compatible. Provide written confirmation from the admixture manufacturer of their compatibility.

2.2 EQUIPMENT

A. Equipment for mixing and injecting grout shall be of a type and adequate size to satisfactorily mix and agitate the grout and force it into grout holes in a continuous flow at the desired pressure. The grout shall be mixed in a grout plant that combines dry cement and water in predetermined proportions. Pumps for all grouting shall be capable of developing and maintaining the required uniform pressure at the grout hole connection.

B. Pumps for Contact Grouting shall not cause the grout pressure to exceed the collapse pressure of the initial tunnel lining and shall no exceed 0.6 times the external earth pressure on the tunnel lining.

C. There shall be one main pump and one standby pump. Pumps shall have sufficient capacity to operate effectively at low pressure and with no more than 5 PCT variation in grouting pressure. A fitting shall be installed at the pump intake to supply the required flushing water for the clearing of pipes and grout holes, plus a bypass system connecting the pump discharge to the tank. The pumps shall be provided with interconnecting pipes and valves to permit immediate transfer if necessary to stand-by equipment to ensure uninterrupted grouting.

D. A high speed colloidal mixer shall be provided that is capable of thoroughly mixing water, cement, sand, and additives. The mixer shall be provided with a device capable of accurately measuring the amount of various ingredients, and shall have a capacity to ensure that grouting is performed at the maximum specified flow rate.

E. A sump tank (agitator) shall be provided with the ability to keep in suspension all of the solid materials contained in the mixture. It shall be provided with screens that allow retaining and removal from the mixer any hardened grout, lumps, or unwanted material. The injected volume shall be computer controlled and the sump tank shall be calibrated in tenths of the volume injected.

F. The arrangement of the grouting equipment shall provide for continuous circulation of the grout in the system and permit accurate pressure control. Equipment and lines shall be kept clean by continuous circulation of grout and by periodic flushing with water. Configure equipment so flushing can be accomplished with the grout intake valves closed, with water supply valves open, and the grout pump running at full speed.

G. Provide a pressure gauge at the grout pump.

H. At the point of injection, valves and accurate, calibrated in-line pressure gauges and flow meters shall be provided, so that the pressure and grout flow at the grout hole may be

continuously monitored and regulated by increasing or decreasing the flow in the return line.

I. Equipment and grouting procedures shall be such that grouting pressures at the grout hole connection in excess of the maximum specified pressure shall not occur.

J. The accuracy of all of the gauges shall be periodically checked. Spare gauges shall be available on site at all times. Gauges shall be calibrated once per week. No grouting is permitted unless this requirement is met.

K. In addition to the grout mixer, mechanical agitator tanks equipped with 100 mesh screens shall be used.

L. Rotary drilling equipment shall be used to drill any additional grout holes, and shall be of sufficient power and versatility to bore holes at any angle and to such depth as may be required.

M. Hoses for grouting operations shall have an inside diameter not less than 1-1/2 IN and not greater than 2 IN, and shall be capable of withstanding the maximum water and grout pressures to be used with a minimum safety factor of 1.5.

N. All pipe, fittings, and appurtenances required for constructing the grout holes, grout hole connections, and air vents, shall be provided by the Contractor. No grout holes are permitted in the force main pipe.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All grouting shall be performed where shown on the Drawings, as specified herein, and where directed by the Engineer.

B. Develop one or more grout mixes, as necessary, to completely fill the voids behind the initial tunnel lining, shaft lining, or casing pipe, to fill the annular space between the tunnel primary support system and the carrier pipe, to stabilize the ground, control water ingress, with acceptable set times, strength, and durability. All gout mixes shall be subject to review by the Engineer per Section 01 33 00.

C. Notify the Engineer at least 24 HRS in advance of the grouting operations. All grouting shall be done in the presence of the Engineer.

D. Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.

E. Operate any dewatering systems until the grouting operations are complete, where applicable. The well discharge from dewatering shall be closely monitored during any

adjacent grouting operations in order to avoid grout reducing the effective and normal operation of the dewatering system.

F. Do not grout unless gauges are operational.

G. All grout, which is not injected as needed into the Work within 90 minutes after mixing shall be removed from the mixer, sump, and supply line and shall be wasted.

H. When the distance between any element of the plant and the hole being grouted is greater than 100 FT, the Contractor shall provide suitable telephonic and/or signalling systems between the various parts of the job in order to facilitate operations and control.

I. Grouting equipment and piping shall be cleaned and be periodically flushed with water or other means. Flush water shall not be allowed in grout.

J. If using ready-mix trucks, no water shall be added to the grout after the truck has left the batch plant. No wash water or waste grout (from cleaning of trucks, hopper, etc.) shall be allowed to contaminate the grout.

3.2 MIXING AND INJECTION OF GROUT

A. All materials shall be free of lumps when put into the mixer and the grout mix shall be completely agitated. Grout shall flow unimpeded and shall completely fill all voids.

B. Batch and mix cellular grout (if used) mechanically to ensure consistency of the mix. Wet solids thoroughly before introducing the foaming agent. Operate the batch system to maintain slurry weight within 3 PCT of the design density. Introduce foam into the slurry in accordance with manufacturer's recommendations.

C. Make connections for injecting grout at each hole as specified herein and where shown on the Drawings. The injection of grout during any stage of grouting shall be performed continuously, filling all spaces and voids and avoiding disturbance of grout that has initially set. The grouting process shall be operated and controlled so that the grout will be delivered uniformly and steadily.

D. Grouting will be considered complete at a particular area when there is no visible escape outlet and no more grout can be forced through the grout pipe. Care should be taken that grout does not escape and be forced into nearby basements, manholes, or sewers, or cause damage to adjacent utilities. Do not overstress liners. Should it become evident that more grout is being used than could be reasonably be effective adjacent to the pipe, the reason for the apparent surplus shall be determined by the Contractor and remedial measures shall be taken by the Contractor at no additional cost to the Contract.

E. Grouting shall progress from grout hole to grout hole on the sequence indicated in the reviewed Shop Drawing Submittal, or as directed by the Engineer.

F. After the grouting at any grout hole is complete, the pressure shall be maintained by means of a stopcock or other suitable device until the grout has set to the extent that it will be retained in the hole.

3.3 STABILIZATION GROUTING

A. Notify the Engineer of all proposed stabilization grouting operations and perform all stabilization drilling and grouting operations only in the presence of the Engineer.

B. No grouting shall be performed without pressure gauges in place and in good working order.

C. Drill grout holes at the locations, directions, inclinations, and spacing and to the diameters and lengths required to stabilize the ground.

D. Holes shall be drilled using blow out preventers.

E. Upon completion of grouting at each connection, close the connection valve and leave it in place until the grout has set.

F. Before advancing the excavation into/below a grouted zone, the stabilization grout shall be allowed to cure for at least 6 HRS.

3.4 CONTACT GROUTING

A. Provide grout hole connections in the casing pipe either with the pipe as delivered or by subsequent work after the casing pipe has been installed. Tunnel liner plate shall have grout holes with threaded plugs provided by the liner plate manufacturer.

B. Clean out grout holes or pipes that become obstructed before grouting.

C. Do not place grout behind any cast-in-place concrete until the concrete has attained a minimum of 75 PCT of the design strength and at least 14 days after concreting to avoid damage from grout injection.

D. Perform grouting at the lowest pressure necessary to fill any remaining voids behind the initial lining that will not cause movement or damage to the lining. Do not exceed the collapse pressure of the casing pipe or a pressure greater than 0.6 times the vertical load on the outside of the pipe.

E. After completion of the grouting, fill the grout holes/pipes and vent pipes with dry pack or thick grout, to produce a smooth finished surface. If a carrier pipe is to be subsequently installed inside the initial liner, then ensure that the grouting holes and the completion of these holes does not interfere with the installation of the carrier pipe.

3.5 BACKFILL GROUTING

A. Cellular Grout:

1. Place cellular concrete in multiple lifts. Place the backfill grout using a minimum of two lifts. Monolithic placement of the backfill grout may be acceptable, provided the Contractor can demonstrate with supporting calculations that the placement techniques shall not induce unacceptable movement or any deformation of the carrier pipe or collapse of the cellular concrete.
2. Backfill grouting operations shall be performed from the downstream to the upstream end of the casing pipe.
3. Cellular concrete shall overflow from high point vent until:
   a. A minimum of 1 CY overflows.
   b. Weight samples from the overflow matches or exceeds the density being pumped into the casing, and a sample is taken.

B. Sand-Cement Grout:

1. Install this grout by pumping into the annular space between the casing pipe and the carrier pipe.
2. The grouting may be done in a progressive manner with multiple lifts or along the pipe in the manner reviewed by the Engineer.
3. Contractor must demonstrate that the annular space is completely full as the grouting progresses.
4. Provisions must be made to vent the air from the annular space during backfill grouting.

3.6 FIELD QUALITY CONTROL

A. Reporting and Testing:

1. The Contractor shall be responsible for all quality control testing of the grouting.
2. Location and layout of grout injection points, if not shown on the Drawings, shall be by the Contractor and acceptable to the Engineer.
3. Daily records shall be maintained by the Contractor and submitted to the Engineer as specified herein.
4. The Contractor shall perform slump tests of grout and take measurements of grout mix quantities to verify the grout mix, as follows:
   a. Slump testing:
      1) Perform slump tests using grout samples obtained as close as possible to the point of injection. Grout samples shall not be obtained from the grout mixer.
      2) Perform slump tests in general conformance with ASTM C143, but rodding of the grout is not required and shall not be performed.
      3) Frequency of slump testing will be at least twice during each grout shift.
   b. Grout Mix Proportions:
      1) Grout mix proportions will be checked at least once daily.
   c. Compressive Strength:
      1) Prepare samples for compressive testing based on three sample sets per grout shift and test these samples one set of these samples at 3 days, 7 days, and 28 days.

3.7 CLEANUP

A. Cleanup of the work area after compaction grouting operations shall occur on a contemporaneous basis.

B. Final clean up shall be completed within two (2) days of demobilizing the compaction grouting equipment from the location.

C. Remove all grout spillage and residue from the work area.

D. The interior surface of the carrier pipe shall be maintained smooth and free from defects. Any damage to the carrier pipe caused by or occurring during the grouting operations shall be repaired by a method approved by the Engineer at no additional cost to the Contract.

END OF SECTION

DIVISION 40
PROCESS INTERCONNECTIONS

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SECTION 40 05 00 - PIPE AND PIPE FITTINGS: BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Process piping systems.
2. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 09 96 00 - High Performance Industrial Coatings.
3. Section 10 14 00 - Identification Devices.
4. Section 40 05 07 - Pipe Support Systems.
5. Section 40 05 19 – Pipe: Ductile
6. Section 40 05 26 – Pipe: Cast-Iron Soil
7. Section 40 05 39 – Pipe: Pipe: Reinforced Concrete
8. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 BASIS OF PAYMENT

A. Unless specified elsewhere, the work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Iron and Steel Institute (AISI).
2. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings.
3. ASTM International (ASTM):
   a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc- Coated, Welded and Seamless.
   b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   c. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
4. American Water Works Association (AWWA):
   a. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type
5. American Water Works Association/American National Standards Institute (AWWA/ANSI):

a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

6. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
7. International Plumbing Code (IPC).

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.4 DEFINITIONS

A. HPIC: High performance industrial coating. See Section 09 96 00.

1.5 SYSTEM DESCRIPTION

A. Piping Systems Organization and Definition:

1. Piping services are grouped into designated systems according to the physical properties of the fluid conveyed, system pressure, piping size and system materials of construction.
2. See PIPING SPECIFICATION SCHEDULES in PART 3.

PART 2 - PRODUCTS

2.1 PIPING SPECIFICATION SCHEDULES

A. Piping system materials, fittings and appurtenances are subject to requirements of specific piping specification schedules located at the end of PART 3 of this Specification Section.

2.2 COMPONENTS AND ACCESSORIES

A. Reducers:

1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections. Equipment matching reducers shall be at no additional cost to the Contract.
2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

B. Protective Coating and Lining:

1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.
2. Field coating pipe in accordance with Specification Section 09 96 00.

C. Underground Warning Tape:

1. See Specification Section 10 14 00.

PART 3 - EXECUTION

3.1 EXTERIOR BURIED PIPING INSTALLATION

A. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.

B. Install expansion devices as necessary to allow expansion and contraction movement.

C. Lining Up Push-On Joint Piping:

1. Lay piping on route lines shown on Drawings.
2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
3. Observe maximum deflection values stated in manufacturer's written literature.
4. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

D. Anchorage and Blocking:

1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.

3.2 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:

1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support for Exposed Piping:

1. Use methods of piping support as shown on Drawings and as required in Specification Section 40 05 07.
2. Piping support systems for piping 12 IN and greater are shown on the Drawings.
3. Support systems for piping smaller than 12 IN DIA are not shown on the Drawings.
   a. Contractor is responsible for design of these support systems per Specification Section 40 05 07.

4. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.

1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Provide full face gaskets on all systems.

H. Anchorage and Blocking:

1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

I. Equipment Pipe Connections:

1. Equipment - General:
   a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
   b. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
      1) Provide tightening torque in accordance with manufacturer's recommendations.
   c. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
   d. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
   e. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
   f. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four (4) bolts per joint installed and tightened.
      1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
      2) Realign as necessary, install flange bolts and make equipment connection.
   g. Provide utility connections to equipment shown on Drawings, scheduled or specified.

3.3 FIELD QUALITY CONTROL

A. Pipe Testing - General:

1. Test piping systems as follows:
   a. Test exposed, non-insulated piping systems upon completion of system.
   b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
2. Utilize pressures, media and pressure test durations as specified in the PIPING SPECIFICATION SCHEDULES.
3. Isolate equipment which may be damaged by the specified pressure test conditions.

4. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
   a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
   b. Notify the Engineer 24 HRS prior to each test.
5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance.
6. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:

1. Testing medium shall be in accordance with the following:

PIPE LINE SIZE (DIA)	GRAVITY OR PUMPED	SPECIFIED TEST PRESSURE	TESTING MEDIUM
Up to and including 48 IN	Gravity	25 PSIG or less	Air or water
Above 48 IN	Gravity	25 PSIG or less	Water
All sizes	Pumped	100 PSIG	Water

2. Allowable leakage rates:
   a. All exposed piping systems and all pressure piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.
   b. Hydrostatic infiltration test for sanitary and stormwater sewers (groundwater level is above the top of pipe):
      1) Maxium allowable leakage rate: 200 GAL per inch diameter per mile of pipe per day when depth of groundwater over top of pipe is 2 to 6 FT.
      2) Leakage rate at heads greater than 6 FT: Maxium allowable leakage rate (gallons per inch diameter per mile of pipe per day) equals 82 by (actual head to the 1/2 power).
   c. For low pressure (less than 25 PSIG) air testing, the acceptable time for loss of 1 PSIG of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
4	0.3
6	0.7
24	3.6
36	6.0
48	7.6

3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the

test.
2) Provide temporary restraints for expansion joints for additional pressure load under test.
3) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
4) Do not coat or insulate exposed piping until successful performance of pressure test.

b. Soil, waste, drain and vent systems:
1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
2) Eliminate leaks before proceeding with insulating work or concealing piping.
3) Minimum test heights shall be 10 FT above highest stack inlet.

c. Larger diameter (above 36 IN) gravity plant piping:
1) Plug downstream end of segment to be tested.
a) Provide bracing as required.
2) Fill segment and upstream structure to normal operating level as per hydraulic profile.
3) Allow 24 HRS for absorption losses.
a) Refill to original level.
4) Provide reservoir to maintain constant head over duration of test.
5) Record reservoir water volume at beginning and end of test.

4. Air testing methodology:
a. General:
1) Assure air is ambient temperature.

b. Low pressure air testing:
1) Place plugs in line and inflate to 25 PSIG.
2) Check pneumatic plugs for proper sealing.
3) Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water that may be over the pipe.
a) Use test gage conforming to ASME B40.100 with 0 to 15 PSI scale and accuracy of 1 PCT of full range.
4) Allow 2 minutes for air pressure to stabilize.
5) After stabilization period (3.5 PSIG minimum pressure in pipe) discontinue air supply to line segment.
6) Record pressure at beginning and end of test.

3.4 CLEANING AND PURGING

A. Cleaning:

1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.

a. Clean equipment, pipe, - and fittings of grease, metal cuttings, and sediment which may have accumulated by operation of system, from testing, or from other causes.
b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without additional cost to Contract.

3.5 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

3.6 PIPE INSULATION

A. Insulate pipe and pipe fittings in accordance with Specification Section 40 42 00.

3.7 SCHEDULES

A. SPECIFICATION SCHEDULE - SYSTEM 2

1. General:
   a. Piping symbol and service:
      1) SEFF – Station Effluent.
      2) SRC – Station Recirculation.
   b. Test requirements:
      1) Test medium: Water.
      2) Pressure: 25 PSIG.
      3) Duration: 6 HRS.
2. System components:
   a. Pipe size 10 IN through 36 IN:
      1) Exposed service:
         a) Material:
            (i) Flanged: Ductile iron, Pressure Class 150.
         b) Reference: AWWA/ANSI C115/A21.15.
         c) Lining: Cement-mortar per AWWA/ANSI C104/A21.4.
         d) Coating: HPIC, See Specification Section 09 96 00.
         e) Fittings: Flanged either AWWA/ANSI C110/A21.10 ductile or gray iron.
   b. Gaskets:
      1) Flanged joints: Neoprene or synthetic rubber per AWWA/ANSI C111/A21.11.

B. SPECIFICATION SCHEDULE - SYSTEM 15

1. General:
   a. Piping symbol and service:
      1) SINF – Station Influent
   b. Test requirements:
      1) Hydrostatic infiltration testing. See the FIELD QUALITY CONTROL Article in PART 3 of Section 40 05 39.
2. System components:
   a. Pipe size 96 IN:
      1) Buried service up to 65 FT bury depth.
         a) Material: Reinforced Concrete Pressure Pipe, Non-cylinder Type.
         b) Reference: ASTM C302.
         c) Lining: None.
         d) Coatings: None.
         e) Fittings: None.
         f) Joints: Push-on, flush bell with spigot groove joint with O-ring gaskets.
         g) Gaskets: Rubber conforming to ASTM C361.
         h) Grouting: See Section 31 73 14 for pressure grouting the annular space around the conveyance piping.

C.SPECIFICATION SCHEDULE - SYSTEM 21

1. General:
   a. Piping symbol and service:
      1) FD – Floor Drain
      2) RD – Roof Drain.
      3) RDOF – Roof Drain Overflow.
   b. Test requirements:
      1) Test medium: Water.
      2) Pressure: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
      3) Duration: 6 HRS.
   c. Gaskets: Rubber, ASTM C564.
2. System components:
   a. Pipe size 2 IN and larger:
      1) Exposed service.
         a) Material: Cast iron soil pipe.
         b) Reference: ASTM A74, CISPI 301.
         c) Lining: None.
         d) Coating: HPIC; See Specification Section 09 96 00.
         e) Fittings: ASTM A74.
         f) Joints: No-hub with elastomeric sealing sleeve and stainless steel clamp assembly conforming to CISPI 301.
3. Drain Piping Installation:
   a. Install horizontal soil or waste lines less than 4 IN diameter with a slope of not less than 1/4 IN/FT or 2 PCT toward the point of disposal.
   b. Install 4 IN and larger piping at 1/8 IN per foot.
   c. Install as close to construction as possible to maintain maximum head room.
   d. Make changes of direction with 1/8 bends and junctions with wye fittings.

e. Use short wye fittings in vertical pipe only.
f. Install handhole test tee at base of each stack.
g. Install cleanouts at dead ends, at changes of direction and at 50 FT intervals on horizontal runs.
    1) Where cleanouts occur in concealed spaces, provide with extensions to floors above or to walls as required.
h. Install piping true to grade and alignment.
    1) Begin at the system low point.
i. Locate vertical extensions of underground piping below partition walls for concealment in wall.
    1) In locations where hubs are wider than partition, set hubs 1 IN below final floor.
j. Install concealed in finished structures such as administration and office facilities and at locations shown on Drawings.
k. For hub and spigot joints, install hub facing flow.

END OF SECTION

SECTION 40 05 07 - PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe support and anchor systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 01 - General Requirements.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 05 50 00 - Metal Fabrications.
4. Section 09 96 00 - High Performance Industrial Coatings.
5. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B31.3, Process Piping.
2. ANVIL International (ANVIL).
3. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M- Grades.
   d. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   e. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
4. American Welding Society (AWS):
   a. D1.1, Structural Welding Code - Steel.
5. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
   a. SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
   b. SP-69, Pipe Hangers and Supports - Selection and Application.

B. Responsibility:

1. Support systems for piping greater than 12 IN DIA with internal pressure over 100 PSI and piping with product temperatures over 200 DEGF are shown on the Drawings.

2. Contractor shall design support systems for 12 IN DIA piping and smaller, and for larger diameter piping where supports are not shown on the Drawings.
3. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
4. General piping support details may be indicated on the Drawings in certain locations for pipe smaller than 12 IN DIA.
5. Contractor shall incorporate those details with requirements of this Specification Section to provide the piping support system.

C. Each type of pipe hanger or support shall be the product of one manufacturer.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.
   d. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
   e. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
   f. Submit detail design calculations and scaled drawings prepared and signed by a registered Professional Engineer in the State of Illinois.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 MANUFACTURED UNITS

A. General:

1. Galvanized components:
   a. Electro-galvanized components:
      1) Bar, forged or cast fabrications: ASTM B633, SC4.
      2) Rolled sheet fabrications: ASTM A917 and ASTM A918, 50N50NU.
   b. Hot-dipped galvanized components: See Specification Section 05 50 00.
2. Dissimilar metals protection:

a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.

B. Hanger Rods:

1. Material:
   a. Non-corrosive areas:
      1) ASTM A36.
      2) ASTM A575, Grade M1020.
      3) ASTM A576, Grade 1020.
      4) Minimum allowable tensile stress of 12,000 PSI at 650 DEGF per MSS SP- 58.
   b. Corrosive areas:
      1) 304 stainless steel per ASTM A276.
2. Continuously threaded.
3. Electro-galvanized or cadmium plated after threads are cut.
4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 IN DIA (min)	610
1/2 IN DIA	1,130
5/8 IN DIA	1,810
3/4 IN DIA	2,710
7/8 IN DIA	3,770
1 IN DIA	4,960

C. Hangers:

1. Corrosive areas: 304 stainless steel.
2. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER STYLE
All except noted	4 IN and less	ANVIL Figure 108 with Figure 114
All except noted	Over 4 IN	ANVIL Figure 590

D. Concrete Inserts for Hanger Rods:

1. Corrosive areas: 304 stainless steel.
2. Continuous slots: Unistrut #P1000.
3. Individual inserts: ANVIL Figure 281.
4. See Specification Section 03 15 19, mechanical anchors.

E. Beam Clamps for Hanger Rods:

1. Corrosive areas: 304 stainless steel.

2. Heavy duty.
3. ANVIL Figure 134.

F. Trapeze Hangers for Suspended Piping:

1. General:
   a. Material: 304 stainless steel.
   b. Angles, channels, or other structural shapes.
   c. Curved roller surfaces at support point corresponding with type of hanger required.

G. Vertical Pipe Supports:

1. At base of riser.
2. Lateral movement:
   a. Clamps or brackets:
      1) Type 316 stainless steel.

H. Pipe Support Saddle:

1. For pipe located 3 FT or less from floor elevation, except as otherwise indicated on Drawings.
2. Stainless steel.
3. ANVIL Figure 264.

I. Pipe Support Risers:

1. Schedule 40 pipe.
2. 304 L stainless steel.
3. Size: As recommended by saddle manufacturer.

J. Pipe Support Base Plate:

1. 4 IN larger than support.
2. Collar 3/16 IN thickness, circular in shape, and sleeve type connection to pipe.
3. Collar fitted over outside of support pipe and extended 2 IN from floor plate.
4. Collar welded to floor plate.
5. Edges ground smooth.
6. Assembly hot-dipped galvanized after fabrication.

K. Pipe Covering Protection Saddle:

1. For insulated pipe at point of support.
2. ANVIL Figure 167, Type B.

L. Pipe Anchors:

1. For locations shown on the Drawings.
2. 1/4 IN steel plate construction.
3. Hot-dipped galvanized after fabrication.
4. Designed to prevent movement of pipe at point of attachment.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.

1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. Check all physical clearances between piping, support system and structure.

1. Provide for vertical adjustment after erection.

E. Support vertical pipe runs at base of riser.

1. Support pipes for lateral movement with clamps or brackets.

F. Place hangers are to be installed on outside of pipe insulation.

1. Use a pipe covering protection saddle for insulated pipe at support point.
2. Insulated piping over 1-1/2 IN: Provide a 12 IN length of high density perlite or high density calcium silicate at saddle.

G. Provide 20 GA galvanized steel pipe saddle for fiberglass and plastic support points to ensure minimum contact width of 4 IN.

H. Pipe Support Spacing:

1. General:
   a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
   b. Locate pipe supports at maximum spacing scheduled unless indicated otherwise on the Drawings.
   c. Provide at least one (1) support for each length of pipe at each change of direction and at each valve.
2. Cast-iron soil pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2 thru 4	10
5 thru 8	15

3. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one (1) hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:

1) Place hanger within 2 FT of each side of fittings to keep pipes in alignment.

4. Space supports for soil and waste pipe and other piping systems not included above every 5 FT.
5. Provide continuous support for nylon tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.

1. Included in this requirement are movements from:
   a. Trap discharge.
   b. Water hammer.
   c. Similar internal forces.

B. Weld Supports:

1. AWS D1.1.
2. Weld anchors to pipe in accordance with ASME B31.3.

C. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

D. Inspect hangers for:

1. Design offset.
2. Adequacy of clearance for piping and supports in the hot and cold positions.
3. Guides to permit movement without binding.
4. Adequacy of anchors.

E. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

F. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.

1. Install concrete inserts as concrete forms are installed.

G. Welding:

1. Welding rods: ASTM and AWS standards.
2. Integral attachments:
   a. Include welded-on ears, shoes, plates and angle clips.
   b. Ensure material for integral attachments is of good weldable quality.
3. Preheating, welding and postheat treating: ASME B31.3, Chapter V.

H. Field Painting:

1. Comply with Specification Section 09 96 00.

END OF SECTION

SECTION 40 05 19 - PIPE - DUCTILE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile iron piping, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 METHOD OF MEASUREMENT

A. The work specified herein for pump discharge and recirculation piping systems will be measured for payment at the contract unit price per foot for DUCTILE IRON PIPE, FLANGED of the size, type, and pressure class specified and shown on the Drawings upon completion and acceptance by the Engineer.

1.3 BASIS OF PAYMENT

A. The work specified herein for pump discharge and recirculation piping systems shall be paid for at the contract unit price per foot for DUCTILE IRON PIPE, FLANGED of the size shown on the Drawings and pressure class specified. The contract unit price shall be payment in full for all material, fittings, gaskets, fasteners, tools, equipment, labor, supervision, and any other items required to complete the work.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. ASTM International (ASTM):
      a. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   3. American Water Works Association (AWWA):
      a. C606, Standard for Grooved and Shouldered Joints.
   4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
      b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
      c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray- Iron Threaded Flanges.
      e. C150/A21.50, Standard for Thickness Design of Ductile-Iron Pipe.
      f. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
   5. Society of Automotive Engineers (SAE):

a. AMS-QQ-P-416, Cadmium Plating - Electro-deposited.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ductile Iron Pipe:
   1. AWWA/ANSI C115/A21.15.
   2. AWWA/ANSI C150/A21.50.
   3. AWWA/ANSI C151/A21.51.

B. Fittings and Flanges:
   1. AWWA/ANSI C110/A21.10.
   2. AWWA/ANSI C115/A21.15.
   3. Flanges drilled and faced per ASME B16.1 for both 125 and 250 PSI applications.

C. Nuts and Bolts:
   1. Exposed: Mechanical galvanized ASTM B695, Class 40.
   2. Heads and dimensions per ASME B1.1.
   3. Threaded per ASME B1.1.
   4. Project ends 1/4 to 1/2 IN beyond nuts.

D. Gaskets: See Section 40 05 00.

E. See Piping Schedules in Section 40 05 00.

2.2 FABRICATION

A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.

B. Furnish cast parts with lacquer finish compatible with finish coat.

2.3 LININGS AND COATINGS

A. See Section 40 05 00.

2.4 SOURCE QUALITY CONTROL

A. Factory Test:
   1. Subject pipe to hydrostatic test of not less than 500 PSI with the pipe under the full test pressure for at least 10 seconds.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Joining Method - Flanged Joints:
   1. Install in accordance with AWWA/ANSI C115/A21.15.
   2. Gaskets shall be Neoprene or synthetic rubber and shall conform to AWWA/ANSI C111/A21.11.
   3. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
   4. Make flange faces flat and perpendicular to pipe centerline.

5. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
6. Allow one (1) flange free movement in any direction while bolts are being tightened.
7. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
8. Gradually tighten flange bolts uniformly to permit even gasket compression.

B. Cutting:
   1. Do not damage interior lining material during cutting.
   2. Use abrasive wheel cutters or saws.
   3. Make square cuts.
   4. Bevel and free cut ends of sharp edges after cutting.

C. Support exposed pipe in accordance with Sections 40 05 00 and 40 05 07.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

END OF SECTION

SECTION 40 05 26 - PIPE - CAST-IRON SOIL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cast-iron soil piping, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 05 00 - Pipe and Pipe Fittings: Basic Requirements.
   3. Section 40 05 07 – Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. See Section 40 05 00.

B. Provide joint type specifically approved by applicable plumbing code.

C. Referenced Standards:
   1. ASTM International (ASTM):
      a. A74, Standard Specification for Cast-Iron Soil Pipe and Fittings.
      b. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
   2. Cast Iron Soil Pipe Institute (CISPI):
      a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
      b. 310,Standard for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Section 40 05 00.

PART 2 - PRODUCTS

2.1 MATERIALS

A. See Piping Schedules in Section 40 05 00.

2.2 FABRICATION

A. Cast-Iron Soil Pipe:

1. SV service rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Observe manufacturer's recommendation for handling, cutting, jointing, installing, and testing.

B. Install products in accordance with CISPI.

C. Support exposed piping in accordance with Section 40 05 00 and as specified in Section 04 05 07.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

END OF SECTION

SECTION 40 05 39 - PIPE - REINFORCED CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforced concrete pressure pipe, non-cylinder type.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 31 73 14 - Tunnel, Casing, and Shaft Grouting.
   3. Section 31 63 29 - Temporary Excavation Retention System
   4. Section 40 05 00 - Pipe and Pipe Fittings: Basic Requirements.

1.2 METHOD OF MEASUREMENT

A. The work specified herein will be measured for payment at the contract unit price per foot in place for REINFORCED CONCRETE PRESSURE PIPE of the size and pressure class specified and shown on the Drawings upon completion and acceptance by the Engineer.

1.3 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract unit price per foot for REINFORCED CONCRETE PRESSURE PIPE of the size and pressure class specified and shown on the Drawings. The work associated with the REINFORCED CONCRTE PRESSURE PIPE includes backfill grouting as specified in Section 31 73 14. Any stabilization grouting required before piping installation shall be installed and paid for per Section 31 63 29.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. Reinforced Concrete Pipe (RCP):
      a. ASTM International (ASTM):
         1) C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
         2) C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
         3) C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
         4) C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.
      b. American Water Works Association (AWWA):
         1) C302, Standard for Reinforced Concrete Pressure Pipe, Non-cylinder Type.
   2. Installation and testing:
      a. American Water Works Association (AWWA):
         1) M9, Installation of Concrete Pipe.

B. Conduct testing methods to evaluate physical properties of pipe in full compliance with ASTM C497.

1. Report full results test showing compliance with referenced standard.

C. Determine acceptability of RCP in all diameters and classes by appropriate ASTM plant tests, including such test to indicate specified design strengths have been met prior to shipment.
   1. Conduct three-edged bearing test as specified to determine the loading to produce a 0.01 IN crack extending 12 IN or more.
      a. Complete bearing test prior to shipment date of lot tested.
   2. Conduct crushing test, as specified on cured concrete cylinders.
      a. Achieve specified 28-day design compressive strength prior to shipment date of lot tested.

1.5 SYSTEM DESCRIPTION

A. Provide each pipe, fitting, special appurtenance with a plainly and permanently waterproofed, marked identification.
   1. Include but not necessarily limit markings to the following:
      a. Size and class of pipe, pressure rating in compliance with referenced standards.
      b. Date of manufacture.
      c. Manufacturer's trademark.
      d. Manufacturer's name.
      e. Full details on fittings and pipe schedule regarding angles of change, reduction.
      f. Special notations and tagging of special items in regard to line location.

1.6 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Concrete materials:
         1) Chemical and physical properties.
         2) Mix design.
      d. Reinforcement cage and steel cylinders for special designs not utilizing table values contained in references standards.
         1) Chemical and physical properties.
         2) Area of steel.
         3) Cage configuration.
      e. Joint details.
      f. Connection details.
      g. Pressure grout pipe locations (radially) and spacing.
      h. Tabulated laying schedule.
         1) Reference to project stationary and invert elevations.
         2) Identify pressure zones, each of design pressure or transient loading

zones applicable, and point of change from one (1) zone to another.
3) Pipe diameter.
4) Pipe wall thickness.

i. Test reports: Include six (6) copies of D (0.01) - Load and Failure Test Reports, cylinder compression test results, and joint tests (if required).

j. Alkalinity tests:
1) The alkalinity of the cover concrete shall be determined by the manufacturer and verified by an independent testing laboratory at intervals determined by Engineer.
2) Two (2) drill hole samples shall be obtained and tested from a single pipe section for each day's production for each pipe diameter produced during the first week of production.
a) The alkalinity of the test pipe section shall be computed as the average of the two (2) drill samples.
b) After the first week of production, one (1) pipe section shall be drilled, sampled, and tested for each pipe diameter produced for each week's production.
3) The exact procedure of obtaining samples, analyzing them, and the method of calculation of the resultant AZ factor will be submitted to the Engineer for approval prior to commencing testing.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

A. Provide pressure service RCP for minimum internal hydrostatic pressures of 50 PSI and in full compliance with AWWA C302.
1. Provide sealed joints using continuous rubber gasket conforming to requirements of ASTM C361.
2. Type of joint shall be concrete joint with spigot groove and O-ring gasket.
a. United States Bureau of Reclamation Type R-2.
b. The rubber gasket joint shall serve as the sole element to create a water tight joint.
3. Provide pipe rated for the depth of bury indicated on the Drawings and an average external water table depth to the crown of the pipe of 50 FT.

B. Provide pressure grout pipes through the pipe sidewall to enable the connection of grout hoses for the pressurized contact grouting of the annular space between the soil and the outer face of the piping. Contractor shall coordinate with the pipe manufacturer to provide a compatible interface between the contact grouting system and the process pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Observe all recommendations in accordance with AWWA M9 for installation, delivery, and storage of pipe material.

B. See Specification Section 31 73 14 for requirements for pressure grouting the annular space between the piping and the soil.

C. See Specification Section 40 05 00.

3.2 PRESSURE AND LEAKAGE TEST

A. Subject pipe to the following required in-place tests:

B. Hydrostatic Infiltration Test:
   1. Perform and observe following testing criteria and procedures for non-pressure service or gravity drainage piping for compliance with infiltration allowances.
      a. Contractor shall bulkhead and seal the invert of the piping such that all infiltrating water is collected in the bottom of the lowest pipe segment. After the specified test period, the depth of water shall be recorded along the mid line of the pipe invert at a maximum interval of 50 FT and reported to the Engineer. Volume of infiltration shall be calculated as a composite chord area multiplied by the interval length over the entire distance of the pipe segment being tested, or where the water is no longer ponding, whichever is less.
      b. Maximum infiltration rate shall be as specified in Section 40 05 00.
   2. If the infiltration rate exceeds the maximum amount specified, the Contractor shall reduce the infiltration rate to the specified maximum rate, at no additional cost. The Contractor shall submit a procedure and any proposed products and materials to the Engineer. The Contractor must receive approval from the Engineer before implementing the proposed procedure.

END OF SECTION

SECTION 40 05 59 - SLUICE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Water control gates and operators.
   1. Sluice gates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. C561, Standard for Stainless Steel Slide Gates.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

A. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. General arrangement drawings and catalog cut sheets are not acceptable for installation drawings. Installation drawings shall be detailed and custom created for this specific project.
      c. The content of Operation and Maintenance Manuals.

1.5 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, F.O.B. its factory, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within 12 months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Water Control Gates-Sluice Type:
      a. RW Gate Company, Troy, NY.
      b. Or equal.

2. Electric Gate Operators.
   a. AUMA Actuators Inc.
      1) Model SAMEL-Open/Close Service.
      2) Model SARMEL-Modulating Service.

B. No like, equivalent or "or-equal" item or substitution is permitted without written approval of the Engineer and the substitution meets all requirements in this Specification Section.

C. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 SLUICE GATES

A. General:
   1. Provide gates meeting requirements of AWWA C561 as modified per this Specification Section.
   2. The gate manufacturer shall be ISO 9001:2008 certified. Copy of certification shall be provided with Shop Drawing submittals.

B. Design:
   1. Working stresses shall be in accordance with the latest revision of AWWA C561.

C. Materials:
   1. Frame: Stainless steel, A-240, type 304L.
   2. Disc/Slide: Stainless steel, A-240, type 304L.
   3. Self-adjusting side and top seals: UHMWPE, ASTM D4020.
   4. Flush bottom invert seal: EPDM, ASTM D2000.
   5. Pedestal: Stainless steel, A-240, type 304L stainless steel.
   6. Fasteners: Stainless steel, A-276, type 316.
   7. Stems: Stainless steel, A-276, type 304L.
   8. Stem Guides: Stainless steel, A-240, type 304L.
   9. Stem guide bushings: UHMWPE, ASTM D4020.
   10. Stem brackets and hardware: Stainless steel, type 304.

D. Frame:
   1. Fabricate as one piece construction with mounting flange surface. Gussets shall

be welded to the guide and shall extend across the entire guide to accommodate unseating head conditions. Two-piece or sandwich type frames are not acceptable.

2. Wall mounted guides for the 96” x 96” gates and the 72” x 72” gate shall have a minimum weight of 35 LBS/FT. The 30” x 30” gates and the 108” x 84” gates shall have a minimum weight of 13 LBS/FT for the guides.
3. Guide extensions shall be Z-shaped or C-shaped for rigidity and shall have a minimum weight of 6.5 LBS/FT. Angles are not acceptable guide extensions.
4. On self-contained gates, two yoke members shall be provided at the top of the frame, above the operating floor. The yoke members shall be C-shaped structural members.
5. The portion of the frame, where the anchor penetrates, shall have a minimum thickness of 1/2 IN.

E. Disc/Slide:
1. Fabricate as one-piece construction with integral horizontal and vertical reinforcing ribs welded to the side plate.
2. The slide shall be reinforced to restrict deflection to 1/720 of the gate span or 1/16 IN, whichever is less.
3. The portion of the slide that engages the frame shall have a minimum thickness of 1/2 IN for the 30” x 30” gates and the 108” x 84” gates and shall have a 3 IN thickness for the 96” x 96” gates and the 72” x 72” gate.
4. Stem connector shall be on the vertical centerline of the disc above the horizontal center. The stem connector shall be constructed of two structural shapes with a minimum of two bolts to connect stem to slide.

F. Seals.
1. The UHMWPE seals shall be self-adjusting by means of a nitrile or EPDM compression cord. Wedges, wedge bars and pressure pads are not acceptable. Upward opening gates shall be provided with a flush bottom invert seal.
2. The invert seal on upward opening gates shall be EPDM and shall be mechanically fastened to the invert member to provide a flush bottom seal. Invert seals held solely with adhesives are not acceptable.
3. All seals shall be field replaceable and shall be mechanically fastened with stainless steel attachment bolts.
4. All seals shall be replaceable without disassembly of the frame and without the need to remove the gate from the wall.

G. Pedestal:
1. Stainless steel pedestals shall have a base plate, adaptor plate and gussets with a minimum thickness of 1/2 IN. The pedestal tube shall have a minimum diameter of 4 IN.

H. Stem:
1. Size to withstand, without buckling or permanent distortion, the stresses induced by the normal operating forces.
2. Design to transmit in compression, 2-1/2 times the rated output of the floor stand with a 40 LB effort on the crank or handwheel.
3. The stem shall have a minimum diameter of 1-1/2 IN for the 30” x 30” gates and a minimum diameter of 2 IN for the remaining gates.
4. The threaded portion of the stem shall have machine rolled, full-depth Acme

threads. Stub threads are not acceptable.

I. Stem Guides:
   1. Provide stem brackets and hardware to connect to structural supports shown on Drawings. Stem guide structural members shall be minimum 3/8 IN thick and shall be sized by the manufacturer to resist design loads.
   2. The stem guides shall have adjustable UHMWPE bushings.

2.3 GATE OPERATORS AND LIFTS

A. General:
   1. Provide lifts in accordance with AWWA C561 as modified in this Specification Section.
   2. Equip all lifts with clear butyrate plastic stem cover with Mylar position indicator strips.
   3. Furnish each electric operator capable of moving its gate at an approximate speed of 12 IN per minute.

B. Electric Operators:
   1. Enclosure:
      a. Rated for the area classification shown on the Drawings.
      b. Furnish all connections terminated with plug and socket connection.
      c. Utilize O-ring seals.
   2. Motor:
      a. Design for 480 V, 3 phase, 60 cycle operation for all operators.
      b. Provide induction type motor with Class F insulation.
      c. Embed thermal switches in motor windings.
      d. Enclose in aluminum or cast iron housing with cooling fins, non-ventilated.
      e. Provide plug and socket terminal connection to facilitate removal or replacement.
   3. Manual override:
      a. Declutchable, manual handwheel.
      b. Provide ability to operate gate using portable operator or heavy-duty electric drill if manual handwheel operation is not desired.
      c. Designed such that inoperable or fused motor shall not prevent manual operation.
   4. Capable of minimum 12 IN per minute opening/closing speed.
   5. Control Circuit:
      a. Furnish integral travel limit switches to de-energize the motor control circuit in both open and closed directions.
      b. Provide a minimum of (4) contacts, (2) normally open (2) normally closed, rated at 10 amps @ 115 V, for each end of travel.
      c. Utilize silver contacts capable of switching a low voltage DC control signal.
      d. Terminate wiring by plug and socket connection.
   6. Limit/Torque Switches:
      a. Furnish counter gear driven limit switches capable of adjustment by no more than five (5) turns of an adjustment spindle.
      b. Utilize mechanically operated torque switches to de-energize the motor circuit when operating torque exceeds the switch setting.

c. Calibrate torque switch adjustment device directly in engineering units of torque.
d. Install space heater in the limit switch compartment.

7. Controls:
   a. Open/close application actuators equipped with:
      1) Reversing starters.
      2) Control transformers.
      3) Open/stop/close pushbuttons.
      4) Local/off/remote selector switch.
         a) Dry contacts for remote indication of “remote” control selection.
      5) Red and green position indicating lights with yellow fault indicator.
      6) Mechanical dial position indicator.
      7) Open and close commands from remote PLC to be 24 VDC circuits.
   b. Throttling/modulating application actuators equipped with:
      1) Positioner:
         a) Capable of accepting a current or voltage analog command signal.
            (1) Loop powered from remote PLC cabinet.
         b) Capable of comparing a signal with gate position.
         c) Capable of zero, span, time delay and dead band signal adjustment.
         d) Rated for 1200 starts per hour.
      2) 4-20 MA signal output transmitter for remote indication.
         a) Loop powered from remote PLC cabinet.
   c. House controls in an enclosure that allows for remote mounting directly to the actuator drive unit or remote mounting in an accessible location. Remote mounted control head shall include:
      1) Motor Starters.
      2) Transformer.
      3) Logic and Interface Boards.
      4) Local – Off – Remote Switch / Open-Stop-Close Pushbuttons / Indicating Lights.
      5) All termination points for field wiring including power, control, and feedback wiring.
   d. Connection between the remote head and actuator housing shall be field wired. Motor manufacturer shall provide a point to point connection drawing.
   e. Motor manufacturer to provide a wall bracket for mounting of the remote control head.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. See Section 43 21 00.
B. Employ and pay for services of equipment manufacturer’s field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise pre-start adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.

4. Conduct start-up of equipment and perform operational checks.
5. Contractor shall provide Engineer with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by the Department.
6. Provide personnel training for a minimum of 4 HRS per day at jobsite on operation and maintenance of the gates and operators.
   a. See Specification Section 01 75 00 for training submittal and format requirements.
   b. Contractor installation assistance, startup and training to be completed in two separate trips:
      1) Trip 1: Three (3) days on-site to be provided during construction to assist the Contractor in gate installation.
      2) Trip 2: Three (3) days on-site to be provided for startup of equipment and training of staff.

3.2 CONTROL GATE SCHEDULE

GATE TAG NUMBER	OPERATOR (2)	OPENING SIZE W x H INCH	MAX DIMENSIONS W x H INCH	GATE TYPE	MAX SEATING HEAD FT (1)	MAX UNSEATING HEAD FT (1)	Motor HP
IG-01	Electric Open-Close Service	96-IN DIA	120 X 162	Non Self-Contained	35	15	4
IG-02	Electric Open-Close Service	96-IN DIA	120 X 162	Non Self-Contained	35	15	4
IG-03	Electric Open-Close Service	72 X 72	96 X 120	Non Self-Contained	35	35	3
RG-01	Electric Modulating Service	30-IN DIA	40X 52	Non Self-Contained	10	10	1/3
RG-02 (3)	Electric Modulating Service	30-IN DIA	40X 52	Self-Contained (4)	10	10	1/3
DG-01	Electric Open-Close Service	108 X 84	118 X 202	Self-Contained	10	10	1
DG-02	Electric Open-Close Service	108 X 84	118 X 202	Self-Contained	10	10	1

NOTES:
(1) Seating and unseating heads are measured from gate invert to maximum water surface.
(2) All gates are upward opening.
(3) Spur gearbox shall provide 6-IN lateral offset between input extension stem and centerline of gate.
(4) Yoke and spur gearbox shall be located below floor level.

END OF SECTION

SECTION 40 42 00 - PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Insulation:
      a. Piping insulation.
      b. Duct insulation.
      c. Equipment insulation.
   2. Adhesives, mastics, sealants, and finishes.
   3. Grease and air ventilation duct wrap fire protection systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 05 00 – Pipe and Pipe Fittings: Basic Requirements
   3. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
      b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
      c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      d. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      e. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      f. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
      g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      h. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      i. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
      j. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      l. E119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
      m. E136, Combustion Characteristics of Building Materials in a Vertical Tube

Furnace.
n. E162, Surface Flammability of Materials.
o. E814, Through-Penetration, 2-Hour Firestop Test.
p. E2336: Standard Test Methods Fire Resistive Grease Duct Enclosure Systems.
2. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
3. National Fire Protection Association (NFPA):
a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratories, Inc. (UL):
a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
5. National Commercial and Industrial Insulation Standards (2013 seventh edition).
a. Published by Midwest Insulation Contractors Association (MICA).
b. Endorsed by National Insulation Association (NIA).
c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Fiberglass insulation:
a. CertainTeed Corporation.
b. Johns Manville.
c. Owens Corning.
d. Knauf.
2. PVC jacket:
a. Ceel-Co.
b. PIC Plastics.
3. Equipment insulation:
a. CertainTeed Corporation.
b. Johns Manville.
c. Owens Corning.
4. Ductwork insulation:
a. CertainTeed.
b. Johns Manville.
c. Owens Corning.
5. High density perlite:
a. Johns Manville.
b. Industrial Insulation Group (LIC).
6. High density calcium silicate:
a. Industrial Insulation Group (LIC).

7. Adhesives, mastics, sealants, and finishes:
   a. Foster Products.
   b. Childers.
   c. Dow Corning.
   d. Johns Manville.
   e. Knauf.

2.2 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:
   1. Preformed fiberglass pipe insulation:
      a. Density: 4 LBS/CF.
      b. Temperature rated: 650 DEGF.
      c. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DEGF.
      d. Fire hazard rating:
         1) UL 723, ASTM E84, NFPA 255.
         2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.
   3. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.
      c. Flame attenuated glass fibers bonded with thermosetting resin.
   4. Piping jackets (general applications):
      a. Aluminum: 16 MIL embossed aluminum.
      b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC.
      c. Piping jacket not required on concealed piping.
   5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 PIPE INSULATION INSERTS AT HANGERS

A. High Density Perlite:
   1. Pre-formed.
   2. Fire hazard rating:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread: Zero (0).
      c. Smoke developed: Zero (0).
   3. Average density: 13 LBS/CF.
   4. Compressive strength: 80 PSI to produce 5 PCT compression.
   5. Maximum surface temperature: 1,200 DEGF.

B. High Density Calcium Silicate:
   1. Pre-formed.

2. Fire hazard rating:
   a. UL 723, ASTM E84, NFPA 255.
   b. Flame spread: Zero (0).
   c. Smoke developed: Zero (0).
3. Average density: 14 LBS/CF.
4. Compressive strength: 100 PSI to produce 5 PCT compression.
5. Maximum surface temperature: 1,200 DEGF.

2.4 EQUIPMENT INSULATION

A. Insulation for Equipment:
   1. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Provide minimum insulation thickness conforming to Schedules, or as shown on Drawings.

2.5 DUCTWORK INSULATION: FIBERGLASS

A. Flexible Insulation:
   1. Material: Commercial-grade fiberglass thermal insulation, formaldehyde free.
   2. Scheduled thickness and installed R-value. Installed R-value when compressed to a maximum of 25 PCT following recommended duct wrap stretch outs.
   3. Factory-applied foil scrim vapor barrier facing.
   4. Average thermal conductivity not to exceed 0.27 (Btu-IN)/(HR-FT^2-DegF) at a mean temperature of 75 DEGF (installed).
   5. Fungi and bacteria resistance:
      a. ASTM C1338.
      b. Does not breed or promote growth.
   6. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   7. Basis of design: Johns Manville Microlite fiberglass duct wrap insulation.

B. Semi-Rigid Insulation for Indoor Installation:
   1. Scheduled thickness and R-value.
   2. Factory applied vapor barrier facing-white scrim foil.
   3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at a mean temperature of 75 DEGF.
   4. Fungi and bacteria resistance:
      a. ASTM C1338.
      b. Does not breed or promote growth.
   5. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 0.5 PCT moisture by volume when exposed to moisture laden air at 120 DEGF and 96 PCT RH.

C. Semi-Rigid Insulation for Outdoor Installation:
   1. Scheduled thickness and R-value.
   2. Factory-applied foil scrim vapor barrier facing.

3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 DEGF.
4. Minimum density: 3 LBS/CF.
5. Fungi and bacteria resistance:
   a. ASTM C1338.
   b. Does not breed or promote growth.
6. Basis of Design: Johns Manville #815 SPIN-GLASS fiberglass duct insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. General:
   1. Piping below ground covered with earth will not be insulated.
   2. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
   3. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
      a. Consider ductwork, piping and equipment above ceilings as concealed.
   4. Provide release for insulation application after installation and testing is complete.
      a. Apply insulation on clean, dry surfaces after inspection.
   5. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
   6. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
      a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
      b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
   7. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Piping Insulation - Fiberglass:
   1. Apply over clean dry pipe.
      a. Butt all joints together firmly.
   2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
   3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
   4. PVC pipe jacket:
      a. Apply jacketing with a minimum of 1 IN overlap.
         1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
      b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
         1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
      c. Provide pre-molded PVC covers of same material and manufacturer as jacket

for fittings, valves, flanges, and related items in insulated piping systems.

5. Aluminum pipe jacket:
   a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
   b. Provide smooth and straight joint with a minimum 2 IN overlap.
   c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
   d. Center spacing of screws 5 IN maximum or as required to provide smooth tight- fitted joints.
   e. Place joints on least exposed side of piping to obtain neat appearance.

D. Equipment: Install per manufacturer's instructions.

E. Ductwork Insulation - Fiberglass:
   1. Flexible insulation:
      a. Butt edges tightly.
         1) Secure insulation with Benjamin Foster 85-20 adhesive applied in 6 IN strips on 12 IN centers and/or pins, applied on not more than 18 IN centers so that the insulation conforms to the duct surfaces uniformly and firmly.
      b. Seal joints with facing overlap or 4 IN wide strips of like facing material adhered and stapled in place.
      c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85- 20.
      d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.
   2. Semi-rigid insulation and duct interior lining board:
      a. Impaling over pins.
         1) Apply insulation with edges tightly butted.
         2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
         3) Clip pins off close to clip.
         4) Space pins as required to hold insulation firmly against duct surface but not less than one (1) pin per 1.5 SQ FT.
         5) Seal joints and speed clips with 3 IN wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
      b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
         1) Cover the entire surface of duct with adhesive.
         2) Use corner metal angle to protect edge of insulation.
         3) Protect edge of insulation.
         4) Seal joints as above.
      c. For outdoor application finish with Benjamin Foster #4610 weatherproof mastic with white glass fabric membrane.

3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

A. Pipe, Fittings and Valves:

1. Fiberglass.

APPLICATION	PIPE SIZE	THICKNESS	JACKET
Roof Drainage (RD and RDOF)	2-1/2 to 6 IN	1 IN	PVC

B. Ductwork:
1. Fiberglass.

DUCT SERVICE	INSULATION AND THICKNESS	MINIMUM R-VALUE ($HR\text{-}FT^2\text{-}DegF)/Btu$
Outside air and supply air downstream of heat recovery units, outside building	2-1/2 IN semi-rigid for outdoor installation	12.0
Outside air ducts, inside building	2-1/2 IN semi-rigid with vapor barrier	12.0
Supply and return air ducts inside building	2 IN flexible with vapor barrier	6.0
Supply and return air ducts outside building and where exposed to atmospheric air	2-1/2 IN semi-rigid for outdoor installation	12.0
Return air duct in non-conditioned areas including shafts	2-1/2 IN flexible with vapor barrier	12.0
Exhaust air ducts upstream of heat recovery units, inside building	1-1/2 IN semi-rigid	6.0
Exhaust air ducts upstream of heat recovery units, outside building	2-1/2 IN semi-rigid for outdoor installation	12.0
All other ductwork	Uninsulated	N/A

END OF SECTION

SECTION 40 90 00 - INSTRUMENTATION FOR PROCESS CONTROL - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 10 14 00 - Identification Devices.
   3. Section 40 90 05 – Supervisory Control and Data Acquisition Equipment
   4. Section 41 90 10 - Primary Meters and Transmitters.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. Canadian Standards Association (CSA).
   2. FM Global (FM).
   3. The International Society of Automation (ISA):
      a. 7.0.01, Quality Standard for Instrument Air.
      b. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      d. S5.4, Standard Instrument Loop Diagrams.
      e. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   6. National Institute of Standards and Technology (NIST).
   7. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Qualifications:
   1. Instrumentation subcontractor:
      a. Experience:
         1) Have satisfactorily provided a control system for a minimum of five (5) projects of similar magnitude and function.

C. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.4 DEFINITIONS

A. Architecturally finished area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.

B. Non-architecturally Finished Area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.

C. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

D. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

E. Outdoor Area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

F. Instrument Air Header: The segment of air supply piping and tubing which transports air from the compressed instrument air source through the branch isolation valve of any takeoff (branch) line.

G. Branch Line: The segment of air supply piping and tubing which transports air from the outlet of the air header branch isolation valve through an air user's isolation valve.

H. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

I. Calibrate: To standardize a device so that it provides a specified response to known inputs.

1.5 SYSTEM DESCRIPTION

A. Control System Requirements:
   1. This Specification Section provides the general requirements for the instrument and control system.
   2. The instrument and control system consists of all primary elements, transmitters, switches, controllers, computers, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. All signals shall be directly linearly proportional to measured variable unless specifically noted otherwise.

C. Single Instrumentation Subcontractor:
   1. Furnish and coordinate instrumentation system through a single instrumentation

subcontractor.
   a. The instrumentation subcontractor shall be responsible for functional operations of all systems, performance of control system engineering, supervision of installation, final connections, calibrations, preparation of Drawings and Operation and Maintenance Manuals, start-up, training, demonstration of substantial completion and all other aspects of the control system.
2. Ensure coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

1.6 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   3. Limit the scope of each submittal to one (1) Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 40 90 00.
   4. Product technical data including:
      a. Equipment catalog cut sheets.
      b. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument.
      c. Materials of construction.
      d. Minimum and maximum flow ranges.
      e. Pressure loss curves.
      f. Physical limits of components including temperature and pressure limits.
      g. Size and weight.
      h. Electrical power requirements and wiring diagrams.
      i. NEMA rating of housings.
      j. Submittals shall be marked with arrows to show exact features to be provided.
   5. Loop diagrams per ISA S5.4 as specified in Specification Section 40 98 00.
   6. Comprehensive set of wiring diagrams as specified in Specification Section 40 98 00.
   7. Panel Fabrication Drawings as specified in Specification Section 40 98 00.
   8. PLC/DCS equipment Drawings.
   9. HMI graphics.
   10. Nameplate layout Drawings.
   11. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
      a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be

employed exclusively throughout submittals.

12. All Shop Drawings shall be modified with as-built information/corrections.
13. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
    a. Furnish electronic files on CD-ROM or DVD-ROM media.
    b. Drawings in MicroStation format.
14. Provide a parameter setting summary sheet for each field configurable device.
15. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
        1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
16. Testing reports: Source quality control reports.

B. Contract Closeout Information:
    1. Operation and Maintenance Data:
        a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
    2. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

1.8 SITE CONDITIONS

A. Unless designated otherwise on the Drawings, area designations are as follows:
    1. Outdoor area:
        a. Wet.
        b. Corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
        c. Below grade vaults and manholes:
            1) Subject to temporary submergence when specifically designated on the Drawings or Specifications.
    2. Architecturally finished area:
        a. Dry.
        b. Noncorrosive unless designated otherwise on the Drawings or in the Specifications.
        c. Nonhazardous unless designated otherwise on the Drawings or in the Specifications.
    3. Non-architecturally finished area: As designated elsewhere on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the following:
   1. Areas designated as wet: NEMA Type 4.
   2. Areas designated as wet and/or corrosive: NEMA Type 4X.
   3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
      a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
      a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
   6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. System Operating Criteria:
   1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two (2) cycles per minute or a magnitude of movement of 0.5 PCT full travel.
   2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
   3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 PCT of full scale over a 6:1 operating range.
   4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 PCT of full travel regardless of force required to position final element.
   5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0 PCT of full scale.
   6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10 14 00.

B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per the requirements of the Electrical design.

C. Panel-Mounted Instruments:
   1. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
   2. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

3.2 FIELD QUALITY CONTROL

A. See Specification Section 01 75 00.

B. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
   1. Documentation requirements include the utilization of the forms located at the end of this Specification Section.
      a. Loop Check-out Sheet.
      b. Instrument Certification Sheet.
      c. Final Control Element Certification Sheet.

C. In the event that instrument air is not available during calibration and testing, supply either filtered, dry, instrument quality air from a portable compressor or bottled, dry, instrument quality air.
   1. Do not, under any circumstances, apply hydrostatic test to any part of the air supply system or pneumatic control system.

D. Pneumatic Signal Tubing Testing:
   1. Before the leak test is begun, blow clean with dry air.
   2. Test signal tubing per ISA 7.0.01, except for tubing runs of less than 10 FT where simple soap bubble testing will suffice.
   3. If a leak is detected, repair the leak and repeat the leak test.
   4. After completion of the leak test, check each signal line for obstructions.
      a. If any are indicated, remove and retest.

E. Instrumentation Calibration:
   1. Verify that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
   2. Calibrate all field-mounted instruments, other than local pressure and temperature gages, after the device is mounted in place to assure proper installed operation.

3. Calibrate in accordance with the manufacturer's specifications.
4. Bench calibrate pressure and temperature gages.
   a. Field mount gage within seven (7) days of calibration.
5. Check the calibration of each transmitter and gage across its specified range at 0, 25, 50, 75, and 100 PCT.
   a. Check for both increasing and decreasing input signals to detect hysteresis.
6. Replace any instrument which cannot be properly adjusted.
7. Stroke control valves with clean dry air to verify control action, positioner settings, and solenoid functions.
8. Calibration equipment shall be certified by an independent agency with traceability to NIST.
   a. Certification shall be up-to-date.
   b. Use of equipment with expired certifications shall not be permitted.
9. Calibration equipment shall be at least three (3) times more accurate as the device being calibrated.

F. Loop check-out requirements are as follows:
   1. Check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
      a. Use actual signals where available.
      b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
         1) Verify that readings at all loop components are in agreement.
         2) Make corrections as required.
            a) Following any corrections, retest the loop as before.
   2. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
   3. Check all interlocks to the maximum extent possible.
   4. In addition to any other as-recorded documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Engineer.

G. Provide verification of system assembly, power, ground, and I/O tests.

H. Verify existence and measure adequacy of all grounds required for instrumentation and controls.

END OF SECTION

SECTION 40 90 05 - SUPERVISORY, CONTROL AND DATA ACQUISITION (SCADA) EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTIONS AND RESPONSIBILITIES

A. Process Control System (PCS): a complete, integrated system of PLC's, HMI's, Windows-based computers, instruments, devices, wireless and wired process control networks, software, Application Engineering, and ancillary equipment for monitoring and control of storm water collection facilities.

B. System Integrator: Organization, whose principle function is design, program, configure, manufacture, provide and install and service of PCS. An organization, retained by and under the direction of the Contractor, who shall assume complete responsibility for: detail design, manufacture, installation, configuration, technically advising on and certifying correctness of installation, testing and adjusting, documenting and starting-up, and training of the complete PCS.

C. SCADA (Supervisory Control and Data Acquisition) system shall be provided to function as the "Master Control" for the Pump Station facility. The SCADA system shall consist of, but not be limited to; programmable controllers, computer, HMI's, software, network and communications equipment, process instrumentation and control devices, uninterruptible power supply (UPS), and other devices as required and/or as indicated on Contract Drawings.

D. System Integrator shall inspect Equipment provided under this Section prior to shipment to Project site.

E. System Integrator shall coordinate work with Contactor to insure that:

1. All components provided under this Section are properly installed.
2. All components provided under this Section are properly configured.
3. The proper type, size, and number of control wires within conduits are provided.
4. Proper electric power circuits are provided for all components and systems.

F. System Integrator shall be responsible for the operational testing of the HMI's, SCADA software, and PLC software programs.

G. Systems Integrator shall be responsible for the configuration and setup of the Power Monitoring Devices provided as part of the Process Control System. The setup shall include data access via the Process Control Network.

H. System Integrator shall be responsible for all Application Engineering. The System Integrator shall provide all programming and configuration of equipment and software including development of graphic displays, alarm logs, and event viewer screens. Display development shall be coordinated with existing Department standards. The Department

standard programming code shall be used as basis, and is available as .pdf during bid-phase upon request.

I. System Integrator shall be responsible for coordination of voltage levels and signal types for signals connected to Process Control System. Provide relays, signal isolators, termination or pull-up resistors, attenuators, signal conditioners or other devices only as required for proper interfacing and operation of non-compatible devices. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, isolation barriers, or relays to interface with equipment provided under this Contract shall be included whether shown on the Drawings or not.

J. All materials, equipment, labor, installation, configuration, software, programming, and incidentals required to achieve a fully integrated and operational system shall be furnished and installed complete by a qualified System Integrator with a minimum of 10-years' experience with comparable size projects. The System Integrator shall design and coordinate the instrumentation and control system for proper operation with related equipment and materials.

K. The System Integrator shall provide a detailed descriptive narrative of the Pump Station control system strategy describing auto/manual pump controls locally, at MCC, and at SCADA panel. The control system narrative shall include analog level control, float backup, monitoring and security systems, communications architecture and scheme for monitoring at District 1, IDOT TSC, and EMC Contractor's facility. The control system narrative shall include all system components shown on E and IC Drawings within contract documents. HMI screens shall accompany the control system narrative along with any photographs, cut sheets, or other materials that aid in the understanding of Pump Station controls. Pump Station control system strategy shall use Contract documents as a basis for a more detailed narrative and expand in greater detail for each piece of equipment.

L. The System Integrator shall coordinate with the Electrical Contractor in the installation of the control system and shall perform all on-site testing, calibration, start-up, troubleshooting, and training of PCS for the Department staff.

M. All necessary coordination required for interfacing the proposed Pump Station facility with the proposed SCADA system shall be provided by the System Integrator. The System Integrator shall coordinate with other equipment suppliers, such as, but not limited to, of Main Pumps and Low Flow Pumps, MV MCC and LV MCC, Mechanical Screen, Sluice Gates, Overhead Crane, Fire Alarm system, Combustible Gas Monitoring System, AEGIS/IAP, etc. The coordination includes developing translators for communication to Modbus TCP equipment of the other equipment suppliers.

N. The Pump Station SCADA system shall be remotely monitored at District 1 Headquarters, IDOT TSC, and the Electrical Maintenance Facility via the existing Department's fiber-optic backbone (primary means), with backup by redundant 4G radio equipment and technology. Each remote monitoring site monitors the respective Pump Station, as well as other the Department Pump Station facilities. Currently, Allen Bradley RSView is the Human Machine Interface (HMI) software that is installed at the

workstations at these locations and is the means in which the operators monitor the Pump Stations.

1. Contractor is responsible for coordination with the System Integrator and IDOT's Electrical Maintenance Contractor (EMC) required for ensuring the proper functioning of the remote monitoring systems.
2. All inputs at the remote monitoring locations shall be checked via each means of communications. Field test results of all I/O points verifying functionality for remote monitoring shall be submitted to Engineer for review. Contractor to provide PLC I/O addresses for network monitoring from remote locations.
3. The integration work at the remote monitoring locations shall be performed by the EMC. Payment for this work specified under this paragraph shall be paid for under Article 109.05 of IDOT's Standard Specifications for Road and Bridge Construction. The work shall include integration of new PS04 facility at the remote monitoring HMI. An allowance of $30,000 shall be included for this work under pay item: PS04 INTEGRATION AT REMOTE MONITORING STATIONS. However, the Contractor will be paid only for the actual fees paid by him to the EMC plus an administrative cost in accordance with Section 109.05.

1.2 PROGRESS PAYMENTS

1. Progress payments will be in accordance with Section 109 of the Standard Specifications.
2. Equipment specified under this section will be considered 80% complete once "Substantially Complete", corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approved and delivered, and all outstanding issues have been completed.

1.3 BASIS OF PAYMENT

A. Payment for work specified in this Section, unless otherwise noted herein, shall be included in the Contract lump sum price for the item, PUMP STATION SCADA EQUIPMENT.

B. Payment for work specified in Section 2.4, shall be included in the Contract lump sum price for the item, GAS DETECTION PANEL.

C. Payment for work specified in Section 1.1.N.3 shall be included in the Contract lump sum price for the item, PS04 INTEGRATION AT REMOTE MONITORING STATIONS.

1.4 SYSTEM INTEGRATOR

A. Complete Integration Services

B. Meade Electric.

C. Wunderlich-Malec

D. ICS Healy-Ruff.

1.5 SYSTEM INTEGRATOR EXPERIENCE REQUIREMENT

A. The Contractor shall utilize a System Integrator having the experience and knowledge, as defined herein, to undertake the work specified in this Section. The System Integrator shall be an organization having the following organizational and individual experience, knowledge, and capabilities:

1. System Integrator shall be regularly engaged in the design, installation, and servicing of wastewater and stormwater collection and treatment PCS.
2. System Integrator shall demonstrate the ability to produce electrical and control logic diagrams in the level of detail required by this specification.
3. System Integrator shall have previously executed a minimum of five (5) wastewater and/or stormwater collection treatment PCS projects of similar size and complexity to this Project incorporating PLC's and HMI platforms included in this Project.
4. Systems Integrator shall have previously successfully executed Ethernet wired networked projects of comparable size and complexity to this Project.
5. The person(s) performing the field Instrumentation and Controls work as required by the Contract Documents shall have a minimum of five (5) years of experience on PLC-based systems.
6. System Integrator shall provide, on-site, a Control Systems Engineer to commission the functional testing, start-up and training as required by the Contract Documents. The individual shall have authored and commissioned control logic for no fewer than three (3) projects of similar or greater complexity, and shall have a demonstrated proficiency in authoring logic in PLC ladder logic.
7. Upon request of Engineer and in addition to other specified requirements, Contractor shall provide a minimum of five (5) System Integrator references to confirm compliance with these requirements.
8. Upon written approval of Engineer, additional System Integrator's that meet all requirements may be considered by the Contractor.

1.6 SUBMITTALS

A. Submit project specific product data, shop drawings, project documentation, O&M data and record documents in accordance with the provisions of Section 01 33 00, and the following:

1. Bill of Material: List all the materials and equipment to be furnished. Tag number, manufacturer's complete catalog number, technical descriptions, service, location, and cross-reference numbers of instruction sheet, specification data sheet and wiring diagram shall be included under each item.
2. Specification Data and Drawings: Furnish instrument specification data sheet as per ISA standard instrument specification form, if applicable, wiring and/or connection diagram, outline dimensions, installation diagram and manufacturer's project specific catalog number for each instrument. A common set of drawings with setting and/or scale individually listed may be furnished for instruments with identical specification except setting and/or scale.
3. All Drawings shall be generated in CAD software. There shall not be handwritten additions/changes/updates. Photocopy or other electronic duplication and submission of Contract Documents are not acceptable and will be rejected.

B.System Diagrams

1. Panel Layout Drawings: Furnish panel drawings for each instrument/control panel/control station. Drawings shall show all panel mounted devices to scale, dimensioned and shall include legend. List bill of materials including manufacturer’s part numbers, show panel or cabinet structure, outline dimension, internal and external device/equipment arrangements, devices, cutouts and mounting details of instruments, protection and control devices, terminal blocks, wire ways and piping. Prepare in general accordance with NFPA 79, Annex D. A detailed terminal block blowup section shall also be included showing terminal block number for each terminal block.
2. Elementary Schematic Diagrams: Furnish ladder type circuit diagrams prepared to facilitate the understanding of the system functionality, maintenance and fault detection.
   a. Control devices shall be shown between vertical lines that represent control power wiring, with the left line representing control circuits common and right representing operating coils common except where permitted by Clause 9 of NFPA 79.
   b. Control devices shall be shown on numbered horizontal lines (rungs) between the vertical lines.
   c. Drawings shall include a cross referencing scheme used in conjunction with each relay, output device, limit switch, and other devices so that any contact related to a device can be readily located on the drawings.
   d. Component designations shall be included for all devices, with the same designations used on Panel Layout Drawings.
   e. All depictions of devices shall be specific for selected manufacturer included with submittal, and shall include detailed terminal numbering scheme as specified by manufacturer of said device.
   f. Each panel terminal within a terminal strip shall be numbered. When multiple terminal strips exist, each shall be given a unique identification. Terminal strip identification shall be included on Panel Layout Drawings.
   g. All wires shall be numbered; wire numbers shall be applied to labels in accordance with Section 26 00 03. Wiring and devices external to panel shall be clearly identified.

h. Control devices shall utilize the symbology depicted in NFPA 79 and IEEE 315.
i. Switch symbols shall be shown with utilities turned off and devices in their normal starting condition. Include control settings on the diagrams when available (timer settings, trip current, etc.).
j. Drawings shall indicate source of control circuit power (lighting panel circuit number, etc.).
k. Drawings shall be prepared on a per-panel basis.

3. Instrument Loop Diagram: Furnish all analog and digital loops for all instrument sensors, secondary instruments, I/O functions, alarms, control and displays using ISA standard symbols per ISA Standard S5.4.
4. SCADA System Block Diagram: Furnish system hardware configuration and identify model numbers of each system component.
5. PLC Equipment Layout Drawing: Furnish system hardware layout for each individual component (module, rack, power supply, etc.), and their relative location to one another. This shall be a scaled drawing whereby each component manufacturer's number is easily readable.
6. Interconnecting Wiring and/or Piping Diagrams (to/from): Show schematically the wiring and conduit runs for each instrumentation and control system. The diagram shall show and identify, with location noted, all instruments, piping and appurtenances furnished under this Section and related electrical equipment furnished under other Sections. All terminal blocks and pipe taps shall be identified.
7. SCADA System Block Diagram: Furnish system hardware configuration and identify model numbers of each system component.
8. I/O List segregated by PLC module and module type. Include detailed description of each I/O point with respect to function (i.e.: Pump 1 Running, etc.).
9. Process Control Network Drawings: Furnish Drawings showing connections between Process Control System devices including computers, HMI's, PLC's, radios, power monitors, and network devices. Drawings shall indicate network domain and device addresses, subnet masks, gateways, and other pertinent network address information.
10. Detailed Pump Control system descriptions of floats and SCADA control and associated communications with remote facilities.
11. SCADA screen shots.

C. Software Documentation

1. Submit SCADA system software, I/O point data base listing, programming ladder diagrams, graphic pages and report forms in prints. Software, application programs, ladder diagrams and control logics shall also be submitted in CD format.

D. Test Procedures

1. Detailed field test procedure for SCADA Panel.
2. Detailed field test procedure for Combustible Gas Monitor and associated alarms and circuits.

E. Certified Factory Test Reports

1. Provide certified factory test reports for all tested equipment and components to depict proper functionality in accordance with Specifications.

F. O&M Manuals

1. Submit project specific instruction manuals covering installation, operation, calibration, maintenance, diagnostic and repair for all hardware and software.
2. Refer to Section 01 33 04 for additional requirements.

G. Record Documents

1. Accurately record actual calibration setting and scales of instruments.
2. Approved Shop Drawings.
3. Record Contract Drawings.
4. Refer to Section 01 33 04 for additional requirements.

1.7 WORK FOR HIRE

A. Any and all configuration, programming, setup or other software functions (SOFTWARE) performed on all intelligent devices provided as part of this Project is considered “Work for Hire” under the 1976 Copyright Act as amended (title 17 of the United States Code). The SOFTWARE shall be owned by the Department and shall be turned over to the Department fully documented with accompanying commentary as the work is completed.

B. The Department intends only to obtain the SOFTWARE for its own use.

C. The Department will not prevent the SOFTWARE supplier from reuse of the SOFTWARE concepts and ideas for other projects. Any reuse of the SOFTWARE concepts and ideas generated under this Project is solely the responsibility of the SOFTWARE supplier. The SOFTWARE supplier shall defend, indemnify and hold harmless the Department from all claims, damages and expenses including reasonable litigation costs, arising out of any use, misuse or misapplication of SOFTWARE concepts and ideas.

1.8 OPERATIONAL AND PERFORMANCE REQUIREMENTS

A. The SCADA system includes a rack-mount computer system as the HMI screens server, redundant PLC processors for Pump Station system control, redundant analog wet-well level sensing system, and multi-float/relay level monitoring system as the tertiary pump control system. Communications with remote monitoring sites is also included.

B. The redundant PLC’s utilize the analog level signals measured with the primary and secondary level sensors for Pump control, while the float mode utilizes the digital ball float signals for backup Pump control and validation of level sensor signals.

C. The redundant PLC’s operate in parallel with the “primary” processor controlling the Pumps based on water level in the wet-well. The “secondary” processor monitors the health of the “primary” processor and, upon failure, immediately assumes control of the Pumps in a bump-less transfer over a fiber optic link between the “primary” and “secondary” processors. When a PLC processor fails it shall generate an alarm.

D. Water elevations for SCADA Pump control is shown on Drawings. The PLC shall check the validity of the primary level signal and the secondary level signal using float level signals as broad reference, and select a valid signal for pump control. If the primary and secondary level signals differ by an adjustable set value, it shall generate an alarm. If the PLC deem both the primary and secondary level signals invalid or out of range, broken wire, etc., then the point level inputs signals from the multi-float system shall be used for pump control. If the primary PLC fails, and the secondary PLC fails, then the point level inputs signals from the multi-float system shall be used for pump control.

E. The SCADA System shall be designed for full automatic PLC control of the Pump Station, and shall also be designed to allow manual operation. In the event of loss of signal(s) from water level sensing device(s), the SCADA system shall be capable of accepting data by manual entry of observed water levels via keypad/board or touch screen from operating personnel at the Pump Station. This shall be considered an override of the automatic functions of the Pump Station permissible via password authentication.

F. Pumping operation of the facility shall respond to water levels sensed in accordance with the pumping operation tables shown on the Drawings. The PLC's and associated personal computer with SCADA software herein specified shall be capable of automatically controlling pumping operations and storing of all digital and analog points for a period of 1 year. Provide alarm output to denote condition when storage capacity approaches 90% full prior to overwriting data.

G. The mechanical screens shall operate automatically based on the level sensor signals as sensed by the level sensing instruments of the SCADA system. The automatic screen operations shall be as follows:

1. If the level differential between upstream and wet well level sensors exceeds a pre-set high differential level setpoint, the SCADA system shall issue a signal to run both screens at low speed. Level setpoint shall be adjustable at SCADA Panel HMI screens.
2. If the level differential between upstream and wet well level sensor exceeds a pre-set high-high differential level setpoint, the SCADA system shall issue a signal to run both screens continuously at high speed. Level setpoint shall be adjustable at SCADA Panel HMI screens.
3. If two main pumps are called to operate, the SCADA Panel shall issue a signal to run both screens at low speed.
4. If six main pumps are called to operate, the SCADA Panel shall issue a signal to run both screens at high speed.
5. If the level differential between primary and secondary wet well level sensor exceeds a pre-set differential level setpoint (0.5 feet differential), it shall denote a clogged screen condition. Under such a condition, the SCADA system shall issue a signal to run both screens at low speed. Level setpoint shall be adjustable at SCADA Panel HMI screens.
6. Both screens shall be exercised in the event that a screen operation has not taken place within pre-set time. Time setpoint shall be adjustable at the SCADA Panel HMI.

H. The mechanical screens shall operate based on the backup float signals in the event of PLC failure or if float control mode has been activated. The float-based screen operations shall be as follows:

1. If Main Pump-2 is called to operate, the SCADA Panel shall issue a signal to run both screens at low speed.
2. If Main Pump-6 called to operate, the SCADA Panel shall issue a signal to run both screens at high speed.

I. In the event of an over-rotate condition within either mechanical screen, the respective screen master control panel shall automatically attempt reverse screen operation followed an attempt to perform another rake operation. This process shall be attempted three (3) times until cleared, upon which a lockout fault condition shall be initiated at the respective screen. Reversing operation can also be manually operated at the respective screen's local control panel. The lockout fault signal status will be sent as a SCADA alarm.

J. The SCADA panel logic shall operate the Pump Station as a pump sequencer for the Main Pumps and Low Flow Pumps when called. The Main Pump Lead/Lag sequencer at the HMI shall be Operator-selectable, and shall sequence based on: runtime hours, number of starts, number of on/off cycles, or simply alternate each cycle. The Operator may also opt for manual selection of pump sequence. These options and modifications shall be located at the HMI and shall be password protected.

K. The SCADA panel shall have a 3-position "Control Mode" selector switch, "Floats/Reset/Auto" whereby in "Auto" mode:

1. The PLC will automatically sequence the Pumps in a Lead/Lag configuration (as described above). See Figure 1.8.13 below for tabulated description of pump operation based on rising water level and falling water levels.
2. Shall the any Pump fail to start, overload, over-temp, seal fail, MCC breaker off, or H-O-A switch set to anything other than "AUTO", then the respective Pump is automatically removed from the pump sequencer, and the next Lag Pump takes the failed pump position in the pump sequencer, and the failed pump becomes the Lag Pump until the original fail condition is corrected. The failed pump, with tripped/failed conditions after corrected, shall be placed back into the pump sequencer immediately irrespective of the completion of pump cycle.
3. Shall a Main Pump fail due to over-temp and/or seal fail as detected by respective pump and motor protection relay, then any succeeding pumps that fail due to the same condition (motor protection relay) shall remain in the pump sequencer and shall be called to run over-riding the condition.
4. If the primary and secondary analog level elements fail as determined internal to the PLC, and/or both the redundant PLC's fail, and/or the high float switch is activated, and/or the low level switch is activated, then float mode control is automatically enabled and alarms shall be generated. The float mode remains enabled until manually reset by an Operator at the Pump Station once the fail condition is corrected. This is accomplished by switching the 3-position selector switch to "reset" position, and then back to "Auto" position.
5. All pumps shall be inhibited from running in automatic mode if:

a. Any influent gate is not “confirmed open” by the PLC.
b. Any recirculation gate is not “confirmed closed” by the PLC.
c. Any discharge gate is not “confirmed open” by the PLC.

L. The SCADA panel shall have a 3-position selector switch “Control Mode”, “Floats/Reset/Auto” whereby in “Floats” mode:

1. The redundant PLC’s will be inhibited in this mode, and the Pump Station will operate exclusively on the backup float mode control.
2. The Float Mode backup system shall be hardwired as identified below. If a Pump fails to start, overload, over-temp, seal fail, MCC breaker off, or H-O-A switch set to “off”, the Lag Pump does not start until called to run at Lag Pump Float level activation.
   a. Lead Low Flow Pump: LFP-1
   b. Lag Low Flow Pump: LFP-2
   c. Lead Main Pump: MP-1
   d. Lag-1 Main Pump: MP-2
   e. Lag-2 Main Pump: MP-3
   f. Lag-3 Main Pump: MP-4
   g. Lag-4 Main Pump: MP-5
   h. Lag-5 Main Pump: MP-6
   i. Lag-6 Main Pump: MP-7
   j. Lag-7 Main Pump: MP-8 (low flow pumps shall be stopped at this level)
   k. Lag-8 Main Pump: MP-9
   l. Backup/Standby Pump: MP-10

M. Main Pumps and Low Flow Pumps shall be allowed to run at any one time under PLC automatic control, or float mode control. Under no condition shall two pumps be allowed to start simultaneously.

N. The Lead Main Pump is defined as the first Main Pump called to run on rising water level. The Lag Main Pump is defined as the next Main Pump called to run on rising water level. Both of these pumps are preceded by the Low Flow Pump operating at the levels indicated on the Drawings.

O. Pumps, when called to run in all modes of operation, shall be delayed by a time delay relay located in the local pump starter compartment. Time delay relays shall be set such that only one Pump can be started at a time. Time delay setting for each pump shall be included in shop drawing phase and included in wiring schematics for the Pump Station.

P. Control of the Pumps shall be as shown in Figure 1.8.13 below:

FIGURE 1.8.13

PLC Control			**Float Mode Control**		
Elev.	Rising Level Action	Falling Level Action	Rising Level Action	Falling Level Action	Elev.

562.50		Low Water Level Alarm		Low Water Level Alarm	562.50
563.50		Stop Lead Low Flow Pump		Stop Low Flow Pump-1	563.50
564.50		Stop Lag Low Flow Pump		Stop Low Flow Pump-2	564.50
568.75	Start Lead Low Flow Pump	Start Lead Low Flow Pump	Start Low Flow Pump-1	Start Low Flow Pump-1	568.75
		Start Lag Low Flow Pump		Start Low Flow Pump-2	
		Stop Lead Main Pump		Stop Main Pump-1	
569.75	Start Lag Low Flow Pump	Stop Lag-1 Main Pump	Start Low Flow Pump-2	Stop Main Pump-2	569.75
570.75	Start Lead Main Pump	Stop Lag-2 Main Pump	Start Main Pump-1	Stop Main Pump-3	570.75
		Stop Lag-9 Main Pump*		Start Main Pump-10**	
571.75	Start Lag-1 Main Pump	Stop Lag-3 Main Pump	Start Main Pump-2	Stop Main Pump-4	571.75
572.75	Start Lag-2 Main Pump	Stop Lag-4 Main Pump	Start Main Pump-3	Stop Main Pump-5	572.75
573.75	Start Lag-3 Main Pump	Stop Lag-5 Main Pump	Start Main Pump-4	Stop Main Pump-6	573.75
574.75	Start Lag-4 Main Pump	Stop Lag-6 Main Pump	Start Main Pump-5	Stop Main Pump-7	574.75
575.75	Start Lag-5 Main Pump	Stop Lag-7 Main Pump	Start Main Pump-6	Stop Main Pump-8	575.75
576.75	Start Lag-6 Main Pump	Stop Lag-8 Main Pump	Start Main Pump-7	Stop Main Pump-9	576.75
577.75	Start Lag-7 Main Pump		Start Main Pump-8		577.75
	Stop Lead Low Flow Pump		Stop Low Flow Pump-1		
	Stop Lag Low Flow Pump		Stop Low Flow Pump-2		
578.75	Start Lag-8 Main Pump		Start Main Pump-9		578.75
579.75	Start Lag-9 Main Pump*		Start Main Pump-10**		579.75
593.00	High Water Level Alarm		High Water Level Alarm		593.00

* In SCADA Mode, Lag-9 Main Pump operates based on failure of any given main pump to start.
** In Float Mode, Main Pump-10 operates based on failure of any given main pump to start.

1.9 RELATED SECTIONS

A. Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)

B. Section 26 00 01 – General Electrical Provisions.

C. Section 26 00 03 – Basic Electrical Materials and Methods.

D. Section 26 13 26 – Medium Voltage Metal Clad Switchgear

E. Section 26 18 39 – Medium Voltage Motor Starters

F. Section 26 24 19 – Motor Control Center.

G. Section 26 00 05 – Miscellaneous Electrical Equipment.

H. Section 40 90 00 – Instrumentation for Process Control

I. Section 40 91 10 – Primary Meters and Transmitters

J. Section 41 22 13 – Electric Overhead Travelling Bridge Crane

K. Section 43 25 13 – Pumping Equipment: Submersible End-Suction Pumps

L. Section 46 21 11 – Mechanical Screens

1.10 REFERENCE

A. ISA Standards and Recommended Practices for Instrumentation and Control.

1.11 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within twelve (12) months of the date of Final Acceptance of the entire Project by the Engineer.

1.12 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling shall be in accordance with the provisions of Section 01 65 50.

1.13 SCADA SYSTEM I/O LIST

A. Abbreviations:

1. (DI) Discrete Input

2. (RO) Relay Output
3. (AI) Analog Input
4. (AO) Analog Output

B.PLC (ControlLogix platform) Hardwired I/O Points:

DESCRIPTION	DI	RO	AI	AO	NOTE
East Influent Gate, In Discharge	1				
East Influent Gate, In Recirc. / Isol.	1				
East Influent Gate, In Transition	1				
East Influent Gate, In Remote	1				
East Upstream Level			1		
Wet Well Primary Level (East)			1		
Level Signal Fail (East)		1			
Wet Well Low Level (East)		1			
Wet Well High Level (East)		1			
East Wet Well, Backup Float Signal (LS-101A)	1				
East Wet Well, Backup Float Signal (LS-101B)	1				
East Wet Well, Backup Float Signal (LS-101C)	1				
East Wet Well, Backup Float Signal (LS-101D)	1				
East Wet Well, Backup Float Signal (LS-101E)	1				
East Wet Well, Backup Float Signal (LS-101F)	1				
East Wet Well, Backup Float Signal (LS-101G)	1				
East Wet Well, Backup Float Signal (LS-101H)	1				
East Wet Well, Backup Float Signal (LS-101I)	1				
East Discharge Gate, In Discharge	1				
East Discharge Gate, In Recirc. / Isol.	1				
East Discharge Gate, In Transition	1				
East Discharge Gate, In Remote	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
East Recirculation Gate, In Recirc.	1				
East Recirculation Gate, In Discharge	1				
East Recirculation Gate, In Transition	1				
East Recirculation Gate, In Remote	1				
East Screen, Over-Rotate	1				
East Screen, Over-Torque	1				
East Screen, Overload / Overtemp	1				
East Screen, Not In Auto	1				
East Screen, Screen Running	1				
East Screen, Run Low-Speed		1			
East Screen, Run High-Speed		1			
Discharge Chamber, Level			1		
East Bar Screen Clogged		1			
West Influent Gate, In Discharge	1				
West Influent Gate, In Recirc. / Isol.	1				
West Influent Gate, In Transition	1				
West Influent Gate, In Remote	1				
West Upstream Level			1		
Wet Well Secondary Level (West)			1		
Level Signal Fail (West)		1			
Wet Well Low Level (West)		1			
Wet Well High Level (West)		1			
West Wet Well, Backup Float Signal (LS-102A)	1				
West Wet Well, Backup Float Signal (LS-102B)	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
West Wet Well, Backup Float Signal (LS-102C)	1				
West Wet Well, Backup Float Signal (LS-102D)	1				
West Wet Well, Backup Float Signal (LS-102E)	1				
West Wet Well, Backup Float Signal (LS-102F)	1				
West Wet Well, Backup Float Signal (LS-102G)	1				
West Wet Well, Backup Float Signal (LS-102H)	1				
West Wet Well, Backup Float Signal (LS-102I)	1				
West Discharge Gate, In Discharge	1				
West Discharge Gate, In Recirc. / Isol.	1				
West Discharge Gate, In Transition	1				
West Discharge Gate, In Remote	1				
West Recirculation Gate, In Recirc.	1				
West Recirculation Gate, In Discharge	1				
West Recirculation Gate, In Transition	1				
West Recirculation Gate, In Remote	1				
West Screen, Over-Rotate	1				
West Screen, Over-Torque	1				
West Screen, Overload / Overtemp	1				
West Screen, Not In Auto	1				
West Screen, Screen Running	1				
West Screen, Run Low-Speed		1			
West Screen, Run High-Speed		1			
West Bar Screen Clogged		1			
Equalization Gate, In Discharge	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
Equalization Gate, In Recirc. / Isol.	1				
Equalization Gate, In Transition	1				
Equalization Gate, In Remote	1				
Main Pump-1, Fail to Start		1			
Main Pump-1, Disconnect Open	1				
Main Pump-1, Pump Call SCADA		1			
Main Pump-1, Pump Call SCADA		1			
Main Pump-1, Pump Call Float	1				
Main Pump-1, In Auto	1				
Main Pump-1, In Off	1				
Main Pump-1, Running	1				
Main Pump-1, MPR Trip	1				
Main Pump-1, Over-Temperature	1				
Main Pump-1, Moisture	1				
Main Pump-1, PMPR Override		1			
Main Pump-1, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-1, Under-current		1			
Main Pump-2, Fail to Start		1			
Main Pump-2, Disconnect Open	1				
Main Pump-2, Pump Call SCADA		1			
Main Pump-2, Pump Call SCADA		1			
Main Pump-2, Pump Call Float	1				
Main Pump-2, In Auto	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-2, In Off	1				
Main Pump-2, Running	1				
Main Pump-2, MPR Trip	1				
Main Pump-2, Over-Temperature	1				
Main Pump-2, Moisture	1				
Main Pump-2, PMPR Override		1			
Main Pump-2, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-2, Under-current		1			
Main Pump-3, Fail to Start		1			
Main Pump-3, Disconnect Open	1				
Main Pump-3, Pump Call SCADA		1			
Main Pump-3, Pump Call SCADA		1			
Main Pump-3, Pump Call Float	1				
Main Pump-3, In Auto	1				
Main Pump-3, In Off	1				
Main Pump-3, Running	1				
Main Pump-3, MPR Trip	1				
Main Pump-3, Over-Temperature	1				
Main Pump-3, Moisture	1				
Main Pump-3, PMPR Override		1			
Main Pump-3, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-3, Under-current		1			
Main Pump-4, Fail to Start		1			
Main Pump-4, Disconnect Open	1				
Main Pump-4, Pump Call SCADA		1			
Main Pump-4, Pump Call SCADA		1			
Main Pump-4, Pump Call Float	1				
Main Pump-4, In Auto	1				
Main Pump-4, In Off	1				
Main Pump-4, Running	1				
Main Pump-4, MPR Trip	1				
Main Pump-4, Over-Temperature	1				
Main Pump-4, Moisture	1				
Main Pump-4, PMPR Override		1			
Main Pump-4, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-4, Under-current		1			
Main Pump-5, Fail to Start		1			
Main Pump-5, Disconnect Open	1				
Main Pump-5, Pump Call SCADA		1			
Main Pump-5, Pump Call SCADA		1			
Main Pump-5, Pump Call Float	1				
Main Pump-5, In Auto	1				
Main Pump-5, In Off	1				
Main Pump-5, Running	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-5, MPR Trip	1				
Main Pump-5, Over-Temperature	1				
Main Pump-5, Moisture	1				
Main Pump-5, PMPR Override		1			
Main Pump-5, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-5, Under-current		1			
Main Pump-6, Fail to Start		1			
Main Pump-6, Disconnect Open	1				
Main Pump-6, Pump Call SCADA		1			
Main Pump-6, Pump Call SCADA		1			
Main Pump-6, Pump Call Float	1				
Main Pump-6, In Auto	1				
Main Pump-6, In Off	1				
Main Pump-6, Running	1				
Main Pump-6, MPR Trip	1				
Main Pump-6, Over-Temperature	1				
Main Pump-6, Moisture	1				
Main Pump-6, PMPR Override		1			
Main Pump-6, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-6, Under-current		1			
Main Pump-7, Fail to Start		1			

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-7, Disconnect Open	1				
Main Pump-7, Pump Call SCADA		1			
Main Pump-7, Pump Call SCADA		1			
Main Pump-7, Pump Call Float	1				
Main Pump-7, In Auto	1				
Main Pump-7, In Off	1				
Main Pump-7, Running	1				
Main Pump-7, MPR Trip	1				
Main Pump-7, Over-Temperature	1				
Main Pump-7, Moisture	1				
Main Pump-7, PMPR Override		1			
Main Pump-7, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-7, Under-current		1			
Main Pump-8, Fail to Start		1			
Main Pump-8, Disconnect Open	1				
Main Pump-8, Pump Call SCADA		1			
Main Pump-8, Pump Call SCADA		1			
Main Pump-8, Pump Call Float	1				
Main Pump-8, In Auto	1				
Main Pump-8, In Off	1				
Main Pump-8, Running	1				
Main Pump-8, MPR Trip	1				
Main Pump-8, Over-Temperature	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-8, Moisture	1				
Main Pump-8, PMPR Override		1			
Main Pump-8, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-8, Under-current		1			
Main Pump-9, Fail to Start		1			
Main Pump-9, Disconnect Open	1				
Main Pump-9, Pump Call SCADA		1			
Main Pump-9, Pump Call SCADA		1			
Main Pump-9, Pump Call Float	1				
Main Pump-9, In Auto	1				
Main Pump-9, In Off	1				
Main Pump-9, Running	1				
Main Pump-9, MPR Trip	1				
Main Pump-9, Over-Temperature	1				
Main Pump-9, Moisture	1				
Main Pump-9, PMPR Override		1			
Main Pump-9, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-9, Under-current		1			
Main Pump-10, Fail to Start		1			
Main Pump-10, Disconnect Open	1				
Main Pump-10, Pump Call SCADA		1			

DESCRIPTION	DI	RO	AI	AO	NOTE
Main Pump-10, Pump Call SCADA		1			
Main Pump-10, Pump Call Float	1				
Main Pump-10, In Auto	1				
Main Pump-10, In Off	1				
Main Pump-10, Running	1				
Main Pump-10, MPR Trip	1				
Main Pump-10, Over-Temperature	1				
Main Pump-10, Moisture	1				
Main Pump-10, PMPR Override		1			
Main Pump-10, Under Maintenance		1			Active when disconnect switch is open and HOA is in off position
Main Pump-10, Under-current		1			
Low Flow Pump-1, Fail to Start		1			
Low Flow Pump-1, Overload Trip	1				
Low Flow Pump-1, Circuit Breaker Open	1				
Low Flow Pump-1, Pump Call SCADA		1			
Low Flow Pump-1, Pump Call SCADA		1			
Low Flow Pump-1, Pump Call Float	1				
Low Flow Pump-1, In Auto	1				
Low Flow Pump-1, Off	1				
Low Flow Pump-1, Running	1				
Low Flow Pump-1, Over-Temperature	1				
Low Flow Pump-1, Moisture	1				
Low Flow Pump-1, Current			1		

DESCRIPTION	DI	RO	AI	AO	NOTE
Low Flow Pump-1, PMPR Override		1			
Low Flow Pump-1, Under Maintenance		1			Active when circuit breaker is open and HOA is in off position
Low Flow Pump-1, Under-current		1			
Low Flow Pump-2, Fail to Start		1			
Low Flow Pump-2, Overload Trip	1				
Low Flow Pump-2, Circuit Breaker Open	1				
Low Flow Pump-2, Pump Call SCADA		1			
Low Flow Pump-2, Pump Call SCADA		1			
Low Flow Pump-2, Pump Call Float	1				
Low Flow Pump-2, In Auto	1				
Low Flow Pump-2, Off	1				
Low Flow Pump-2, Running	1				
Low Flow Pump-2, Over-Temperature	1				
Low Flow Pump-2, Moisture	1				
Low Flow Pump-2, Current			1		
Low Flow Pump-2, PMPR Override		1			
Low Flow Pump-2, Under Maintenance		1			Active when circuit breaker is open and HOA is in off position
Low Flow Pump-2, Under-current		1			
Electrical Room Lighting, On	1				
Pump Room Vicinity Area Lighting, On	1				
Lights-on Alarm		1			

DESCRIPTION	DI	RO	AI	AO	NOTE
Electrical Service #1, Failure	1				
Electrical Service #2, Failure	1				
Electrical Service #1, Ground Fault	1				
Electrical Service #2, Ground Fault	1				
USS1 Main Breaker #1, Open	1				
USS1 Main Breaker #2, Open	1				
USS1 Main Breaker #1, Tripped	1				
USS1 Main Breaker #2, Tripped	1				
USS1 Tie Breaker, Closed	1				
USS1 Tie Breaker, Tripped	1				
USS1 Generator Breaker, Closed	1				
USS1 Generator Breaker, Tripped	1				
USS1 Auto Transfer System Failed	1				
USS1, 750kVA TX #1 Breaker Open	1				
USS1, 750kVA TX #1 Breaker Tripped	1				
USS1, 750kVA TX #2 Breaker Open	1				
USS1, 750kVA TX #2 Breaker Tripped	1				
MCC1 Main Breaker #1, Open	1				
MCC1 Main Breaker #1, Tripped	1				
MCC1 Main Breaker #2, Open	1				
MCC1 Main Breaker #2, Tripped	1				
MCC1 Tie Breaker, Closed	1				
Bridge Crane, System Failure	1				
Combustible Gas Monitor, Alarm	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
Combustible Gas Monitor, Warning	1				
Combustible Gas Monitor, Trouble	1				
Fire Alarm Control Panel, Alarm	1				
Fire Alarm Control Panel, Trouble	1				
Pavement Flood, Alarm		1			
Pump SCADA Alarm		1			
SCADA/PLC Failure Alarm		1			
Discharge Chamber Flood		1			
Intrusion Alarm	1				
Pump Station Occupied	1				
SF1-PR Fan, Running	1				
SF1-PR Fan, Fail	1				
SF1-PR Fan, Run Too Long		1			
SF2-PR Fan, Running	1				
SF2-PR Fan, Fail	1				
SF2-PR Fan, Run Too Long		1			
EF1-PR Fan, Running	1				
EF1-PR Fan, Fail	1				
EF1-PR Fan, Run Too Long		1			
EF2-PR Fan, Running	1				
EF2-PR Fan, Fail	1				
EF2-PR Fan, Run Too Long		1			
SF-S1 Fan, Running	1				
SF-S1 Fan, Fail	1				

DESCRIPTION	DI	RO	AI	AO	NOTE
SF-S1 Fan, Run Too Long		1			
SF-S2 Fan, Running	1				
SF-S2 Fan, Fail	1				
SF-S2 Fan, Run Too Long		1			
SF-ER Fan, Running	1				
SF-ER Fan, Fail	1				
120VAC Line Filter #1, Alarm	1				
120VAC Power Supply #1 Alarm	1				
24VDC Power Supply #1 Alarm	1				
120VAC Line Filter #2, Failure	1				
120VAC Power Supply #2 Alarm	1				
24VDC Power Supply #2 Alarm	1				
Main Control Mode, Automatic	1				
Float Mode Active	1				
PLC System, Failure		1			
UPS #1, System Failure	1				
UPS #1, Low Battery	1				
UPS #2, System Failure	1				
UPS #2, Low Battery	1				
Sub-Total	208	96	7		
Spare	32	24	9	0	
TOTAL	240	120	16	0	

C. SCADA data via Modbus TCP:

1. SEL-351 LPR (Electrical Service #1):

a. Line-Line Voltage.
b. Line Current.
c. Power (kW).
d. Power Factor.

2. SEL-351 LPR (Electrical Service #2):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
3. SEL-751A TPR (4160V Tie Breaker)
   a. Line Current
4. SEL-700G GPR (Temporary Generator):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
5. SEL-751A FPR (750kVA Transformer #1):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
6. SEL-751A FPR (750kVA Transformer #2):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
7. SEL-710 MPR (Main Pump-1):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
8. SEL-710 MPR (Main Pump-2):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
9. SEL-710 MPR (Main Pump-3):
   a. Line-Line Voltage.
   b. Line Current.
   c. Power (kW).
   d. Power Factor.
10. SEL-710 MPR (Main Pump-4):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.

11. SEL-710 MPR (Main Pump-5):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
12. SEL-710 MPR (Main Pump-6):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
13. SEL-710 MPR (Main Pump-7):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
14. SEL-710 MPR (Main Pump-8):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
15. SEL-710 MPR (Main Pump-9):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
16. SEL-710 MPR (Main Pump-10):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
17. PMPR Communication Unit in MP03 Starter Section for MP01, MP03, and MP05
    a. Motor Winding Temperature (Highest of three phases)
    b. Main Bearing Temperature
    c. Support Bearing Temperature
    d. Vibration
18. PMPR Communication Unit in MP07 Starter Section for MP07, and MP09
    a. Motor Winding Temperature (Highest of three phases)
    b. Main Bearing Temperature
    c. Support Bearing Temperature
    d. Vibration
19. PMPR Communication Unit in MP04 Starter Section for MP02, MP04, and MP06
    a. Motor Winding Temperature (Highest of three phases)
    b. Main Bearing Temperature
    c. Support Bearing Temperature
    d. Vibration
20. PMPR Communication Unit in MP08 Starter Section for MP08, and MP10

a. Motor Winding Temperature (Highest of three phases)
b. Main Bearing Temperature
c. Support Bearing Temperature
d. Vibration

21. LFP01 PMPR Communication Unit
    a. Motor Winding Temperature (Highest of three phases)
    b. Main Bearing Temperature
    c. Support Bearing Temperature
    d. Vibration
22. LFP02 PMPR Communication Unit
    a. Motor Winding Temperature (Highest of three phases)
    b. Main Bearing Temperature
    c. Support Bearing Temperature
    d. Vibration
23. Surge Protective Device (MCC1 Source #1):
    a. Battery life (%)
    b. Protection Available (%)
    c. Sags
    d. Surges
    e. Swells
    f. Dropouts
24. Surge Protective Device (MCC1 Source #2):
    a. Battery life (%)
    b. Protection Available (%)
    c. Sags
    d. Surges
    e. Swells
    f. Dropouts
25. Power Monitoring Transmitter (MCC1 Source #1):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.
26. Power Monitoring Transmitter (MCC1 Source #2):
    a. Line-Line Voltage.
    b. Line Current.
    c. Power (kW).
    d. Power Factor.

1.14 SYSTEM DESCRIPTION

A. The following points are not intended to be a comprehensive list of the system's features, only summarize the major functions of the system. The SCADA system specified herein shall perform the following generalized functions:

1. Perform real-time process control, including proportional integral derivative control action, sequencing, process calculations, etc.
2. Collect and store accurate, reliable operating information for present and future uses.

3. Assist The Department operating personnel by noting and communicating off-normal operating conditions and equipment failures.
4. Accumulate and store equipment running times for use in preventative maintenance.
5. Provide color graphic displays and summary reports for use by the plant operating and supervisory personnel.
6. Provide trending for all analog values.
7. Provide control system monitoring and diagnostics.

B. The system is based on the SCADA system architecture diagram shown on Drawings. The system shall include:

1. Redundant programmable logic controllers (PLC's) with local input/output (I/O), network communications and other capabilities as specified herein and shown on the SCADA system architecture diagram.
2. SCADA computer with redundant Human Machine Interface (HMI) with control/graphic software.
3. HMI's shall be linked to the PLC's over an Ethernet/IP based local area network (LAN) via managed Ethernet Switch.
4. Communications with Power Monitors.
5. Communications with outside entities (District 1, IDOT TSC, and Maintenance Contractor).

C. All process control functions including PID, calculations, sequencing, set-points, timing, etc., shall be done in the PLC. The real-time database, report generation, graphic screens, program development, set-point modification, data archiving, etc., shall be done by the HMI computer.

D. HMI computer shall be loaded with FactoryTalk View SE Client, and FactoryTalk Historian SE (500 tags), and shall be capable of displaying separate screens at each HMI.

PART 2 - PRODUCTS:

2.1 REQUEST FOR SUBSTITUTION

A. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.

B. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.

C. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not

identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 FIELD DEVICES:

A. Equipment listed in the table below shall conform to the instrumentation standards described in the paragraphs following the table:

1. Level Instrumentation (L Series).

Tag	Device Type	Location/Description	Additional Information
LS-101A	Float	East Wet Well	
LS-101B	Float	East Wet Well	
LS-101C	Float	East Wet Well	
LS-101D	Float	East Wet Well	
LS-101E	Float	East Wet Well	
LS-101F	Float	East Wet Well	
LS-101G	Float	East Wet Well	
LS-101H	Float	East Wet Well	
LS-101I	Float	East Wet Well	
LS-102A	Float	West Wet Well	
LS-102B	Float	West Wet Well	
LS-102C	Float	West Wet Well	
LS-102D	Float	West Wet Well	
LS-102E	Float	West Wet Well	
LS-102F	Float	West Wet Well	
LS-102G	Float	West Wet Well	
LS-102H	Float	West Wet Well	
LS-102I	Float	West Wet Well	
LE-411A	Level Sensor	East Upstream Channel	Hydrostatic
LIT-411A1	Level Transmitter	Pump Room	
LIT-411A2	Process Indicator	SCADA Panel	
LE-411B	Level Sensor	Primary Signal (East Well Level)	Hydrostatic
LIT-411B1	Level Transmitter	Pump Room	
LIT-411B2	Process Indicator	SCADA Panel	
LE-412A	Level Sensor	West Upstream Channel	Hydrostatic
LIT-412A1	Level Transmitter	Pump Room	
LIT-412A2	Process Indicator	SCADA Panel	
LE-412B	Level Sensor	Secondary Signal (West Well Level)	Hydrostatic
LIT-412B1	Level Transmitter	Pump Room	
LIT-412B2	Process Indicator	SCADA Panel	
LE-421	Level Sensor	Discharge Combination Box	Ultrasonic
LIT-421A	Level Transmitter	Pump Room	
LIT-421B	Process Indicator	SCADA Panel	

2.3 OPERATOR DEVICES AND CONTROL STATION COMPONENTS:

A.Manufacturer:

1. Allen Bradley 800T/800H.
2. Square D Class 9001, Type K.

B.Construction:

1. Heavy duty.

2. Watertight.
3. Oil-tight.
4. Flush panel mounting.
5. Size to mount in 30.5-mm diameter.
6. Match NEMA rating of device with the installed location environmental classification.

C. Pushbuttons:

1. Flush head unless specified elsewhere.
2. Contact Blocks:
   a. Double break silver contacts.
   b. Ac Ratings: 7,200 va make, 720 va break.
   c. Single pole, double throw or double pole, single throw.
   d. Up to six tandem blocks.
3. Momentary contact unless specified elsewhere.
4. Non-illuminated.
5. Legend plates, as required, for type of operation or as specified elsewhere.

D. Selector Switches:

1. Maintained position unless specified elsewhere.
2. Contact Blocks:
   a. Double break silver contacts.
   b. Ac Ratings: 7,200 va make, 720 va break.
   c. Contact configuration as specified.
   d. Up to six tandem blocks.
3. Number of positions as specified elsewhere.
4. Knob Lever Style unless specified elsewhere.
5. Legend plates as required for type of operation or specified elsewhere.

E. Pilot Lights:

1. LED Type.
2. Transformer type.
3. Colored lens as specified elsewhere.
4. Interchangeable lenses.
5. Transformer rated for 120Vac
6. Push to test.
7. Legend plates as specified elsewhere.

F. Control Stations:

1. NEMA ratings:
   a. NEMA 7 in Class 1, Division 1 or 2 Hazardous (Classified) Locations.
   b. NEMA 4X 316 stainless steel in indoor wet/corrosive locations or outdoors.
   c. NEMA 12 in other areas.

G. Legend Plates:

1. Engraved metal.

2. 2-1/4” square minimum.
3. Silver background, black letters.

H. Nameplates:

1. Engraved laminated plastic.
2. Letters 3/16 in. high.
3. Black letters on white background.
4. Identify per equipment controlled, using names found on Drawings.

2.4 COMBUSTIBLE GAS DETECTOR:

A. Manufacturer:

1. MSA.
2. General Monitors “Smart Sensor” Series.
3. Honeywell
4. The manufacturer must be capable of supplying all equipment used to check or calibrate the sensor / transmitter units.
5. The manufacturer must be capable of providing on-site service with factory trained personnel.
6. The manufacturer must be capable of providing on-site training for Engineer.

B. Master Gas Controller:

1. Enclosure Type - NEMA 4X Metal Enclosure with Glass window for read-out viewing.
2. 8 input analog sensor channels minimum.
3. Operating Temperature range: -10° to +40°C (14° to 104°F).
4. Operating Humidity range 0-90% RH, non-condensing.
5. 115 / 230 VAC ± 15% 50/60 Hz.
6. The system shall have the ability to operate with 1 or 2 channel controller boards.
7. Each module shall have two (SPDT) relays with change-over contacts for verification of Warning and Alarm conditions.
8. Shall be a large 4-digit 7-segment back lit Liquid Crystal Display and bright LED’s to provide ease of reading and alarm notification.
9. The Display provides information on the gas concentration, alarm status, measurement units, flags indicating status and settings such as calibration interval, time-out function, alarm ON delay and alarm inhibit.
10. Ability to choose from lower explosive limit (LEL), LELm, PPM, % Vol, g/m3 or blank.
11. Controller shall have user defined access codes to prevent accidental or undesired tampering.
12. Audible Alarm push-button reset switch shall silence the Audible Alarm when alarm points are exceeded. The LED visual alarms will remain on as long as alarm levels are exceeded. This push-button will reset latched alarms if normal gas conditions exist.
13. Warning and Alarm Relay Set Points shall be customer selectable between 1-100% of the measuring range.

14. Failure mode shall utilize two SPST relays in series and shall be normally energized. 5A / 24VDC and 250VAC - resistive load.
15. Shall be high brightness LED's to provide ease of reading and alarm / failure notification.
16. Each unit shall have two, SPDT relays.
17. Complies with UL / CSA 61010-1 per MET.
18. Instruments shall have one year parts and labor standard warranty with extended warranty available.
19. The Controller shall not require periodic maintenance other than verifying the Sensor Transmitter inputs are responding to the target gases.
20. Provide relay contacts for remote monitoring alarming as shown on Drawings.
    1. Provide reset pushbutton integral to front of Master Gas Controller.

C. Sensor Requirements:

1. Infrared (IR) Combustible Sensor shall detect 0-100% LEL of combustible gas.
2. Sensor module shall store all calibration data so that module may be calibrated off-site and field-installed without necessity of recalibration.
3. Heated optics prevent condensation buildup.
4. 4–20 mA analog output.
5. Complete product shall have minimum useful life of three (3) years.
6. IR source within infrared sensor will have minimum useful life of ten (10) years.
7. Sensor/transmitter will be contained within a 316 stainless steel enclosure suitable for location in Class I, Division 2, Groups A, B, C & D classified areas.
8. Optional junction box enclosure shall have minimum of three entries, allowing for mounting options for sensor, power and signal, and should be constructed with 316 stainless steel.

D. Hydrocarbon combustible gasses to be detected include:

1. Octane
2. Ethane
3. Ethanol
4. Propane
5. Butane

E. Provide permanently installed remote test gas applicator and tubing for all combustible gas detectors that are not easily accessed without the use of tools, ladders, or other means.

F. The gas detection system shall measure and display gas concentration. The system shall alarm when preset limits are exceeded. Relays and timers for different alarm set-point levels shall be provided as additional contacts for alarms and ventilation controls. Relays shall be located in SCADA Panel.

G. The system shall consist of four (4) dual-channel monitor/readout units, one (1) relay programmer module, one (1) power supply unit, four (4) alarm relays, a horn relay, a buzzer and three (3) remotely mounted gas sensor/transmitter units. An independent

monitoring channel shall be provided with each sensor/transmitter having a full scale range as specified. The sensor units shall be capable of being located remote from the monitor/readout unit by up to 5000 feet. Sensor unit shall receive power from and send signals corresponding to gas values to the monitor/readout unit. Each sensor unit shall be mounted in an enclosure suitable for NEC Class I, Division 2, Group C & D hazardous locations. The sensor units shall have provisions for mounting to a wall or similar structure.

H. The combustible gas monitor/readout unit shall be of the wall-mount type suitable for mounting at location in Electrical Room. All wiring connections shall be marked with functional designations such that connections can be made without the use of diagrams or tables. All connections must be easily accessible from the front. An external sealed switch shall be provided to allow for alarm reset and audible alarm silencing without opening the enclosure. All unused channel spaces shall be neatly blanked off.

I. Alarms and relays at the monitoring/readout unit shall be set for the following levels of gas concentration – dry contacts shall be provided for the following:

1. "WARNING" 5% LEL
2. "ALARM" 10% LEL
3. “TROUBLE” Failure of sensor or master controller.

J. The combustible gas sensor/transmitter shall be of the infrared type sensing element with 3-wire loop detector lead-in (LDL) signal transmitting electronic circuit designed to monitor the presence of petroleum (complex hydrocarbon) vapor in the ambient air. The transmitter circuit shall produce a 4 -20 mA output signal proportional to 0 to 100% LDL and shall be mounted in an explosion proof enclosure with a 3-1/2 digit LCD display. The transmitter circuit shall have real time clock and internal memory for day stamping and logging minimum and maximum gas concentrations.

K. In response to a WARNING or ALARM signal from the gas detection system, due to a high concentration of explosive vapor in the monitored space, an explosion-proof horn and alarm strobe beacon shall be energized at all levels of the Pump Station. The ventilation system for the monitored space shall be activated if GS-1, GS-2, GS-3, GS-4, GS-5 or GS-6 detect combustible vapors. The Grit Chamber sensor, GS-7, shall alarm, but not activate ventilation system.

L. A calibration test kit for field checking the calibration of the gas detection system shall be furnished. The kit shall be complete, including a light weight carrying case, dispensing valve, regulator assembly and hose, test coils and necessary cylinder for type of calibrating gas. The test kit shall be stored in an approved cabinet adjacent to and match the air monitor panel. Test kit shall include detailed instructions on carrying out calibration including programmed offsets for included test gas.

M. Spare parts shall be provided for the air monitoring equipment as follows:

1. One set of fuses, one sensor head assembly and one sensor.

N. The services of a qualified representative of the manufacturer shall be provided to inspect the installation, make any adjustments, test the equipment, field calibrate the air

monitoring equipment upon completion of the installation; after 24 hours of operation and again after one week; and instruct the operating personnel in the operation, calibration and maintenance of the equipment.

O. The Combustible Gas Detection System and Fire Alarm System share common strobes and horn annunciators. Reset of system is accomplished at respective system responsible for alarming.

2.5 CURRENT SENSING SWITCH

A. Manufacturer:

1. AcuAMP ACS200
2. Eaton
3. Veris Industries
4. Or equal

B. Input Range: 0-6, 6-40, 40-175 Amp (Jumper selectable).

C. Output: Normally open relay (1A @ 240Vac).

D. UL Listed.

E. Panel Mount.

2.6 ELECTRONIC PROCESS INDICATOR (LEVEL DISPLAY AT SCADA PANEL):

A. Manufacturer:

1. Precision Digital.
2. Red Lion, IMP.
3. Moore Industries.

B. 4-20mA DC Input.

C. 4-20mA DC Output (retransmission of input signal)

D. 4 ½ digit LED indicator.

E. 120VAC powered for controls.

F. Enclosure shall reflect same NEMA rating as panel it is located in.

2.7 INTRINSICALLY SAFE RELAY:

A. Manufacturer:

1. P.R. Electronics.
2. No Substitutes.

B. 2 channel input (mechanical contacts).

C. Universal power supply: 21.6-253Vac / 19.2-300Vdc.

D. Output: 2x relay, SPDT, 250Vac, 1 amp.

E. Protection: IP20.

F. Mounting: DIN rail.

G. Operating temperature: -20℃ to 60℃.

H. Operating humidity: <95% non-condensing.

I. UL-913, UL-508 Listed.

2.8 LINE FILTER:

A. Manufacturer:

1. Emerson Islatrol IE Series.

B. UL 1449 Surge Voltage Rating:

1. 120V Normal Mode: 330 Volts.
2. 120V Common Mode: 400 Volts.

C. Peak Surge Current Capability (8 x 20 µs)

1. 120V Line to Neutral: 15,000 Amps.
2. Line to Ground: 15,000 Amps.
3. Neutral to Ground: 15,000 Amps.
4. Total: 45,000 Amps.

D. Frequency Response (Forward-Reverse)

1. Normal Mode: 100 kHz to 50MHz - 90 dBMin.
2. Common Mode: 5MHz to 50MHz - 60 dBMin.

E. Typical Category A Ringwave (6kV, 200A, 100kHz) Normal Mode/Common Mode

1. 3 Amp: 1 V/300 V
2. 5 Amp: 0.7 V/292 V
3. 10 Amp: 0.7 V/300 V
4. 20 Amp: 0.7 V/300 V

F. Typical Category B Ringwave (6kV, 500A, 100kHz) Normal Mode/Common Mode

1. 3 Amp: 178 V/300 V
2. 5 Amp: 162 V/291 V
3. 10 Amp: 153 V/300 V
4. 20 Amp: 200 V/300 V

G. MCOV

1. 120 Volt: 150 VRMS
2. 240 Volt: 275 VRMS
3. Line Frequency: 47 - 63 Hz
4. Connection: Terminal
5. Mounting Type: DIN/Flange
6. Weight: < 3 lbs

H. Response Time

1. Normal Mode: < 0.5 ns
2. Common Mode: < 5 ns
3. Operating Temperature: -40℃ to +45℃
   Derate Linearly to 60% at +70ºC
4. Operating Humidity: 0% to 95%

I. Other Features:

1. LED status indication and form C contact for remote indication.
2. DIN mountable enclosure.
3. UL 1449, 1283, CUL recognized, CE.
4. 10 year warranty.

2.9 ENCLOSURE THERMOSTAT:

A.Manufacturer:

1. Hoffman.
2. Or Equal.

B.Features:

1. One normally open and one normally closed contact.
2. 32℉ to 142℉ adjustability.
3. Bimetallic sensor element.
4. DIN mountable.

2.10 ENCLOSURE FAN:

A.Manufacturer:

1. Hoffman.
2. Or Equal.

B.Features:

1. Size for enclosure heat dissipation requirements.
2. Includes filters and grille.
3. Include one additional filter.
4. Include exhaust grille.

2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS):

A. Manufacturer:

1. APC
2. Emerson
3. Alpha
4. Liebert
5. Eaton

B. Uninterruptible Power Supply (UPS) System shall be provided for the SCADA and instrumentation systems as shown on the Drawings and specified herein. Each UPS shall sustain operation during short-term power failures, and shall provide power for an orderly shutdown to prevent the loss of data during power failure and shall provide full isolation between the control system and the plant power system.

C. Provide true on-line non switching uninterruptible power supply (UPS). Double power conversion on-line operation including rectifier and inverter, constantly conditioned AC output.

D. Provide make-before-break automatically operated bypass contactor to bypass UPS to allow operation of system controls in event of UPS failure.

E. Each system shall consist of a static dc to ac sine wave inverter, a battery charger, sealed batteries, a monitor and transfer switch, and accessories as listed below.

F. Each system shall operate on a 120-volt, 60-Hz ac branch circuit. The input ac circuit shall supply energy to the battery charger which shall supply energy to the inverter as well as to the battery to maintain its charge. The output of the inverter shall supply energy to the load. If the input ac circuit is interrupted, the inverter shall continue to supply energy to the load without interruption, drawing power from the battery. If the input ac circuit is restored prior to discharge of the battery, the charger shall resume the supply of energy to the inverter and shall restore the battery to full charge. In the event of malfunction of the battery charger, battery or inverter that results in interruption of the output from the inverter, the monitor shall detect this condition and shall automatically transfer the load to the system's ac input circuit within 25 milliseconds. After the malfunction is corrected, the load shall be retransferred to the inverter manually.

G. System output voltage shall be regulated within plus or minus 5 percent of 120 volts and frequency stability shall be plus or minus 1/2 percent of 60-Hz. The output characteristic shall be sinusoidal with not more than 5 percent total harmonic distortion at full load with input ac circuit at 120 volts. For a 20 percent instantaneous load change, voltage overshoot or undershoot shall be not more than plus or minus 10 percent. For a 10 to 90 percent load change, recovery time shall be not longer than 100 milliseconds.

H. The UPS system shall have an efficiency of at least 92% when operated from AC line.

I. UPS shall supply power to PLC's, HMI's, Ethernet Switch, DC power supplies, field instruments, and other low voltage control devices as specified and as shown on Drawings and Plans.

J. UPS shall have enough capacity to power these devices for a period of 30 minutes after the utility power has failed. Provide with extended battery module(s) to meet this requirement.

K. Size UPS for 125% of connected electrical load with 1500VA as a minimum UPS size.

1. The System Integrator shall provide sizing data on the UPS listing all loads and calculations required for sizing the UPS system, and include with submittal.

L. 19" Rack Mount Form Factor shall be used unless stated otherwise on Drawings or Specifications.

M. UPS shall be located in network wall-mount Rack (NET-1). Additional batteries, if required may be mounted externally with the written approval of Engineer.

2.12 DC POWER SUPPLIES:

A. Manufacturer:

1. Phoenix Contact Quint-PS
2. ABB
3. Sola/Hevi-Duty

B. General

1. Power supply shall be fully enclosed, and provide screw terminations. All wiring points and plug connections shall be "touch safe" with no live voltages that can make contact with a misplaced finger in accordance with IEC 529. Housing shall be at least IP20.
2. Power Supplies shall have an efficiency of at least 80%.
3. The power shall have an MTBF (Mean Time Between Failures) greater than 500,000 hours according to IEC 1709.
4. The power supply shall be able to withstand shock of 30G in all space directions according to IEC 68-2-27 and vibration up to 2.3G 90 min. <15hz, amplitude = +/- 2.5mm/15-150hz, according to IEC 68-2-6.
5. Power supplies shall be UL-508A listed to allow the use of the power supply at full rated output amperage with no "de-rating".

C. Mounting

1. All power supplies shall have integral metal mounting foot to attach to 35mm DIN-rail conforming to DIN EN50022.

D. Wire Connections

1. Attach wires to the power supplies by means of a cable-clamping terminal block activated by a screw. Connections shall be gas-tight, and the terminal block shall be fabricated with non-ferrous, non-corrosive materials.
2. Wire connection for currents less than 20A shall use pluggable terminals on both input and output ends.
3. Pluggable terminals shall accept wire sizes 24 through 14 AWG.

E. Equipment

1. Nominal current rating to be based on an operating temperature of 60℃ or higher.
2. Power supplies shall have a visible "DC Power OK" indicator. This indicator will flash when the output drops below 10% of the adjusted output voltage.
3. Ambient temperature range for operation shall be at least -25°C to +70°C
4. Residual ripple shall not exceed 100 mV peak to peak at nominal current values.
5. Integral surge suppression shall be incorporated into the power supply.
6. Power supplies shall conform to CE electromagnetic compatibility as described in EN61000-6-2 and EN 50081-2.
7. Power supplies shall have means of limiting DC current in case of short circuit or an overload and shall automatically reset themselves when the fault is corrected.
8. Power supplies when wired in parallel will not require external circuitry.
9. Power supplies shall have a voltage monitoring relay contact and signaling output.
10. Input must auto-range between 85 to 264VAC and 90 to 350VDC for 1 phase power supplies with no manual intervention.
11. Power supplies shall have a power factor of at least 0.6.

2.13 PROGRAMMABLE LOGIC CONTROLLER HARDWARE:

A. Manufacturer:

1. Rockwell Automation.
2. No Substitutes.

B. A Programmable Logic Controller (PLC) system shall be furnished and shall be programmed to operate all functions herein specified. All analog and discrete inputs and outputs shall be provided as necessary. The logic program shall be of universal type architecture and shall not be of a proprietary language. In addition, the programmable controller shall be capable of being interrogated from the District 1 Dispatcher's Alarm Panel, as well as Maintenance Contractor via leased telephone line, and cellular modem. The programmable controller equipment supplier shall be responsible for coordinating and providing a complete and properly functioning software package for the control and operation of the equipment as specified herein.

C. The PLC shall be equipped with sufficient memory and I/O capacity to handle control functions of present system plus 25% spare memory and 25% spare I/O minimum.

D. The System Integrator shall furnish the Pump Station operational program. A CD ROM copy and printout of the PLC control program shall be furnished to DEPARTMENT at the time of start-up. Disk and printed copy of the operating program shall be maintained on

the file with the System Integrator. The system integrator / Contractor shall also turn over software licenses to the Department upon project completion.

1. PLC shall be programmed using RSLogix 5000 (latest edition).

E. Additional Materials:

1. Provide one shelf spare for each I/O module type used on project.
2. Provide one shelf spare for each power supply used on project.
3. Provide one shelf spare for each communications module used on project.

F. Chassis:

1. ControLogix 1756-A4 for primary and secondary processor racks.
2. ControLogix 1756-A17 for I/O racks.

G. Power Supply:

1. ControLogix 1756-PA75 for primary and secondary processor racks.
2. ControLogix 1756-PA75R for I/O racks.

H. Processor:

1. ControLogix 1756-L74.
2. 16MB user Memory.
3. USB port.
4. Provide redundant processors.
5. Provide orderly shutdown on power failure, saving register contents with automatic restart on power restoration.

I. Communication Modules:

1. Ethernet communications with network switch: 1756-EN2T.
2. Ethernet ring topology for communications with remote I/O Rack: 1756-EN2TR.
3. Processor redundancy: 1756-RM.

J. Communication Module to Modbus TCP/IP Devices

1. MicroLogix 1400 PLC or similar ControLogix interface card
2. 120VAC input power with battery backup and nonvolatile battery backed RAM
3. One (1) 10/100 Ethernet/IP port
4. Ethernet Protocol – Modbus TCP/IP
5. Synchronize clock with ControLogix processor

K. Input/Output Modules:

1. Digital Input: ControLogix 1756-IA16I.
2. Relay Output: ControLogix 1756-OW16I.
3. Analog Input: ControLogix 1756-IF8.

L. Satellite Clock Time Synchronization:

1. Time Device: 1756-TIME.

a. Device shall be configured as an IRIG-B Slave and shall synchronize to an external IRIG-B source by using a coaxial cable. Manufacturer and system integrator shall furnish and install all appropriate interface/gateway devices between 1756-TIME and IRIG-B signal generated from SEL-2407 device as specified below, to ensure that PLC system's time clock is atomically synchronized with timed devices shown on Drawings.

M. Wiring and Termination System:

1. Wiring of PLC I/O modules shall be through cable assemblies to individual terminal blocks.
2. Cable assemblies shall be pre-wired and shall have PLC I/O module-specific wiring arms on one end and flying leads on the other.
3. Provide sufficient terminations to accommodate active I/O points, spares, and future expansion.

N. Manufacturer part numbers listed above reflect information known at time of design and shall be independently researched and verified for availability with latest version available prior to submittal.

2.14 SATELLITE SYNCHRONIZED CLOCK

A. Manufacturer

1. Schweitzer SEL-2407 with SEL-9524 antenna.
2. Or Equal.

B. Features:

1. Built-in Time Display with Red LED Letters.
2. IEEE C37.90 and IEC 60255 compliance.
3. Average Time Accuracy (demodulated IRIG-B and pulses) to UTC: ± 100ns
4. Peak Time Accuracy (demodulated IRIG-B and pulses) to UTC: ± 500ns
5. Holdover Accuracy Over 24 Hours at a Constant Temperature: 6.9 ms
6. Demodulated IRIG-B Ports: 6
7. Modulated IRIG-B Ports: 1
8. Power Supply: Universal 18-300VDC or 85-264VAC
9. Management Interface: Serial
10. Operating Temperature:
11. Harsh Environment Coated
12. Antenna Cable Length: 400 feet maximum
13. Form-C Alarm Contact

2.15 MANAGED DATA SWITCHES:

A. Manufacturer:

1. N-Tron 7026TX Series.
2. Sixnet EL Series.
3. Cisco.

4. Or Equal.

B. Features:

1. Twenty-Four (24) RJ-45 10/100BaseTX Ports.
2. ESD and Surge Protection Diodes on all Ports.
3. Auto Sensing 10/100 BaseTX, Duplex, and MDIX
4. Advanced management features including: VLAN, IGMP Snooping, Port Trunking, QoS, and Mirroring, Local Port IP addressing, EtherNet/IP CIP Messaging, Port Security – MAC Address Based.
5. Rack Mounting.
6. Redundant Power Inputs 18-49Vdc.
7. Fault Relay Support
8. -40℃ to 80℃ Operating Temperature.
9. UL Listed.

2.16 PRESSURE GAUGE WITH INDICATOR:

A. Manufacturer:

1. Ashcroft.
2. US Gauge, a Division of Ametek, Inc.

B. Housing Material: 316 Stainless Steel

C. Mounting: Stem

D. Dial Size: 4-1/2 inch

E. Scale shall read in feet of water column.

F. Units shall be bellows or Bourdon tube actuated pressure gauges. Gauges shall be stem mounting with 4-1/2-inch dial size, unless otherwise noted. Scale range shall be as noted accordingly and accuracy shall be plus or minus 1/2 percent of span.

G. The sensing element material shall be phosphor-bronze if coupled with diaphragm seal, otherwise provide stainless steel.

H. Element shall be suitable for temperatures of media monitored, and filled for alleviation of vibration.

I. Provide with two ½" ball valves as shown on Drawings.

J. Provide with diaphragm seal as follows:

1. Lower Housing Material: Unless otherwise noted, type 316 Stainless Steel with flushing connections.
2. Diaphragm Material: Unless otherwise noted, type 316 Stainless Steel.
3. Upper Housing Material: Steel with bleed screw
4. Connections: Threaded Female NPT

5. Filling Fluid: Silicone
6. Unit shall be pressure-sensing suitable for measuring dirty or corrosive fluids.
7. Unit shall be arranged and designed to directly transmit the process pressure by means of the fluid through an opening in the lower housing to a pressure-sensing device attached and sealed to the upper housing by a drilled and threaded boss.
8. Seal shall be suitable for fluid pressures to 500 psig.
9. Unit shall have fill connections and other features required permitting refill of the seal volume and calibration of unit in the field.
10. Unit shall be suitable of for temperature of media monitored.
11. Ametek, Mansfield and Green Division, Type SG or Ashcroft Type 101.

2.17 CONTROL RELAYS:

A. Manufacturer:

1. Allen Bradley.
2. Potter and Brumfield.

B. Operating Data:

1. Pickup Time: 13 ms maximum.
2. Dropout Time: 10 ms maximum.
3. Operating Temperature: -45°F to 150°F.

C. AC Coil:

1. 120Vac.
2. Continuous rated.
3. 3.5va inrush maximum.
4. 1.2va sealed, maximum.
5. 50-60 Hz.
6. Light to indicate energization.
7. Minimum Dropout Voltage: 10% of coil rated voltage.

D. DC Coil:

1. 24Vdc.
2. Continuous rated.
3. Light to indicate energization.
4. Minimum Coil Resistance: 24Vdc: 450 Ω.

E. Contacts:

1. Gold flashed fine silver, gold diffused for 1 amp or less resistive load.
2. Silver cadmium oxide.
3. 3 form C.
4. 300 vac.
5. 10 amp make, 1.5 amp break, (inductive).

F. Rated at 10 million operations.

G. 11 pin, square socket (shall be from same manufacturer as relay).

H. DIN rail mountable.

I. Enclosed and protected by polycarbonate cover.

J. Provide relay-retaining clips.

2.18 TERMINAL BLOCKS:

A. Manufacturer:

1. Allen Bradley.
2. Phoenix Contact.
3. Weidmuller.
4. Or equal.

B. 300 v rating for 120 v circuits and below, 600 v rating for 480 v circuits.

C. Clamping screw type.

D. Isolating end caps for each terminal.

E. Identification on both terminals.

F. Clip-mounted on DIN rail.

G. Accept AWG 12 to 22.

H. Feed-Through Terminals:

1. 20 Amp rating

I. Switched Terminals:

1. Knife disconnect with test sockets.
2. 10 Amp rating.

J. Fused Terminals:

1. Hinged fuse removal/disconnect.
2. 10 Amp rating.
3. Include blown fuse indication.

2.19 POWER AND DATA PORT:

A. Manufacturer:

1. Hubbell PR4X205E.
2. Automation Direct ZP-PGA-32-201.
3. GracePort

B.General

1. One Ethernet port.
2. 120Vac GFCI Receptacle.
3. Bulkhead style.
4. Nema 4X.
5. Mounted on PLC Panel.
6. Wired to internal Ethernet switch.

2.20 ELECTRONIC CURRENT ISOLATOR:

A.Manufacturer:

1. Phoenix Contact Model MCR Series.
2. PR Electronics.
3. Entrelec.

B. Solid state instrument to electrically isolate one instrument loop from another instrument loop. Converter to accept 4-20 mAdc input signal and provide equal but isolated and power-boosted output.

C. Mounting: DIN Rail.

D. Temperature compensated, calibration-free.

E.Signals: Input: 4-20 mAdc into 50 ohms. Output: 4-20 mAdc into output load up to 500 ohms.

F. Isolation: Common mode up to 700Vac between input and output.

G. Accuracy: 0.5% of span.

H. Provide power supply specific to isolator.

2.21 SCADA PANEL (SP-1) LOCATED IN ELECTRICAL ROOM:

A.A SCADA panel shall house redundant programmable logic controllers (PLC's) which shall be programmed for automatic control and monitoring of the operations of all control and monitoring functions at the Pump Station. The PLC's shall control the starting and stopping of Low Flow Pumps and Main Pumps to prevent roadway flooding. The PLC's shall be configured with redundant processors communicating over fiber optic cable with individual power supplies for each processor and redundant power supplies for each I/O rack. I/O communication shall be over Ethernet with ring topology.

B.The SCADA panel shall be NEMA 12, 10 gauge steel, floor mounted, front accessible only, metal enclosed type, arranged for cable and/or conduit entry from the top as required. Panel design shall allow easy access to all internal wiring and appurtenances. Fluorescent lighting kit activated by door switches shall be provided. Thermostatically controlled ventilation fan, air filters, thermostatically controlled space heater, light kit and 120V

receptacle shall be provided. Redundant front of panel HMI's shall also be included whose software application is located on a computer in the Network Rack Enclosure. The panel shall have a full piano hinge door(s) and a 3-point latch with a locking handle. The handle shall have a cylinder type lock keyed to match the Department's system. Additional devices as shown on Drawings.

C. The SCADA panel shall be finished inside and out. Exterior color shall be ANSI 61 and shall match that for the motor control center, and the interior color shall be white or as otherwise approved by the Engineer.

D. Nameplates shall be as specified in Section 26 00 03. All devices located on front door and inside the panel shall be identified with functional nameplates that match device ID's on Drawings.

E. The SCADA panel shall house relays, timers and intrinsically safe relays which shall be wired for backup automatic control and monitoring of the operations of critical functions at the Pump Station. Space shall be allocated for 25% spares for future equipment. The logic shall control the starting and stopping of Low Flow Pumps and Main Pumps to prevent highway flooding. The SCADA panel shall be configured with simple float control hardwired logic and shall serve as a simultaneous backup system to the primary and secondary PLC's in the same Panel. The panels shall conform to all applicable standards of NEMA and ANSI and shall be complete with float type water level control systems integrated as indicated on the Drawings and as specified.

F. Unless otherwise indicated, pushbuttons, selector switches, indicating lights, relays, and other devices shall be provided as part of the SCADA Panel and shall be as similar to those in the MCC and shall be of the same manufacturer and style.

G. Wiring shall be brought to terminal strips within the enclosure and 25 percent spare terminals shall be provided. The identification of terminals shall conform to the schematic diagrams and shall consist of slip-on heat shrink labels as manufactured by Brady, Thomas, or equal. Terminals and devices that are provided for intrinsically safe circuits shall be segregated from all other circuits/devices as described elsewhere.

H. The float control system circuit shall be as specified under "Float Control System". The float relays shall be intrinsically safe.

I. Intrinsically Safe circuits, wiring, mounting and installation shall be in accordance with NEC Article 504 (latest edition).

J. Enclosure shall bear UL listing and UL label for complete equipment package. Enclosure shall include all miscellaneous accessories including, but not limited to, the following: document pockets, steel epoxy painted subpanel, eyebolts for lifting, grouning harnesses, dual ground lugs, door switches, convenience receptacles, ventilation fans, fan thermostats, convenience lights, etc.

2.22 FLOAT CONTROL SYSTEM:

A. The float system shall function as described on Drawings and as described herein.

B. The float control system shall include floats, interconnecting integral cable of length required, and controls for the functions indicated.

C. Floats shall consist of sealed switches encapsulated in 316 stainless steel, Teflon coated with integral neoprene jacketed cable of sufficient length to intercept junction box without splicing.

D. The system shall be intrinsically safe for installation in the wet well, and pavement installations.

E. The system shall be complete with control logic to provide the contacts for control and alarm functions indicated. Intrinsically safe relays and associated wiring shall be located in SCADA Panel.

F. The system shall be complete with all required mounting hardware and accessories.

G. The float system shall be complete with mounting arrangement with a stilling well of adequate size, as shown in Drawing details to minimize collection of debris and calm liquid disturbances. The mounting arrangement shall permit easy removal of the floats and easy realignment when replaced.

H. When float arrangement is such that there is a possibility of float switch entanglement with an adjacent float switch, then two float trees with stilling well assemblies shall be provided - staggering the switches as required to alleviate float switch entanglement.

2.23 NETWORK RACK (NET-1) LOCATED IN ELECTRICAL ROOM:

A. Manufacturer:

1. Tripp-Lite.
2. APC.
3. Or Equal.

B. 19” EIA Compliant Device Mounting.

C. 42U Wall-Mount Rack, ventilated, Lockable plexiglas door.

D. Dimensions (WxDxH): Minimum as shown on Drawings.

E. Include one 2U Pull-out Storage Drawer.

F. 2-year warranty.

2.24 SCADA PANEL HMI COMPUTER:

A. Provide one fully configured computer system including hardware, peripherals, operating software, application software, and configuration as specified herein for running application, data logging, and trending animation.

B. Manufacturer:

1. Dell
2. HP

C. The computer shall be a Intel processor based PC in a rack-mount configuration with the following features as minimum system requirements:

1. Rack-mount configuration.
2. Intel Xeon Processor (6C, 15M, 1.6 GHz, 85W)
3. Memory: 16GB 2133MHz DDR4 Memory.
4. Internal Hard Drive: 1TB, 2.5inch SATA (7.200 RPM)
5. Removable Media Options: 16x DVD+/-RW
6. 10/100/1000 Ethernet port, 1 VGA port
7. Graphics Card shall be dual-port, and capable of running multiple monitors simultaneously.
8. Operating System: Windows 7 (x64) Professional
9. USB Quiet Keyboard
10. USB – Optical Mouse
11. Dual, Hot-Plug, Redundant Power Supply.
12. Input Voltage: 90…264V ac, autoranging
13. Line Frequency: 47…63 Hz
14. Operating Temperature: 0…50 °C (32…122 °F)
15. Operating Humidity: 10…90% without condensation
16. Operating Vibration: 1 g peak, 10…500 Hz
17. Operating Shock: 15 g (1/2 sine, 11 ms)
18. Rating: NEMA Type 12
19. Certifications: UL 60950 recognized component, c-UL 950 recognized component, or UL/c-UL listed when marked; CE marked, C-Tick

D. Three (3) Year Hardware Service Plan with Onsite Service. It shall be effective from the date of final acceptance of the pump station.

E. Provide Microsoft Office Professional software (latest version) installed.

F. System requirements listed above reflect information known at time of design and shall be independently researched, verified, and updated based on availability, and compatibility prior to submittal. Submitted system shall be based on mid range level of performance. Operating system and software shall be most current version that is fully compatible with all software installed on the machine for the project.

G. Provide all software on original media, software publisher licenses, and manuals.

H. The computer shall be capable of off line usage for purposes other than system logging and trending without loss of statistical data.

I. The computer shall be programmed for auto-startup and login to Operator after loss of power.

J. The computer shall be arranged for system monitoring and management. The primary function of the computer shall be to provide monitoring, trend analysis and, operational records for the pump station facility.

K. All software shall be licensed to the Department.

2.25 SYSTEM SOFTWARE

A. General Requirements

1. The System Integrator shall furnish and install all software and programming necessary to provide a fully debugged and operating system based on the system descriptions. The software required shall consist of those programs necessary for the System to perform the functions specified herein, plus enable convenient and efficient preparation of new programs. The System Integrator shall assume complete responsibility for the successful operation of all software and application programs provided as part of the System. All programs shall be completely debugged and operable prior to delivery of the System. The Department shall not be required to expend any programming effort in order to achieve a fully operational system.
2. Software shall be modular, comprised of an integrated group of proven, standard software modules.
3. All of the programs are to be generalized in nature such that DEPARTMENT may later add new functions. Integration of future application programs and the servicing of their input and output requirements, including construction of new printing formats and other system interfaces, shall be accomplished without recompiling of application software.
4. Changes in process parameters, addition and deletion of process schemes or equipment, and addition or modification of graphic displays and printed report formats shall be via the use of process operator and control engineer oriented icons, graphics, and menus organized in a hierarchical fashion.
5. System parameters such as: date, time, set points, alarm limits, PID tuning constants, etc., shall be entered or modified via the LCD/keyboard. Any input which modifies the system shall be logged and a historical disk file with date, new value, and previous value.
6. The System Integrator shall develop and implement all specified screens, logs, reports, etc. The Department shall provide input to the System Integrator in the areas of presentation format, included information and other general operator interface considerations.
7. Provide FactoryTalk View SE Client, FactoryTalk Historian SE (500 tags) and other software as required for a complete an operable system that shall be capable of displaying separate screens on each HMI Monitor.

8. All software shall be licensed to the Department.

2.26 HMI MONITOR:

A. Manufacturer:

1. Hope Industrial Systems Inc.

B. Two required. Both HMI's located at SCADA Panel.

C. Industrial monitor and touch screen, 22" panel mount active matrix LCD, NEMA 4X, stainless steel faceplate, 5-wire resistive analog touch-screen, mouse emulation, USB interface to computer.

D. 1680x1050 resolution, 16:10 widescreen aspect ratio, 16.7 million colors.

E. UL-508A listed.

F. 120Vac.

G. Include vendor cables of sufficient length to connect to computer.

H. 3-year factory warranty.

I. Include hinged screen protector.

2.27 GRAPHICS AND HMI CONFIGURATION:

A. HMI-1 shall be configured to display various graphics screens as the Operator selects for monitoring and control of the Pump Station. HMI-2 shall be configured to display an alarm annunciator-style graphics screen as default with the ability of each HMI to interpose functionality between the two with one click of mouse or active touch space on-screen. Each HMI shall have access to all graphics screens. The HMI's shall operate as redundant equipment.

B. All color displays shall contain and continuously update the displayed process variables, date and time of day. All process values shall be displayed in engineering units. All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers as shown on the Drawings. The following basic types of LCD displays are required:

1. Main menu and navigation screen
2. System overview
3. Help screen
4. Hydraulic profile screen
5. SCADA and float control elevation screens
6. System alarm annunciator screen
7. System event screen

8. Electrical metering screen
9. Portable temporary generator screen
10. Trends screen
11. Status screen
12. Individual pump screens
13. Password protected system administration screen.
14. Network communication diagram.
15. Index displays
16. Graphic displays
17. Single point configuration/status displays
18. Pop-up displays
19. Help displays
20. Adjustable Operator Set-point displays

C. The LCD displays shall make maximum use of the colors available. Colors for status such as open/close, start/stop shall be the same as the indicators on the local control panels and motor control center. The use of color for status shall be unique and consistent for all graphic screens.

D. The LCD displays shall be interlinked for easy and direct access. Navigation shall be accomplished by mouse selection from Windows like pulldown menus or via hot links on displays. Display hot links shall allow navigation from the general to the specific and include a "PREVIOUS" select point for reversing the previous 10 navigation steps.

E. The system shall allow the operator to manually interrogate the status of pumps, valves, etc., via either keyboard entry on the currently displayed graphic screen.

F. Index displays: Display shall be provided as a guide to the available display options. The index displays shall be a complete and logical listing of the names and number of all screens. Provide hot links on the index displays to allow immediate access to any screen listed.

G. Graphic displays: The display shall depict basic process schematic diagrams with representative symbols for pumps, portable generator, etc., combined with real time process variables or conditions. The equipment represented on the display shall be suitably titled for identity. The displays shall be dynamic (i.e., symbols for a pump shall change color indicating run or stop or alarm, the volume of wet wells shall be indicated by varying the height of the interior color of the tank symbol, etc.) The data shall be identified on the display by its name and tag number. All of the current data in the database shall be available for graphic displays. It shall be possible to easily modify an existing display or generate a new display. The graphic displays shall consist of a single master plant flow schematic and multiple subscreens detailing specific plant systems or elements. The process graphic displays shall be comprised of master, area and system displays. The master and area displays shall show general graphic representations of the facility covered with general equipment, alarm, analytical summaries and control capabilities. The system display shall detail all relevant aspects of the individual equipment or system (i.e., an individual pump). The intent is to provide the Operator with an overview (Master)

with the capability to "zoom in" on a process area or a piece of equipment as necessary. The System Integrator shall use the Process, Mechanical, and Instrumentation Drawings included as part of this Contract to generate the graphic displays.

1. Trend display: The trend display shall display the value of a process variable versus time. The intent of the display is to resemble the type of plot produced on an analog recorder, only displayed on the LCD. Each of the assigned points will have its point identification number, point name, current value, and instrument range displayed in the color used for its trend. Each point will be trended in a different color. The time period shall be selected and time and date of start, shall be displayed. The values displayed on an historical trend shall consist of the stored values for each variable trended. Provide both historical and real-time trending capability. Real-time trends shall be updated at the scan frequency of the variable. Provide historical and real-time trending for all analog inputs shown on the P&ID. Points shall be logically grouped on a trend screen as directed by the Department or Engineer.
2. Alarm summary display: The display shall consist of all equipment current in alarm, and shall include the tag number, description, time of occurrence, present status (high, low, normal, etc.). The alarm summary shall identify alarm points by severity by utilizing distinct colors for each severity category. The severity classification shall be a configuration option.
3. System status displays: The displays shall summarize all error status of all devices in the system capable of reporting errors to the CPU (e.g., printers, communication devices, communication lines, remote PLCs, etc.). The display shall indicate if an error is detected or a failure occurs. These displays shall be used primarily for maintenance purposes.
4. Single Point Configuration/Status displays: The configuration/status displays shall be of the software vendors standard format.
5. Pop-up displays: Provide pop-up style displays for operator notification, help screens, or ancillary display functions. Pop-up display shall conform to Microsoft Windows look and feel including pop-up termination or action pushbuttons.
6. Help displays: Provide process help displays for all graphic screens developed for this project. Help displays shall be pop-up type and provide operator information about the process graphic currently displayed.
7. Adjustable Operator Set-point displays: Provide standard display for all adjustable operator setpoint displays.
8. Provide button link graphic icons that allow operator action by selection of the button with the mouse and mouse key. Button link shall be a standard graphic item and be modifiable for any process action or graphic call.

H. Alarm/Equipment Status Reporting:

1. The alarm log shall store all alarms as they occur. The alarm message shall include the time of occurrence, tag name, tag number, and whether it's a low, high, or failure alarm. When the point in alarm returns to normal, the time, point identification number, and return to normal shall be printed. All reports shall include the plant equipment number of the associated device.

2. Equipment status shall be logged whenever a change in status occurs (i.e., start, stop). The status monitoring shall be capable of being disabled and/or suppressed from the operator's console. The equipment status log shall include the time, the equipment name, tag number, and the particular change in status.

2.28 PLC PROGRAM DEVELOPMENT AND SOFTWARE:

A. The System Integrator shall provide all PLC programming and configuration required to implement the control strategies specified in this Section and shown on Drawings for a complete and fully operational Pump Station.

B. ControlLogix PLC's shall be programmed using Allen-Bradley RSLogix 5000 (latest version compatible with all software and hardware).

C. Provide PLC program fully documented with individual rung and page commentary describing the action and interaction of rung with other control ladder logic. The Department standard programming code shall be used as basis, and is available as .pdf during bid-phase upon request.

D. Prior to final completion of construction project, the System Integrator shall turn over two CD's with all PLC programs fully documented and labeled: "Pump Station 4 PLC Programs" with System Integrator full contact information. Two hardcopy of the PLC program shall accompany the CD.

2.29 PLC PROGRAM DEVELOPMENT GUIDELINES:

A. Adjustable operator set-points, alarm values, timer values, control loop tuning parameters, and other numeric values used within PLC and HMI programs shall be part of continuous common data table within program. Parameter changes shall not require modification to instructions within program. Parameter changes shall be adjustable by changing data table through operator input via HMI.

B. Unless specified otherwise, procedure for control power fail restart for equipment shall be as follows:

1. Equipment shall shut down on loss of control power (if UPS has been exhausted).
2. Upon restoration of power, previously running equipment shall be restarted using same sequence of startup used for "Auto" control.
3. Prior to Restart, Auxiliary equipment shall be placed in "Off" position.
4. Equipment Restart shall be sequenced through use of timer functions to prevent simultaneous restart.

C. PLC shall not be enabled to control equipment unless respective field or MCC Hand/Off/Auto, Local/Remote, On/Off/Remote or Open/Close/Remote selector switch is in "Remote" or "Auto" position. Equipment status monitoring/displaying and process parameter logging/trending shall continue in all modes of control.

D. Determination of high, low, Off-Normal conditions shall be by comparing an analog input value to Operator entered set-point values. Off-Normal status bit shall be set when rising

(falling) input value is equal or greater (less) than entered set-point value. Off-Normal status bit shall be reset when falling (rising) input value is equal or less (greater) than entered set-point value minus (plus) entered deadband value. Operator entered high (low) set-point values are absolute values and deadband values are relative values. All values are entered through HMI.

E. Setting of Off-Normal status bits shall cause status conditions to be displayed and/or alarmed at HMI.

F. Resetting Off-Normal status bits shall cause status conditions displayed and/or alarmed at HMI to be cleared.

G. Adjustable delay timers on alarm points shall prevent nuisance alarming or nuisance clearing of alarms. Timer values shall be ranged 0-30 seconds. Initial setting, unless otherwise specified shall be 5 seconds.

H. All status conditions at HMI shall also be logged to data table and event log.

I. Motor Running status shall be monitored and displayed at HMI continuously.

J. Setting of Motor Failed status bits:

1. If motor is required to run via PLC control (MCC Hand/Off/Auto selector switch in “Auto”),
2. And if absence of Motor Running status causes Motor Fail watchdog timer to time out,
3. Then Motor Failed status bit shall be set.

K. Setting a Motor Failed status bit shall cause motor command output to be inhibited and shall cause Motor Failed status to be displayed and alarmed at HMI.

L. Resetting of Motor Failed status bits:

1. If MCC Hand/Off/Auto selector switch is in “Auto” position,
2. And if failure condition is abated,
3. Then Motor Failed status bit shall be reset.

M. Resetting a Motor Failed status bit shall cause motor command output to be re-enabled and shall cause Motor Failed status displayed and alarmed at HMI to be cleared.

N. Adjustable filtering of analog inputs shall eliminate process upsets due to noise. Filtering shall be by running-average method.

O. Integration algorithm shall be included for “Totalizing” analog flow signals.

P. Integration algorithm shall be included for “Totalizing” Equipment Run times (Elapsed Time Meter). Pump ETM and Pump number of starts shall be password protected and require Supervisor level verification to reset.

Q. PLC input coils shall be configured as non-latched unless specified otherwise.

R. PLC output contacts shall be configured as maintained unless specified otherwise.

S. The following are project-specific PLC generated alarms or conditions that are extrapolated based on field I/O conditions:

1. "SCADA PMPR Override" output shall be generated if more than one Main Pump exhibits a High Temp or Seal Fail as detected by the Pump Motor Protection Relay (PMPR). The subsequent pumps, that fail, shall continue to run by SCADA overriding the seal leak and/or over-temp condition of the pump motor protection relay, as shown on the Electrical plans.
2. "Pump Off" is defined as the MCC Hand/Off/Auto switch in the "off" position for maintenance, while "Pump Not Running" is defined as the inverse of pump running.
3. "Pump Fail to Stop" status alarm shall be generated if a Pump is running and Low Water Level float is activated.
4. "Pump Alarm" status transmitted to AEGIS shall be determined as any pump in overload, over-temp, seal-fail condition, or fail to start.
5. "Not in Auto" is defined as the inverse of any PLC input "In Auto".
6. "Pump Under Maintenance" status shall be determined by main breaker in the off position, and the Hand-Off-Auto selector switch in the off position. Pumps shall be removed from PLC automatic sequencer when under maintenance.
7. "Gates in Non-Discharge Mode" status is set when the Recirculation Gate (RG) is not 100% closed, or the Discharge Gate (DG) or Influent Gate (IG) is not 100% open.
8. "SCADA Call" output to supply fans and is generated whenever lights are on in the Pump Station in a respective area as the fans.
9. "FLOAT FAIL" alarm shall be generated when a float fails to activate when water level (as measured by analog level elements) exceeds the floats expected activation level by more than 12". Additionally, if a float remains active when water level drops below the floats deactivation level by more than 12".
10. "PLC Fail" output that is de-energized when primary and secondary level elements are out of range, and/or both PLC processors fail.
11. An alarm shall be generated if the lights and or the fans in the Pump Station are continuously on for more than (an Operator adjustable value) 4 hours.
12. An alarm shall be generated if the Discharge Chamber level continually exceeds 593.00 elevation or signal is out of range for more than (an Operator adjustable) 15 minutes. This alarm shall be designated as Pump Station discharge blockage.
13. An alarm shall be generated if the primary or secondary analog level signals are outside the two float elevations (above and below) or out of range for a period of 30 minutes.

2.30 HMI PROGRAM DEVELOPMENT GUIDELINE:

A. Graphical Screens:

1. Overview screens and reports shall be first screens configured. Coordinate layout and information requirements with Engineer prior to development of screens – see EXECUTION Section below for details and requirements.

2. HMI screens shall be developed for the complete operation of the Pump Station as allowed by design and PLC involvement in the processes.
3. Screen development is understood to be partially an art form in conveying the data in graphical manner that is best understood. Screen development shall be a coordinated effort with the Department with input from being incorporated while staying within the scope of the project. Changes in color, texture, font, area of screen an item is located, and other artistic changes shall be incorporated without additional costs to the Department.
4. Graphic screens for HMI shall be formatted to resemble P&ID's, one-line diagrams, and physical layout of the Pump Station. As a minimum, one graphic display per process loop shall be provided.
5. Screens shall be simplified representation of process flow stream and associated equipment as shown on Drawings. Only major devices shall be shown. Non-reporting equipment such as isolation valves, check valves, need not be shown.
6. Each screen shall include a legend of shapes and colors that depict status of equipment.
7. The following shall be provided as minimum:
   a. Main Menu Screen: Icon selection of all graphics screens available for selection.
   b. Alarm Annunciator-style Screen: The display shall be designed to have the look of an annunciator panel whereby critical Pump Station equipment is listed in individual squares that change color depending upon status of the equipment. If the equipment is operating normal with no alarms, then the square is gray in color. If the equipment is under an alarm condition, the respective square shall turn red and flash. System Integrator shall arrange annunciator graphics screen layout to best portray the application and submit it to Engineer for approval. The following equipment or condition shall be individually segregated with an alarm square:
      1) Pump Fail to Start (qty-12)
      2) Pump Overtemp/moisture (qty-12)
      3) Pump Overload/fault (qty-12)
      4) Pump Not in Auto (qty-12)
      5) Pump Under Maintenance (qty-12)
      6) Wet Well Low Water Level
      7) Wet Well High Water Level
      8) East & West Upstream Level Sensing Failure
      9) Primary & Secondary Level Sensing Failure
      10) Discharge Chamber Level Sensing Failure
      11) Pavement Flooded
      12) Station in Float Mode
      13) Float Failure
      14) Intrusion Alarm
      15) Fire Alarm
      16) Fire Panel Trouble
      17) Utility Service #1 Failure
      18) Utility Service #2 Failure
      19) SCADA Power Failure
      20) SCADA Panel Common Alarm
      21) Gates in non-discharge Mode

22) Combustible Gas Alarm
23) Combustible Gas Warning
24) Combustible Gas Panel Trouble
25) SCADA UPS Low Battery
26) SCADA UPS Failure
27) PLC Failure
28) SPD Failure
29) SCADA Panel Line Filter System Failure
30) Pump Station Occupied
31) Pump Room Ventilation Failure
32) Up to (2) additional signals per pump as defined by the Engineer
33) Up to (10) additional signals as defined by Engineer.

c. System Overview: Depiction of wet well including wet well level and pumps, status of pumps (running/off/out of service), status of gates/valves Open/Closed/Transitioning), and Lead/Lag position of each pump in the pump sequencer. Icon of all other Screens shall be provided for jump to that specific screen.
d. Float Status Screen: Shows wet well level and status of each float switch with legend for status. This screen may be combined with System Overview Screen if all equipment depictions are clear, concise, and unambiguous to the Operator. Icon of all other Screens shall be provided for jump to that specific screen.
e. Individual Pump Screens: Containing graphical information about each Pump. See Drawings for specific requirements, total runtime hours, total number of starts, running/off/under maintenance status, amps, breaker position, overload, overtemp, seal fail status, vibration, motor winding temperature, not in auto, etc. Icon of all other Screens shall be provided for jump to that specific screen.
f. Motor Current Alarm Set-points Screen: contains Operator adjustable variables for low and high current limits for each Pump used for alarming and maintenance purposes. Pumps will not stop based on these entered values. This may be included on the Individual Pump Screen of space permits. Icon of all other Screens shall be provided for jump to that specific screen.
g. Electrical one-line Diagram Screen: containing status of circuit breakers (green = breaker open, red = breaker closed) as seen by the PLC in a graphical power one-line schematic representation. A legend shall also be included indicating color representation. Each power service shall indicate voltages (A-B, A-C, B-C, and each phase with respect to ground), amps of each phase, frequency, power (kW), and power factor. Icon of all other Screens shall be provided for jump to that specific screen.
h. Analog Level Element Set-point Screen: contains Operator adjustable variables for Pump on/off level operation. A default level setting matrix shall also be included as the default Pump Station settings, with a reset-to-defaults selection available. A graphical representation of wet-well, with pumps listed at various levels (Lead, Lag) on the left side of wet-well in order of operation. The numerical level of each level element with floats also represented as reference to the analog level. Icon of all other Screens shall be provided for jump to that specific screen.

i. Station Status Screen: contains depiction of all PLC's and their status with regards to power and communications. Also contains the following: status of each supply fan, gas monitor status, fire alarm panel status, Sump Pump status, AEGIS alarm status, key switch box position, pump room, dry pit, and electrical control room lighting status, etc. Icon of all other Screens shall be provided for jump to that specific screen.
j. Alarm Screens: contains all alarms in a LED style depiction with status of each (normal = green, alarm = red). Any device, equipment, or PLC generated alarm shall be represented with time and date tagged.
k. AEGIS Common Alarm Screen: There is a SCADA Common Alarm that is transmitted to the AEGIS Panel for alerting outside entities of possible alarms in the Pump Station (from Pump Failure, lights on, etc.). Provide an alarm selection screen whereby the Operator may select which Pump Station alarm conditions will be part of the SCADA Common Alarm that is transmitted to the AEGIS Panel. This screen shall have each alarm condition listed and a check box selection matrix. This screen is provided as a means to de-select possible nuisance alarm conditions.
l. Trend Screen: Operator adjustable points for trending. Provide trending capability for all analog inputs at PLC. 96 hours retained data minimum.

8. Operator and Engineering screens shall be segregated to allow password protection of engineering-entered values.
9. There shall be pick-fields on all screens that will allow for return to main menu or to adjacent process flow screen, (continuation of all process flow paths, either entering or existing.
10. Pick-fields shall be activated by placing mouse cursor on object or text and clicking left mouse button, or by selection of associated function key (F1-F12).

B. Data Input:

1. Data entry areas shall be provided at HMI for adjustment of process and alarm set-points. Data entry areas shall be password protected.
2. Upper and lower limits shall be provided for all data entry values. Entry of values outside of limits shall not be accepted and shall generate appropriate error message on screen. Upper and lower limit values shall be adjustable at HMI and shall be password protected.
3. Upper and lower limits shall be provided for all logged analog input values. Logged values outside of limits shall generate appropriate alarm. Upper and lower limit values shall be adjustable at HMI and shall be password protected.
4. Upper and lower limits shall determine range of analog input value. Value shall be scaled in standard Engineering Units.
5. Password protection shall consist of alpha-numeric sequence and shall be intended for Plant Supervisor and Head Operator entry only.
6. Unless otherwise specified process points shall be scanned as follows:
   a. Critical Alarm points and analog input process points shall be scanned continuously.
   b. General Alarm points shall be scanned only on change of state into alarm condition.

c. All other points scanned only when required for display at HMI.

7. All dynamic screen displays shall be updated every 2 seconds, minimum.

C. Display Objects – General

1. Process piping and pumps/fans/mixers may be animated with color to show active/non-active status.
2. Use graphic symbology for rendering of objects.

D. Display Objects – Process Lines and Inline Device Symbology

1. Where inline devices are dynamic in nature, their equipment symbols shall be formatted as Display Objects to change color based upon feedback. Coordinate color use with Department's existing HMI configuration. Recommended color use:
   a. Off – Red.
   b. On – Green.
   c. Fail/Alarm – Red, Flashing.
   d. Status – Amber.
2. Inline devices shall have alphanumeric tag identified near them, adjacent to associated symbol.
3. Arrow heads shall be used as pointers for flow direction at all points of entrance to equipment, at all points where process lines change direction and at points of merger.
4. Process lines entering or leaving screen shall have points of continuation identified by boxed text, indicating From/To screen. One end of box shall form arrow to show direction of flow and act as pick-field for selection of screen of continuation. Color shall be same as associated process line.
5. Process lines shall be identified with flow stream abbreviation as listed in standard symbolic table and as shown on Drawings, where convenient.

E. Display Objects – Data Fields

1. Analog process data not conducive to graphic symbology shall be formatted as rectangular Data Fields:
2. Process values (i.e. Flow, Elapsed Time) shall be displayed as Data Fields near associated device symbol and shall consist of: alphanumeric tag, green in color; data value, white in color, right justified; engineering unit, green in color. Entire field shall be grouped as one block.
3. Data Fields shall be configured with high and low limits (adjustable) as described above.

F. Display Objects – Status Displays

1. Status Displays shall be similar to Data Fields but shall be linked to discrete data points or status bits:
2. Discrete equipment parameters (i.e. Run, Fail, On/Off, Open/Close) shall be indicated as rectangular Status Displays and shall consist of: alphanumeric tag, green in color; single or dual-state equipment value, white in color, center justified. Entire field shall be grouped as one block.
3. Displays shall be classified as Alarms or Events (see below).

G. Data Entry Field:

1. Similar to Data Display Field described above. Allows Operator entry of process values such as set-points.
   a. Pop-up activation for dynamic control of equipment shall be by pick-fields associated with symbol of device to be controlled. Pop-up shall be small window or graphic overlay on current screen in location that will not interfere with current operation. Pop-up will contain necessary symbolism for dynamic control and worded prompts as necessary.

H. Alarming Requirements:

1. Alarms and Events shall be logged to data file.
2. Critical alarms shall alert AEGIS system (See selection matrix above).
3. Alarms shall fall within one of following categories.
   a. Critical: Alarms displayed and annunciated at AEGIS and broadcast to the Department District 1, IDOT TSC, and EMC.
   b. General: Alarms displayed and annunciated at local HMI and logged to alarm event file.
4. Provide alarm summary screen(s) at HMI.
5. Display only current alarms. Acknowledged alarms which are no longer active shall not be displayed.
6. Allow operator to acknowledge alarms using single keystroke or cursor pick at alarm summary screen.
7. Alarm Display shall include following information:
   a. Time and date alarm initially occurred.
   b. Alarm point identification.
   c. Alarm value and engineering units for alarms generated from analog process points.
   d. Description of alarm (up to 40 characters).
8. Events shall be logged to separate data file. Events shall not be displayed unless evoked and shall not be annunciated.
9. In addition to the above, an alarm matrix shall be developed for expanding upon basic FactoryTalk alarming features which allow the Operator to select which alarms shall transmit to AEGIS when active (described in greater detail above).
10. The Operator shall have the ability to silence alarms.
11. The alarm silence feature shall also have a manual override.

I. Data Logging requirements – Analog and Discrete

1. All input process points shall be logged to the hard disk of the HMI computer.
2. Procedure for data collection and storage shall be as follows:
   a. HMI I/O driver shall poll process points as specified on I/O list and transfer data to image table.
   b. HMI shall scan image table for analog process points once every second, and log value to data base.
   c. HMI shall calculate minimum, maximum and average for each analog process point and log to data base.
   d. HMI shall scan image table for discrete process points on status change only, and log value to data base.

J. Trend Display Requirements

1. Configure HMI computer to display logged data in graphical trend format.
2. Trend Display Requirements:
   a. Identification of process point being displayed. Use same nomenclature as used on HMI screens.
   b. Start and end time of data being displayed.
   c. Display shall incorporate movable vertical cursor along time axis. Parameter values at cursor date and time shall be displayed digitally.
   d. Initial configuration of displays shall display data from present time back to 96 hrs prior to present time. Provide capability for operator to enter new start time for data being displayed to view parameter trend more than 96 hrs old. System shall be capable of retrieving 1 year of stored data.
   e. Displays shall include y-axis range identification, including values and engineering units.
   f. Configure trend displays to use maximum of computer screen area possible for purpose of increased resolution.
   g. Trend displays shall be accessible, via single keystroke, from graphic screen displaying trended point.
   h. Organize graphics screens for trend displays into categories by process:
   i. Provide separate graphic screen within each category to display each process point trend. Provide different color for each process point.
   j. Provide separate category for manually entered data from HMI computer.

2.31 PUMP STATION NETWORK EQUIPMENT

A. Provide industrial grade network equipment to integrate the new pump station into the Department's existing pump station network, as shown on Electrical drawings. The equipment shall be compatible with the existing equipment at the other Department pump stations in District 1. It shall be fully configured including mounting hardware, peripherals, operating software, patch cords and configuration for installation in NET-1 rack. The operating software shall be compatible with the existing software at other pump stations, including existing PS04.

B. Manufacturer

1. Hirschmann, a Division of Belden
2. Cisco Industrial Managed Ethernet switches that can interface with existing switches in the Pump Station Network.
3. Approved Equal.

C. The networking equipment shall include 8 port Fast Ethernet switch, managed, software Layer 2 Enhanced, store-and-forward-switching, Hirschmann MS20-0800SAAEHH0 with software version that is compatible with the switches at existing pump stations, and media module for the switch, with two 100BASE-TX ports and two 100BASE-FX single mode fiberoptic ports, Hirschmann MM3-2FXS2/2TX1. Provide DIN rails and patch cords for installation of this equipment in the rack. Coordinate with EMC, obtain IP addresses for

the equipment and integrate the new pump station fully in the existing Pump Station network, as shown on Electrical Drawings.

PART 3 - EXECUTION:

3.1 INSPECTION

A. Verify that field conditions are acceptable and are ready to receive work.

3.2 INSTALLATION

A. Install devices and equipment in accordance with manufacturer's instructions.

B. All wires and cables shall be labeled and identified at both ends. This includes spares.

3.3 HMI SCREEN DEVELOPMENT AND PLC PROGRAMMING

A. Two meetings are required to include: Contractor, System Integrator, Engineer and other Department personnel, as designated by the Engineer in attendance.

1. The first meeting shall be limited to 4 hours and shall consist of a formal review of HMI Screens which shall be provided 48 hours in advance in color hardcopy for all attendees by Contractor. Review shall be an opportunity to provide input to the development and artistic representation for Screens. All requested changes/alterations shall be documented and a formal response to each alteration by the Contractor presented prior to the second meeting. PLC programming and operational strategies are also discussed and input provided. Site of meeting shall be at the discretion of Engineer.
2. The second meeting shall be limited to 4 hours and shall consist of a formal review of HMI Screens which shall be provided 48 hours in advance in color hardcopy for all attendees by Contractor. Review shall be an opportunity to provide input to the development and artistic representation for Screens. All requested changes/alterations shall be documented and a formal response to each alteration by the Contractor presented within 3 weeks of meeting. PLC programming and operational strategies are also discussed and input provided. Site of meeting shall be at the discretion of the Department.

3.4 SYSTEM TESTING:

A. System testing and Start-up including the following, shall include provisions of Section 01 75 00.

B. System Shop Tests:

1. The System Integrator shall simulate the SCADA system within his shop. Shop testing shall include, but not necessarily be limited to, the following:
   a. Manually fill-in required additions to PLC data base.
   b. Manual forcing of outputs.
   c. Operation of the control programs.
   d. Forcing redundant transfer from primary PLC to secondary as a bump-less transfer.
   e. Recall of simulated data points on the HMI display.
   f. Recall of all reports with partial fill-in data and manual fill-in data at time of testing.
   g. Routing testing of logger, AEGIS alarm, and HMI display based upon manual input data.
   h. Change of alarm and limit set-points, etc., and observation of results.
   i. Any additional testing which may be found to be necessary at the time the above is observed.
   j. All necessary contact and analog inputs must be provided to permit satisfactory testing of the above. If analog instrument switch over from one test to another is required, it shall be done in a most expeditious predetermined manner so as to permit nearly continuous testing during final shop acceptance.
   k. Prior to such acceptance tests, the System Integrator shall submit the detailed procedures of the proposed shop tests and a time schedule within which such tests can be run, both subject to acceptance and approval by the Engineer. The System Integrator will be expected to do all necessary pretrial testing and debugging to ascertain that the system is in running order. After the System Integrator has confirmed that the proper responses can be achieved, the date for final shop test may be established.
   l. During shop testing, the System Integrator shall generate hard copy printouts of all reports and graphics, indexes and point I.D.'s on both printer and LCD monitor for submittal, review and correction. A certified letter that the listed shop tests have been performed, and all panels meet contract requirements shall be submitted. The Department reserves the right to be present when shop tests are run.

C. System Field Tests

1. The pre-acceptance test procedures, as outlined in the preceding paragraphs, shall apply. Acceptance testing shall include the following:
   a. Acknowledge receipt of all analog and contact inputs, their reliability value and range.
   b. Transmission of contact and analog signals to perform their intended tasks.
   c. Any additional testing which may be found necessary at the time the above is observed.

D. Start-up and Operational Testing:

1. The start-up services and Operational Test for the following equipment shall be coordinated with the Department and the Department shall be notified at least two weeks in advance:

a. SCADA System
b. Float Control System
c. Pumping System
d. Combustible Gas System
e. Remote Communications with District 1, EMC Contractor, and IDOT TSC.

2. Shall include detailed step-by-step written description of each test performed, parameters for each test, interlocks and prerequisites for each test, and results of each test preformed and room for initials and date for each witness of test. Testing procedures shall be made available in hardcopy two weeks prior, and also during Operational Testing.
3. Engineer shall be given the opportunity to witness all Operational Testing. Contractor shall coordinate schedules of all parties.

3.5 OPERATIONAL TESTING:

A. Pump operational testing shall verify both manual and automatic modes of operation of equipment confirming flow rates, and electrical characteristics are within equipment manufacturer's recommendations, and shall satisfy contract requirements.

B. Automatic pump operational testing under both modes of control shall be performed based on the rising water and falling water conditions.

C. Operational testing shall include verification of local indication, HMI indication, District 1, IDOT TSC, and at Maintenance Contractor's facility indication.

D. Prior to Operational Testing, the Contractor shall coordinate with the IDOT Maintenance Contractor and complete all work at remote locations at District 1 Headquarters, IDOT TSC, and at Maintenance Contractor's facility.

E. With the H-O-A switch at the MCC in "Hand", each Pump shall be started, stopped, and bumped from the Local Control Station and the MCC individually. Pump time delays shall be tested for accuracy. Flow rates and pump motor current shall be documented during running. All associated pump pilot lights shall be tested for function. All pump interlocks (moisture leak/high vibration, overtemp, overload, etc.) shall be tested on each pump (this may require jumpers installed/removed in electrical circuits or manually initiating the fault condition). Motor protection relays and intended functionality shall be tested during this time. Elapsed time meters, number of starts, voltage meter, and motor current shall be confirmed. Low Flow Pump and one Main Pump shall be run concurrently for testing. Two Main Pumps shall be run concurrently for testing. Testing shall utilize both power sources, including closure of tie breakers upon loss of incoming sources. During testing, Contractor shall assure minimum pump submergence is observed at all times. During pump operational testing, Discharge Gate shall be confirmed closed, and the Recirculation Gate is confirmed open.

F. With the H-O-A switch at the MCC in "Auto", pump operational testing shall include SCADA system with analog level element signals as control variable, and also the float system using hardwired control circuitry. These tests shall be performed separately, then concurrently.

G. SCADA Pump testing shall be performed as follows:

1. Confirm wet-well level is above Low Level Alarm Float Switch, and no pumps are running.
2. Place CONTROL MODE selector switch in "AUTO" mode position.
3. Open Recirculation Gates, RG-01 and RG-02 from the Gate Control Panel and receive confirmation.

4. Close Influent Gates, IG-01 and IG-02 and Discharge Gates, DG-01 and DG-02 from the Gate Control Panel and receive confirmation.
5. Fill water in the wet well to the high water alarm level – Contractor shall supply the water needed for testing and shall also supply make-up water when the tests require discharging into the river.
6. For each rising water level benchmark shown on Drawings, verify operation of respective pump. Verify on/off operation. Verify a maximum of two Main Pumps running at a time for a period no longer than 10 seconds to confirm the control logic. Verify HMI pump sequencer operation. Verify Lead/Lag configuration for both scenarios of pump sequencer. Verify pilot light functionality and SCADA HMI operation for each signal and respective status of equipment.
7. Place Lead Pump in “under maintenance” mode and verify Lag1 Pump Operation. Repeat operation with Lag1 Pump “under maintenance” and repeat operation with Lag2 Pump “under maintenance” and so on till the last lag pump.
8. Force Lead Pump PMPR into alarm (this may require an electrical jumper) and verify Lag Pump Operation. Force Lag1 Pump PMPR into alarm and verify continued operation.
9. Verify analog level sensor accuracy and functionality. Intentionally fail primary level signal and verify SCADA system seamlessly transfers control of pumps to secondary analog level element as level control variable. Repeat in reverse with at least one pump running.
10. Verify wet well High Level alarm. Contractor shall supply water needed to test the high level alarm. (at this point, it is suggested to immediately perform Float System Operational Testing, and then return to this point).
11. Restore the pump station to discharge mode, by closing the gates, RG-01 and RG-02 and opening the gates, IG-01, IG-02, DG-01 and DG-02.
12. For each falling water level benchmark shown on Drawings, verify operation of respective pump. Verify pilot light functionality and SCADA HMI operation for each signal and respective status of equipment.
13. Verify wet well Low Level alarm. Contractor shall provide a temporary portable pump to dewater the wet well to check low level alarm.
14. Verify and document all equipment changes of state with respect to water level during functional testing and submit.
15. Verify all alarms at District 1, IDOT TSC, and at Maintenance Contractor’s facility.
16. During testing, Contractor shall assure minimum pump submergence is observed during their pump operation.
17. Verify Float mode is activated by each of the following events:
    a. High Level Float Activated.
    b. Low Level Float Activated.
    c. Primary and secondary level element failure.
    d. PLC dual-processor Failure.
18. Verify Float mode is deactivated and the PLC reassumes automatic control of pumping operations when CONTROL MODE selector switch is moved to “RESET” and then back to “AUTO” position.
19. Verify alarm condition is the result when CONTROL MODE selector switch is moved to “RESET” position and left there.

H. Float System Pump testing shall be performed as follows:

1. Wetwell Float switch trip levels shall be tested /confirmed during SCADA test (see above) and adjusted to elevations shown on Drawings as required prior to beginning this test.
2. Place CONTROL MODE selector switch in “FLOATS” mode position.
3. Open Recirculation Gates and receive confirmation.
4. Close Influent Gates, IG-01 and IG02 and Discharge Gates, DG-01 and DG-02 and receive confirmation.
5. Fill water in the wet well – Contractor shall supply the water to fill the wet well.
6. For each rising water level benchmark shown on Drawings, verify operation of respective pump. Verify on/off operation. Verify a maximum of two Main Pumps running at a time. Verify pilot light functionality for each signal and respective status of equipment.
7. Put Lead Pump in Fail mode (may require jumper of electrical circuit) and verify next Lag Pump operates at the next Start elevation.
8. Verify wetwell High Level Float alarm. Contractor shall supply the water to fill the wet well to submerge the high level alarm floats.
9. Restore pump station to discharge mode, by closing RG-01 and RG-02 and opening IG-01, IG-02, DG-01 and DG-02.
10. For each falling water level benchmark shown on Drawings, verify operation of respective pump. Verify pilot light functionality for each signal and respective status of equipment.
11. Verify wetwell Low Level Float alarm. Contractor shall provide a temporary portable pump to dewater the wet well to check low level alarm.
12. Verify and document all equipment changes of state with respect to water level during functional testing and submit.
13. Verify all alarms at District 1, IDOT TSC, and at Maintenance Contractor’s facility.
14. During testing, Contractor shall assure that the required minimum pump submergence is observed during pump operation.

I. Analog Level sensors shall be performed as follows:

1. Verify 4-20mA output and respective wet-well level at HMI from empty to full wet-well conditions. Full wet well condition shall not flood pavement.
2. Demonstrate failure of primary level element with bump-less transfer of control to the secondary.
3. Demonstrate alarm condition when either analog level element is outside of the two nearest float switches for a period of more than 30 minutes.

J. Combustible Gas System shall be tested in accordance with manufacturer’s written procedures on testing and calibration.

1. Output relays shall be verified for operation at specified gas testing levels.
2. Pump Station alarms verified.
3. System reset verified.

4. Ventilation System coordinated and tested for functionality (all supply and exhaust fans shall operate during a Combustible Gas System alarm plus an additional 15 minutes via an off-delay timer – exception is the Electrical Control Room ventilation equipment.
5. Verify all alarms at HMI, and District 1, IDOT TSC, and at Maintenance Contractor's facilities.

K. Communications:

1. Verify each alarm represented on Drawings at AEGIS panel is transmitted and received at District 1, IDOT TSC, and at Maintenance Contractor's facilities using primary and secondary means of communications.

L. Additional Testing:

1. Verify each SCADA input and output is tested and verified for functionality, document and submit.
2. PLC's shall be tested for bumpless transfer on primary processor failure.
3. Demonstrate a complete SCADA computer failure (by removing power from computer), with PLC maintaining control of the Pump Station. Resumption of power shall bring each HMI back to their respective "Home" screens.
4. Demonstrate UPS failure for each UPS, and alarming.
5. Demonstrate power failure for each 120Vac power circuit to SCADA panel, and alarming.
6. Demonstrate 24Vdc power supply failure and alarming.
7. Demonstrate "Float Failure" when a float fails to activate. Verify for each wet-well float.
8. Verify Pumps are inhibited from running in Auto with gates confirmed closed.
9. Electrical Systems in accordance with procedures as described in relevant Sections (Fire/smoke detection, AEGIS, Intrusion Switches, Generator, ATS, Surge Protection, Grounding, etc.).
10. Mechanical Systems in accordance with procedures as described in relevant Sections (Supply fans, exhaust fans, dampers, heating, air conditioning, etc.).

M. Final Acceptance

1. Satisfactory operation of the work by the Department shall be interpreted to mean that the work is sufficiently advanced to form a reliable system for system operation; the I/O control loops, software, control programs and peripheral equipment are operating properly; the necessary debugging programs have been performed; data output is reliable and control loops are operational. Equipment which was found to be ineffective or inoperable has been returned or replaced, and checking and calibrating of systems has been completed, and completion of all systems has been accomplished.
2. All punch list items has been resolved to the satisfaction of Engineer.
3. All O&M manuals, Record Drawings, and record documents shall be delivered to and approved by Engineer.
4. All contractual spare parts delivered to Engineer.
5. All training completed or scheduled, if off-site.

6. Final acceptance test will be run for 30 days within which cumulative major component down time, consisting of the computer systems and the PLC's does not exceed 4 hours. Repeat test if 4-hour limit is exceeded.
7. Written acceptance of the entire Project by the Department shall be the start date of the guarantee/warranty period.

3.6 OPERATOR TRAINING:

A. Operator training shall be provided at the Department facility (on-site) concurrently with system installation on a prearranged formalized basis and shall include the necessary training aids in conjunction with actual work on the equipment supplied. Work shall include complete review of all operating and training manuals and physical application. Training shall include project-specific examples.

1. Training shall include operation of the SCADA system, changes of control logic and set-points, initiation of diagnostic routine, set up and revisions of graphic and report format, how to perform system shutdown and restart, etc. It shall also include care and maintenance of the equipment.
2. Upon completion of training, the Operators shall be capable of operating the processor equipment, peripherals and I/O equipment to monitor and control the process, system shutdown and restart, diagnose system failure and to initiate routine switch over procedures and component replacement.
3. This training shall consist of a minimum of 1-day (8 hours total) for 5 persons. Training materials and manuals shall be provided for each participant.

3.7 MAINTENANCE TRAINING:

A. The Contractor shall provide 1-day (8 hours total) maintenance training class for 5 persons. The maintenance training may be combined with the Operator Training.

3.8 VISITING JOB SITES:

A. Prospective bidders are urged to visit the job sites in order to familiarize themselves with the extent and the conditions under which the work must be completed. It is the intent that all work requiring additions, revisions, relocation and/or removals of equipment and facilities be fully included in the original bidding; later claims for extra work will not be approved, occasioned by the failure to comply with this disclaimer.

END OF THIS SECTION

SECTION 40 91 10 - PRIMARY METERS AND TRANSMITTERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Level components.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 40 90 00 - Instrumentation for Process Control: Basic Requirements.
   3. Section 40 90 05 - Control Loop Descriptions.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be included in the Contract lump sum price for the Item, PUMP STATION MECHANICAL WORK.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Gas Association (AGA):
      a. Gas Measurement Committee Report #3.
   2. American Iron and Steel Institute (AISI).
   3. American National Standards Institute (ANSI).
   4. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings.
      b. B31.1, Power Piping.
      c. PTC 19.3, Instruments and Apparatus, Part 3 Temperature Measurement.
      d. PTC 19.5, Application of Fluid Meters, Part 2.
      e. Section II, Part A SA-182, Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      f. Section II, Part A SA-479, Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   5. ASTM International (ASTM):
      a. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A182, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      d. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      e. A276, Standard Specification for Stainless Steel Bars and Shapes.
      f. A479, Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
      g. B16, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for

Use in Screw Machines.
h. B75, Standard Specification for Seamless Copper Tube.
i. B124, Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes.
j. B283, Standard Specification for Copper and Copper-Alloy Die Forgings (Hot- Pressed).
k. B453, Standard Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes.

6. Federal Communications Commission (FCC):
   a. 47 CUFTR 15, Radio Frequency Devices.
7. The International Society of Automation (ISA):
   a. MC96.1, Temperature Measurement Thermocouples.
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
9. US Department of Interior Bureau of Reclamation (USDIBR):
   a. Water Measurement Manual.

1.4 SYSTEM DESCRIPTION

A. The instruments specified in this Specification Section are the primary element components for the control loops shown on the "IC" series Drawings and specified in Specification Section 40 90 05.
   1. These instruments are integrated with other control system components specified under Specification Section 40 90 00 series to produce the functional control defined in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Specification Section 40 90 00.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 LEVEL ELEMENTS

A. Direct Acting Float Switches:
   1. Acceptable manufacturers:
      a. Contegra FS 90.

b. Siemens 9G-EF.
c. Anchor-Scientific Roto-Float.

2. Materials:
   a. Float material: Polypropylene or Teflon coated type 316 stainless steel installed in accordance with manufacturer requirements.
   b. Cable jacket: PVC, neoprene.
   c. Cable mounting clip: Polypropylene or 316 stainless steel installed in accordance with manufacturer requirements.
3. Design and fabrication:
   a. Mercury-based switches shall not be allowed.
   b. Provide switch complete with flexible electrical cables.
   c. SPDT contact rated suitable for intrinsically safe low-energy switching.
   d. Direct acting float switch:
      1) Switch actuates on rising level.
      2) Switch deactuates when liquid falls 1 IN below actuation level.
   e. Terminate cables in junction box. For Class 1, Division 2, Class D hazardous locations, provide intrinsically safe relays in corresponding control panel.
   f. Process temperature: 33 deg F to 80 deg F.
   g. Install floats per Drawing details.
4. Schedule:

TAG NUMBER	SERVICE	CONTACT NO/NC	MOUNTING ELEVATION
LS-101A	East Wet Well	NC	562.50
LS-101B	East Wet Well	NO	563.50
LS-101C	East Wet Well	NO	568.75
LS-101D	East Wet Well	NO	570.75
LS-101E	East Wet Well	NO	572.75
LS-101F	East Wet Well	NO	574.75
LS-101G	East Wet Well	NO	576.75
LS-101H	East Wet Well	NO	578.75
LS-101I	East Wet Well	NO	593.00
LS-102A	West Wet Well	NC	562.50
LS-102B	West Wet Well	NO	564.50
LS-102C	West Wet Well	NO	569.75
LS-102D	West Wet Well	NO	571.75
LS-102E	West Wet Well	NO	573.75
LS-102F	West Wet Well	NO	575.75
LS-102G	West Wet Well	NO	577.75
LS-102H	West Wet Well	NO	593.00
LS-102I	West Wet Well	NO	579.75

B. Ultrasonic Level Sensor and Transmitter (Field Device):
   1. Acceptable manufacturers:
      a. Siemens XPS-10 / Hydroranger-200.
      b. Endress + Hauser FDU90 / FMU90.
      c. Rosemount 3105 / 3491.
   2. Materials:
      a. Sensor wetted parts: PVC, polypropylene, KYNAR or polyvinylidene fluoride (PVDF).
   3. Design and fabrication:
      a. Sensor:
         1) Emits ultrasonic sound.
         2) Detects return echo reflected from surface and converts it to electrical energy proportional to level.
         3) Suitable for momentary submersion.
      b. Temperature compensated.
      c. Capable of being configured to ignore false targets.
      d. Operating temperature: -5º F to150º F.
      e. Humidity: 95 PCT non-condensing.
      f. Transmitter:
         1) Capable of producing output signal proportional to level of 4-20 mA DC into 500 ohm load.
         2) Power supply: 120 VAC (+/-10 PCT), 60 Hz.
         3) Inaccuracy: 0.25 PCT of range or 0.24 IN, whichever is greater.
         4) Resolution: 0.1 PCT of span or 0.08 IN, whichever is greater.
         5) Display: Four-digit LED or LCD scalable to engineering units with selectable decimal point.
         6) Temperature: -5 to 122 DEGF.
         7) Humidity: 95 PCT noncondensing.
         8) Memory: EEPROM(non-volitile).
         9) Keypad programmer.
   4. Schedule:

TAG NUMBER	SERVICE	SPAN
LE-421	Discharge Combination Box Level Sensor	4-20 mA : 0-13 ft : 609.28 – 622.28
LIT-421A	Discharge Comination Box Level Indicating Transmitter (Field Device)	
LIT-421B	Discharge Combination Box Level Indicating Transmitter (Process Indicator Inside SCADA Panel)	

C. Hydrostatic Level Sensor and Transmitter (Field Device):
   1. Acceptable manufacturers:
      a. Siemens LH-300 / Hydroranger-200.
      b. Endress + Hauser FMB53.

c. Rosemount 9790 / 3491.

2. Materials:
   a. Submersible sensor suitable for use in an open vessel type installation.
3. Design and fabrication:
   a. Sensor:
      1) Detects hydrostatic pressure (based on level) within vessel and converts it to electrical energy proportional to level.
   b. Temperature compensated.
   c. Operating temperature: -5º F to150º F.
   d. Humidity: 95 PCT non-condensing.
   e. Transmitter:
      1) Capable of producing output signal proportional to level of 4-20 mA DC into 500 ohm load.
      2) Power supply: 120 VAC (+/-10 PCT), 60 Hz.
      3) Inaccuracy: 0.25 PCT of range or 0.24 IN, whichever is greater.
      4) Resolution: 0.1 PCT of span or 0.08 IN, whichever is greater.
      5) Display: Four-digit LED or LCD scalable to engineering units with selectable decimal point.
      6) Temperature: -5 to 122 DEGF.
      7) Humidity: 95 PCT noncondensing.
      8) Memory: EEPROM(non-volitile).
      9) Keypad programmer.
4. Schedule:

TAG NUMBER	SERVICE	SPAN
LE-411A	East Wet Well Upstream Influent Channel Level Sensor	4-20 mA : 2 – 58.25 ft : 568.75 – 625.00
LIT-411A1	East Wet Well Upstream Influent Channel Level Indicating Transmitter (Field Device)	
LIT-411A2	East Wet Well Upstream Influent Channel Level Indicating Transmitter (Process Indicator Inside SCADA Panel)	
LE-411B	East Wet Well Downstream Influent Channel Level Sensor	4-20 mA : 2 – 67 ft : 560.00 – 625.00
LIT-411B1	East Wet Well Downstream Influent Channel Level Indicating Transmitter (Field Device)	
LIT-411B2	East Wet Well Downstream Influent Channel Level Indicating Transmitter (Process Indicator Inside SCADA Panel)	
LE-412A	West Wet Well Upstream Influent Channel Level Sensor	4-20 mA : 2 – 58.25 ft : 568.75 – 625.00
LIT-412A1	West Wet Well Upstream Influent Channel Level Indicating Transmitter (Field Device)	
LIT-412A2	West Wet Well Upstream Influent Channel Level Indicating Transmitter (Process Indicator Inside SCADA Panel)	

TAG NUMBER	SERVICE	SPAN
LE-412B	West Wet Well Downstream Influent Channel Level Sensor	4-20 mA : 2 – 67 ft :
LIT-412B1	West Wet Well Downstream Influent Channel Level Indicating Transmitter (Field Device)	560.00 – 625.00
LIT-412B2	West Wet Well Downstream Influent Channel Level Indicating Transmitter (Process Indicator Inside SCADA Panel)	

D. Process indicator devices inside SCADA Panel (for level indication and transmission) shall be in accordance with requirements specified in Section 40 90 05.

2.3 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
      b. Mounting brackets:
         1) Standard: 316 stainless steel.
         2) Highly corrosive areas: Aluminum.
      c. Mounting plates, angles:
         1) Standard: Carbon steel.
         2) Corrosive areas: 316 stainless steel.
      d. Instrument pipe stands:
         1) Standard: Hot-dip galvanized 2 IN schedule 40, ASTM A106, Grade B carbon steel.
         2) Corrosive areas: 316 stainless steel.

B. Tubing Support Angles and Brackets:
   1. Any of the following materials are acceptable:
      a. Aluminum support with dielectric material between support and tubing.
      b. Type 316 stainless steel.
      c. Fiberglass.

C. Tubing Tray or Channel:
   1. Aluminum.
   2. Provide dielectric material between tray or channel and tubing.

D. Provide handheld communicator compatible with all intelligent transmitters furnished.
   1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
   2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

E. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install instrument mounting pipe stands level and plumb.

C. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

D. Keep foreign matter out of the system.

E. Remove all oil on piping and tubing with solvent before piping and tubing installation.

F. Plug all open ends and connections to keep out contaminants.

G. Instrument Mounting:
   1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
   2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
   3. Mount instruments level, plumb, and support rigidly.
   4. Mount to provide:
      a. Protection from heat, shock, and vibrations.
      b. Accessibility for maintenance.
      c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

DIVISION 41
MATERIAL PROCESSING AND HANDLING EQUIPMENT

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SECTION 41 22 13 - ELECTRIC OVERHEAD TRAVELING BRIDGE CRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electric overhead traveling bridge crane (EOT-1).

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 09 96 00 - High Performance Industrial Coatings.

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract lump sum price for the Item, BRIDGE CRANE.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. American Society of Mechanical Engineers (ASME).
      a. ASME B30.17 Overhead and Gantry Cranes (Top Running, Single Girder)
      b. ASME B30.16 Overhead Hoists- Underhung.
      c. ASME HST-4 Performance Standard for Overhead Hoists.
   4. American Welding Society (AWS).
      a. AWS D14.1 Welding of Material Handling Equipment.
   5. Crane Manufacturers Association of America, Inc. (CMAA):
      a. 70, Standard Specifications for Electric Overhead Traveling Cranes.
      b. 74, Standard Specifications for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes Utilizing Under Running Trolley Hoist.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).

B. Qualifications:
   1. Welding shall be done by certified welders and shall be in accordance with the AWS standards.
   2. Products used in the work of this section shall be produced by manufacturers regularly engaged in this type of work for a minimum 20 years, with a history of successful production of similar size and working environment as acceptable to the Engineer.
   3. Installer shall employ an adequate number of skilled workman who are thoroughly trained and experienced with the specified requirements and the methods needed for proper performance of the work of this section.

C. Coordinate installation to assure proper operation within the confines dictated by structural, equipment, mechanical and electrical installations.

D. Verify hook and lifting heights for each application to assure each system is completely operational over range intended.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the administration of the submittal process.
   2. Complete material list of all components proposed to be furnished and installed under this Section.
   3. Girder layout including supports, connections and appurtenances.
   4. Stop locations and dimensions from interior building surfaces.
   5. Proposed factory coating system shall meet requirements of Section 09 96 00 and shall be submitted with the shop drawings.
   6. Provide OSHA and any other required certification to the Department prior to the Final Acceptance of the entire project.

B. Load test results and certification.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 STORAGE AND HANDLING REQUIREMENTS

A. Storage.
   1. Store and handle materials in such a manner as to avoid damage. All equipment should be stored and protected in accordance with manufacturer's short-term and long-term storage procedures.

1.6 WARRANTY

A. Bridge crane, hoist, trolley, winches, and ancillary items associated with the bridge

crane system shall be warranted by the manufacturer who shall replace or repair any parts that have failed within a period of twelve (12) months from the date of Final Acceptance of the entire project by the Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bridge cranes:
      a. D.R. Cordell & Associates, Inc.

B. No like, equivalent or "or-equal" item or substitution is permitted without written approval from the Engineer and the substitution meets all requirements of this Specification Section.

C. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

D. The Cordell WWTP Hoist, Model GES20-2050MT with 10 ton capacity is the basis of design for this project. Any changes resulting from a substitution proposed by the Contractor shall be constructed at no additional cost to the Contract.

2.2 MATERIALS

A. Electric Operated Traveling Crane (EOT-01):
   1. Bridge Girders: Steel (painted)
   2. End Trucks: Nickel plated steel.
   3. End Truck Wheels: Stainless steel.
   4. End Truck Bumpers: Rubber.
   5. Runway Festoon: Stainless steel components.
   6. Bridge Crane Festoon: Stainless steel components.
   7. Hoist Frame: Nickel plated steel.
   8. Hoist Wheels: Stainless steel.
   9. Wire Rope Drum: Stainless steel.

10. Wire Rope: Stainless steel.
11. Trolley Pinions: Stainless steel.
12. Wheel Pins: Stainless steel.

2.3 COATINGS

A. Epoxy paint shall be factory applied to all motors, reducers, bridge girder, end truck components, and motor brake enclosures in accordance with Specification Section 09 96 00.

B. Nickel plated and stainless steel surfaces shall not be painted.

2.4 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Electric Operated Traveling Crane (EOT-01):
      a. Type:
         1) Top-running, single bridge beam box girder, dual-drive electric.
         2) Direct drive end trucks.
      b. Rated capacity: 10 tons.
      c. Bridge girder span: 64 FT-6 IN.
      d. Runway shall be 103 FT-0 IN.
      e. End truck drives: Two (2).
      f. End truck drive horsepower: 1.5 HP each drive.
      g. Bridge crane traveling maximum speed: 75 FT/min (VFD).
      h. Hoist horsepower: 30 HP.
      i. Hoist lifting maximum speed: 20 FT/min (VFD).
      j. Hoist lift: 90 FT.
      k. Trolley horsepower: 1 HP.
      l. Trolley travel maximum speed: 35 FT/min (VFD).
      m. Winch horsepower: 1 HP.
      n. Power source: 460 VAC, 3 PH, 60 Hz.
      o. Crane overhead clearance: 3 IN minimum to nearest obstruction.
      p. NFPA 70 Classification for all components: Class I, Division 1 or 2, Group D.

B. Bridge Crane.
   1. General:
      a. Rated capacity for the crane shall be clearly labeled and readable from the operator's level on both the bridge girder and hoist.
   2. Runway Beams and Rails:
      a. Runway beams shall be as shown on the Drawings.
      b. Runway rails shall be 40# ASCE.
      c. Runway beams and rails shall be straight, level and parallel to the travel of the crane.
      d. Sufficient strength and rigidity to prevent detrimental lateral or vertical deflection.
   3. Bridge Girder:
      a. Structural steel from standard structural shapes.
      b. Design girder to resist vertical, lateral and torsional forces and stresses as defined by CMAA #74.

c. The maximum vertical deflection of the girder produced by the dead load, weight of the trolley and hoist and the rated load shall not exceed L/800 of the span.
d. Impact factor due to lifting forces shall be 0.5 PCT of the hoisting speed in FT/min, but not less than 15 PCT or more than 50 PCT.
e. Locate safety stops at each end of bridge girder to prevent over-travel of trolley hoist.

4. Bearings: 5000 HRS ABMA L-10.
5. End Trucks:
   a. Carry crane bridge on end trucks sized to carry the rated load when it is lifted at one (1) end of the crane bridge.
   b. End truck wheelbase minimum of 1/8 of the crane span.
   c. Construct from structural channels welded and bolted into a rigid box section.
   d. Assure proper alignment of axles.
   e. Design so that drop of truck is limited to 1 IN in case of axle or wheel failure.
   f. Equip motorized top-running cranes with rail sweeps which extend below the top of the rail and project in front of the crane wheels.
6. End Truck Wheels:
   a. Wheels shall be designed for a minimum of 16.79 kip per wheel.
   b. Two (2) wheels per end truck of 10 IN diameter shall be provided at a wheel base of 8 FT-0 IN.
   c. Top-running double flanged wheels shall be removable and operate on dual anti-friction bearings with minimum of B-10 bearing life.
   d. Support each wheel on roller bearings mounted on stationary axles suitable to take radial and thrust loads.
   e. Factory lubricate and seal bearings.
   f. Wheels may be heat treated.
7. End Truck Drives:
   a. Provide each end truck with a helical gear motor reducer.
   b. Motors integral with fully-enclosed oil splash lubricated gear reducers.
   c. Support gear reduction shaft by precision ball or roller bearings.
   d. Design motors and drives to supply the crane speed specified.
   e. Permanently lubricate and seal motor ball-bearings.
8. Bridge Brake:
   a. Capable of stopping bridge within a distance in feet equal to 10 PCT of full load speed (in fpm) when traveling at full speed with full load.
9. Bumpers and Stops:
   a. Capable of stopping the crane at a rate of deceleration not to exceed 3 FT per second when traveling in either direction at 20 PCT of rated speed.
   b. Sufficient energy absorbing capacity to stop the crane when traveling at full speed with full load.
   c. Stops designed to resist full load speed.
   d. Locate stops at limit of bridge travel.
   e. Limits of travel shall be as shown on the Drawings.
   f. Runway stops shall not engage wheel treads.

C. Hoist and Trolley:
   1. General:

a. Design load carrying parts, except structural members and gears, so that the calculated stress in the material, based on rated load, shall not exceed 20 PCT of the published average ultimate strength of the material.
b. Hoist shall be rated H3 minimum meeting service classification as defined in ASME HST-4M.
c. Comply with CMAA #70 and CMAA #74.
d. Hoist shall be compatible with the specified bridge crane.
e. Rated capacity for each hoist shall be clearly labeled and readable from the operator's level and shown on the hook block.

2. Trolley.
   a. Trolley shall be motorized for operation on the bridge crane girder.
   b. The trolley shall include a worm drive gear reducer, steel trolley side plates, safety drop lugs and rubber bumpers. The final reduction shall be achieved by a pinion gear with grease lubrication.
3. Hoist Gearing:
   a. All gearing shall include a cast high quality, bronze wheel and hardened ground and polished steel worm. Gears shall be mounted between tapered roller bearings and operate in an oil bath except the final reduction at the wheels.
   b. Comply with AGMA specifications for load ratings.
   c. Gears not enclosed in gear boxes shall be provided with safety guards and provisions for lubrication and inspection.
   d. Gearing shall provide a self-locking, mechanical load braking means.
4. Hoist Motor:
   a. The hoist motor shall be an AC squirrel cage motor especially designed for hoisting service and rated for 30 MIN duty cycle.
   b. C Face motors shall be coupled to the gearbox output shaft with flexible couplings and externally mounted for superior cooling characteristics and ease of maintenance.
   c. Motors shall be provided by a domestic manufacturer and not a proprietary product of the hoist manufacturer.
   d. Motors shall include Class F motor insulation with thermal detectors imbedded in the windings.
   e. Motors shall operate at 1,800 RPM with associated gear reduction to achieve desired operating speed.
5. Hoist Brake:
   a. Hoists are to be supplied with a 3 phase electro-mechanical spring set magnetically opened multiple disc motor brake.
6. Winches:
   a. Provide two (2) 700 LB capacity cable winches to assist with pump cable management. The winches shall be suspended from push trolleys for operation on a separate monorail running parallel with the bridge beam, and be mechanically connected to the hoist trolley for traverse purposes.
   b. Winches shall be rated for the hazardous location and constructed for spark-resistant operation.
   c. Cable winches shall have 65 FT of available lift operating at 15 FPM single speed.
   d. Control for winches shall be via Push Button Station / Radio Control and

integrated with the main control station for the crane and hoist. A selector switch and Up – Down buttons will allow the operator to control winch A or winch B or Both. Winches shall include upper and lower limit switches, motor brake and pressure plate to help maintain uniform winding.

e. Winch shall be used to pick power cable feeding pumps. When lifting pumps, the winches will pick the cable using kellems grips located at points along the length of the cable. Two winches are needed to accommodate the length of cable, and when used together will allow the entire length of cable to be suspended in a festooned configuration.

f. Winch shall also be used to pick the float switch cable for float switch removal or adjustment.

2.5 ACCESSORIES

A. Electrification and Controls:

1. Provide electrical power to the motor-driven hoists and trolleys using the following methods as scheduled:
   a. Festoon track system:
      1) Provide stainless steel trolleys with stainless steel wheels supporting round cable at regular intervals across the bridge crane span.
      2) The track system shall be 14 gage stainless steel.
      3) The system shall be designed for operation in areas with an NFPA 70 classification of Class I, Division 1 or 2, Group D.
      4) Include all components and hardware necessary for a complete installation.
2. Controls:
   a. Enclosure:
      1) Controls shall be mounted in a cast aluminum, NEMA 7 control enclosure designed for a corrosive service environment.
      2) Enclosure shall include a through-the-door manual disconnect, a magnetic mainline disconnect on the bridge panel operated from the push button station, and an external green light indicating power to the panel is on.
      3) Devices shall be mounted to the enclosure backing panel and secured via DIN rail when applicable.
      4) All wiring shall be terminated on terminal strips and run via raceways in the control enclosure.
      5) Stepdown transformers are to be sized accordingly and fused providing 115 VAC control voltage.
      6) Magnetic contactors with electronic soft start control shall be used for single speed operations, and VFD's for all multiple speed operations.
      7) Reversing contactors shall be mechanically and electrically interlocked and operated by a fused 115 VAC control circuit.
   b. AEM (Automatic Exerciser Module):
      1) The AEM will automatically cycle the bridge crane, hoist, trolley, and winches on a weekly basis to keep motors and controls exercised to prevent seizing, corrosion and malfunctions.
      2) The bridge crane, hoist, and trolley need to be positioned in a "home" position detected by sensors mounted on the system. If all are positioned "Home", the AEM will automatically operate the bridge, hoist, and trolley

for short timed distances. Any malfunction during the AEM cycle will cause the cycle to cease.

3) The AEM will provide the ability to field adjust the timed distances of operation from 5 SEC up to 60 SEC. The cycles shall also be adjustable from 1 to 10.
4) Prior to any movement, a horn and beacon will be energized and stay energized during all AEM cycles. Horn and beacon will de-energize when the AEM cycle is complete. Any incomplete cycle or fault will result in beacon remaining energized.

c. Radio Control (Primary):
   1) A Remote Radio Control system shall be provided for primary control of the crane, hoist, trolley and mainline disconnect.
   2) The Remote Radio Control system shall be rated for operation in a Class 1, Division 1 and 2, Group D location.
   3) A selector switch or other means shall be provided on the crane to switch from Push Button to Radio control.
   4) The radio control receiver shall be mounted inside the bridge crane enclosure and be provided with two battery operated transmitters.
   5) Crane equipped with radio control shall include a horn and rotating beacon warning light. The horn is operated by a button in the radio transmitter and the beacon operates when the mainline disconnect is on.
d. Pushbutton Station (Secondary):
   1) The 8 Button Intrinsic Push Button Station shall be rated for NEMA 4X and include a pedant cable allowing the station to hang at 627.83.
   2) Function of each push button shall be clearly marked.
   3) A 14 gauge stainless steel festooned track supported from the parallel mounted hoist shall provide a means to move the push button station from end to end of the hoist.
   4) Trolleys shall be equipped with cable saddles and clamps.
   5) Stainless steel carrier chain shall be festooned between trolleys and be shorter than the flat cable to ensure that chains are pulling the trolleys and not the cable.
   6) The control station shall be suspended from a stainless steel strain chain to relieve load from the pendant cable.
   7) Push button control station shall have intrinsically safe circuits.
   8) Ground pushbutton control station to hoist.
e. Space Heaters:
   1) Space heaters shall be included in crane, hoist, and trolley motors and in control enclosures. Space heater for the motors shall be anti-condensation type with a fixed temp setting. Space heaters for the panels shall be thermostatically controlled. Power to system shall be left on position when system is not in use in order for the space heaters to be effective. When system is in use the space heaters will turn off during use of system.
f. Suspend control station from hoist with a short festoon track along hoist length.
g. Clearly mark function of each button.
h. Suspend pushbutton control station in a manner that will protect the electrical conductors against strain.

i. Pushbutton control station shall be operable from 115 V power supply.
j. Ground pushbutton control station to hoist.

3. Runway Power:
   a. Runway power shall be provided for the lengths of the runways shown on the Contract Drawings. Electrification shall be festoon type and sized based on the maximum system(s) amp draw and calculated voltage loss based on system length. Maximum voltage loss shall not exceed 3 PCT from the power taps to the load at the farthest point on the conductor run.
   b. Power shall be a 14 gage stainless steel festooned track system consisting of multi-conductor flat cables suspended at regular intervals from stainless steel trolleys operating on a rigid stainless steel track mounted parallel to the runway rails shall be provided.
   c. Festoon trolleys shall be equipped with cable saddles and clamps. The ends of each wire are to be prepared and tagged for field connection to the bridge crane and shall include a flat cable connector for adapting to the control panel. Stainless steel carrier chain shall be festooned between trolleys and be shorter than the flat cable to ensure that chains are pulling the trolleys and not the cable.
   d. All wiring shall be in conduit per the electrical conduit schedules on the Drawings.
4. Trolley and Hoist Power:
   a. Power shall be a 14 gage stainless steel festooned system consisting of multi-conductor flat cables suspended at regular intervals from stainless steel trolleys operating on a rigid stainless steel track mounted parallel to the bridge girder shall be provided.
   b. Festoon trolleys are to be equipped with cable saddles and clamps. The ends of each wire are to be prepared and tagged for field connection to the bridge crane and shall include a flat cable connector for adapting to the control panel. Stainless steel carrier chain shall be festooned between trolleys and be shorter than the flat cable to ensure that chains are pulling the trolleys and not the cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in strict accordance with the manufacturer's recommendations.

B. Install runway rails with center-to-center distance and elevation within +1/8 IN.

C. Warning Signs:
   1. Maximum 10 FT intervals along rails with electrical conductors.
   2. Warning sign legend and colors:
      a. DANGER (red).
      b. HIGH VOLTAGE (black).
      c. 480 VAC (black).
      d. KEEP OFF (red).

3.2 FIELD QUALITY CONTROL

A. Test crane using 100 PCT rated load, and demonstrate the operation of the AEM system. Testing shall include system inspection and a load test certificate.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise pre-startup adjustments and installation checks and all field tests.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Maintenance Contractor personnel.
   5. Instruct Maintenance Contractor personnel for 8 HRS during one (1) day at the jobsite on the operation and maintenance of the hoist, trolley, winches, and crane equipment.

C. Touch up all marred or abraded painted surfaces as specified in Section 09 96 00.

END OF SECTION

DIVISION 43
PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

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SECTION 43 21 00 - PUMPING EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pumping equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 09 96 00 - High Performance Industrial Coatings.
   3. Section 43 25 13 - Pumping Equipment: Submersible End Suction Pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ANSI/Hydraulic Institute (ANSI/HI):
      a. 9.6.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.
      b. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
      c. 9.6.6, Rotodynamic Pumps for Pump Piping.
      d. 11.6, Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
      e. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:
   1. BEP: Best Efficiency Point.
   2. NPSH3: Net Positive Suction Head for 3 PCT head loss.
   3. TDH: Total Dynamic Head.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Performance data and curves with flow (GPM), head (FT), horsepower, input kilowatts, hydraulic efficiency, overall efficiency, rotating speed (rpm), BEP, and NPSH3 requirements.
      b. Motor data shall include:
         1) Manufacturer.
         2) Nameplate rated kilowatts (horsepower).
         3) Rated voltage.
         4) Full load rpm.
         5) Efficiency.

6) Full load current.
7) No load current.
8) Full load power factor.
9) NEMA design letter.
10) Locked rotor motor starting inrush current and NEC code letter.
11) Insulation class.
12) Service factor.
13) Recommended starting restrictions, including allowable starts per hour.
14) Recommended maximum KVAR rating of power factor correction capacitors.
15) Class 1, Division 2, Group D rating. FM approved.

c. Pump Nameplate Data shall include:
1) Pump manufacturer name.
2) Pump model and serial number.
3) Nominal size.
4) Impeller code.
5) Impeller diameter.
6) Suction and discharge size.
7) Specific duty conditions.
8) Customer name.
9) Rated rpm and rated HP
10) Max temperature rating.
11) Total weight of pump and motor assembly.

d. Pump accessory data:
1) Pump sensor monitoring system.
2) Deep lift mechanism.
3) Deep lift guide bracket.
4) Cable yoke details.
5) Guide rails.
6) Guide rail brackets (top and intermediate).
7) Pump cable support grips.
8) Pump cable data.

e. Solids passage information.
f. General installation arrangement details and drawings, including dimensions.
g. Anchor bolt and mounting information required for proper installation of the equipment specified.
h. Spare parts list.
i. Shop painting procedure, details of coating system, and color.
j. Warranty information obtained by Contractor to be transferred to the Department upon Final Acceptance of the entire project.

B. Certifications:
1. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
2. Verification of Primary and Secondary design conditions.

C. Test reports:
1. Factory hydrostatic test.

2. Six (6) certified copies of the factory test results for each pump including analysis of test results and any recommendations.

D. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

E. Informational Submittals:
   1. Commissioning Statement:
      a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Maintenance Contractor personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pumps:
      a. See individual pump Specification Section.

2.2 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to:
   1. Shut-off condition.

2.3 ACCESSORIES

A. See Specification Section 43 25 13.

2.4 FABRICATION

A. Pump Support:
   1. Design base to support weight of drive, discharge piping, and pump for each type of installation.
   2. Comply with HI vibration limitations.
   3. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.5 SOURCE QUALITY CONTROL

A. Factory hydrostatic test all pumps at 200 PCT of shut-off head for a minimum of 10 minutes.

B. Provide factory tests:
   1. All units:
      a. Conduct tests in accordance with HI.
         1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per ANSI/HI 14.6 for Rotodynamic Pumps.

2) Shut-off head and design conditions: Positive unilateral performance tolerances meeting Grade 1U per ANSI/HI 11.6 for Rotodynamic Submersible Pumps.

2. All pumps:
   a. Head (FT) versus flow (gpm) pump curves:
      1) Efficiencies along curve.
      2) Brake horsepower along each curve.
      3) Voltage, amperage, KW and Power Factor at each selected point on the curve.
      4) Full color snapshot of the screen taken at each testing point.
   3. Results certified by a registered Professional Engineer.

C. Statically and dynamically balance each pump per ANSI/HI standards.
   1. If specifically required in the individual pump specification sections, field vibration test pumps:
      a. To meet requirements of ANSI/HI 9.6.4 for Rotodynamic Pumps at any point on the pumps and motor.

D. To meet requirements of ANSI/HI 11.6 for Submersible Pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. Equipment Base:
   1. Construct level in both directions.
   2. Take particular care at anchor bolt locations so these areas are flat and level.

D. Grouting:
   1. After machine base has been shimmed, leveled onto equipment base, couplings aligned and mounting bolts tightened to correct torque value, place a dam or formwork around base to contain grouting between equipment base and equipment support pad.
      a. Extend dam or formwork to cover leveling shims and blocks.
      b. Do not use nuts below the machine base to level the unit.
   2. Saturate top of roughened concrete subbase with water before grouting.
      a. Add grout until entire space under machine base is filled to the top of the base underside.
      b. Puddle grout by working a stiff wire through the grout and vent holes to work grout in place and release any entrained air in the grout or base cavity.
   3. When the grout has sufficiently hardened, remove dam or formwork and finish the exposed grout surface to fine, smooth surface.
      a. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout.
      b. When the grout has fully hardened (after a minimum of seven (7) days) tighten

all anchor bolts to engage equipment base to grout, shims, and equipment support pad.

c. Recheck driver-driven unit for proper alignment.

E. Submersible Units:

1. Assemble connecting piping with gaskets in place and minimum of eight (8) bolts per joint installed and tightened.
   a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
   b. Realign as necessary, install flange bolts and make equipment connection.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial start-up of equipment and perform operational checks.
4. Instruct Maintenance Contractor personnel for the specified minimum number of hours at jobsite per Specification Section 43 25 13 on operation and maintenance of pumping equipment.

END OF SECTION

SECTION 43 25 13 - PUMPING EQUIPMENT - SUBMERSIBLE END-SUCTION PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submersible non-clog centrifugal stormwater pumps in a wet pit application.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 03 15 19 – Anchorage to Concrete
   3. Section 09 96 00 - High Performance Industrial Coatings.
   4. Section 26 05 13 – Medium Voltage Cables
   5. Section 26 18 39 – Medium Voltage Motor Starters
   6. Section 26 24 19 – Motor Control Center
   7. Section 40 90 05 – Supervisory Control and Data Acquisition (SCADA) Equipment
   8. Section 43 21 00 - Pumping Equipment: Basic Requirements.

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.
   1. The work specified herein for LOW FLOW PUMP will be measured for payment on a contract unit price basis upon completion and acceptance of a fully-functional LOW FLOW PUMP system.
   2. Provide one (1) identical spare low flow pump assembly with power and control cables to be measured for payment on a lump sum basis upon completion and acceptance.
   3. The work specified herein for MAIN PUMPS will be measured for payment on a contract unit price basis upon completion and acceptance of a fully-functional MAIN PUMP system.
   4. Provide one (1) identical spare main pump assembly with power and control cables to be measured for payment on a lump sum basis.

1.2 BASIS OF PAYMENT

A. The work specified herein for LOW FLOW PUMP shall be paid for at the contract unit

price for LOW FLOW PUMP, which price shall be payment in full for all material, freight, tools, equipment, appurtenances, labor, supervision, testing, and any other items required to complete the work on the LOW FLOW PUMPS.

B. The spare low flow pump shall not be included in the LOW FLOW PUMP unit price work but shall be paid for at the contract lump sum price for the Item, COMPLETE SPARE LOW FLOW PUMP ASSEMBLY.

C. The work specified herein for MAIN PUMPS shall be paid for at the contract unit price for MAIN PUMPS, which price shall be payment in full for all material, freight, tools, equipment, appurtenances, labor, supervision, testing, and any other items required to complete the work on the MAIN PUMPS.

D. The spare main pump shall not be included in the MAIN PUMPS unit price work but shall be paid for at the contract lump sum price for the Item, COMPLETE SPARE MAIN PUMP ASSEMBLY.

1.3 QUALITY ASSURANCE

A. Pumps shall meet quality assurance standards outlined in Section 43 21 00.

B. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American National Standards Institute (ANSI).
   3. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
   4. FM Global (FM).
   5. Hydraulic Institute (HI):
      a. Standards for Centrifugal, Rotary and Reciprocating Pumps.
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   7. National Fire Protection Agency (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 500, Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2.
   8. Underwriters Laboratories, Inc. (UL).
      a. 62, Flexible Cord and Fixture Wire.

1.4 SYSTEM DESCRIPTION

A. The pump station includes two (2) low flow pumps and ten (10) main pumps installed in a mirrored wet well arrangement with one (1) low flow pump and five (5) main pumps on each side. The pumps are isolated in individual pump chambers with flow conditioning elements around the inlet of each pump. The flow conditioning elements were physically modeled and are detailed on the plans.

B. One (1) identical spare Low Flow Pump and one (1) identical spare Main Pump shall be provided and stored in the pump station as indicated on the plans.

C. Provide single source coordination responsibility through the pump manufacturer for the entire system including but not limited to the following:
   1. Pumps.
   2. Motors.

3. Discharge base elbows.
4. Discharge base elbow anchor bolt sizing and placement.
5. Pump monitoring system.
6. Pump lifting mechanism with guide frame including cable yoke and kellems grips.
7. Guide rails.
8. Guide rail intermediate and upper brackets.
9. Transportation and storage support frame assembly for each size of pump.

1.5 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the administration of the submittal process.
   2. Requirements in Specification Section 43 21 00.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 04 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Executed Manufacturer's Installation Certification Form
   1. See Specification Section 01 33 00 for requirements for the administration of the submittal process.

1.6 DELIVERY, STORAGE AND HANDLING

A. Per Section 01 65 50.

1.7 COORDINATION

A. Contractor shall coordinate with the equipment specified in Division 26 and Division 40 and perform any necessary work to interface between the pumps and electrical system to provide a fully-operational system.

1.8 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair, any part or parts returned to it, which examination shall show to have failed under normal use and service by the user within sixty (60) months of the date of Final Acceptance of the entire Project by the Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Flygt.

B. No like, equivalent or "or-equal" item or substitution is permitted without written approval of the Engineer and the substitution meets all requirements in this Specification Section.

C. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Pumps:
   1. Pump case: Cast iron, ASTM A48, Class 35B.
   2. Motor housing: Cast iron, ASTM A48, Class 25 or Class 30.
   3. Impeller: ASTM CD4MCuN Duplex Stainless Steel.
   4. Shaft:
      a. Stainless steel, ANSI, Series 300 or 400.
      b. Type 316 stainless steel shaft sleeve.
   5. Wear Surfaces: Hardened Stainless Steel wear rings with the stationary ring harder than the rotating ring. Suction cover: Cast Iron, ASTM A-532.
   6. O-rings: Nitrile (Buna-N) or fluorocarbon (Viton).
   7. Fasteners: Type 316 stainless steel.
   8. Lower ring seal: Tungsten-carbide both faces or Silicon Carbide both faces.
   9. Upper ring seal: Tungsten-carbide both faces or carbon and ceramic or carbon and Ni-resist.
   10. Seal metal parts: Stainless steel.

B. Wet Pit Accessories:
   1. Guide rails: Type 316 Stainless steel.
   2. Base elbow: Cast iron, ASTM A48, Class 35.

2.3 EQUIPMENT

A. Pump Performance and Configuration Requirements:

PARAMETER	**LOW FLOW PUMPS** (LFP-01 and LFP-02)	**MAIN PUMPS** (MP-01 thru MP-10)
Shutoff Head	115 FT to 120 FT	80 FT to 85 FT
Primary Design Condition		
Flow	7,000 GPM	22,555 GPM

PARAMETER	LOW FLOW PUMPS (LFP-01 and LFP-02)	MAIN PUMPS (MP-01 thru MP-10)
Head	64 FT	62.5 FT
Minimum Hydraulic Efficiency	75 PCT	85 PCT
Flow Relative to BEP	95 PCT to 105 PCT	95 PCT to 110 PCT
Maximum NPSH3	22 FT	24 FT
Secondary Condition		
Flow	8,400 GPM	29,000 GPM
Head	49 FT	38 FT
Minimum Hydraulic Efficiency	70 PCT	72 PCT
Flow Relative to BEP	130 PCT	140 PCT
Maximum NPSH3	30 FT	36 FT
Suction Diameter	13.78 IN	31.5 IN
Discharge Diameter	14 IN	24 IN
Minimum Solids Passage Diameter	3 IN	4.9 IN
Motor requirements		
Voltage	480 VAC	4160 VAC
Phase	3-phase	3-phase
Frequency	60-Hz	60-Hz
Rated Operating Speed	1185 RPM	715 RPM
Service factor	1.15	1.15
Minimum motor efficiency at the Design Condition	92.5 PCT	94.5 PCT
Minimum power factor at full load	80 PCT	81 PCT
Maximum nameplate horsepower	150 HP	440 HP
Drive Type	Constant speed	Constant speed
Minimum Starts Per Hour	15	15
Ambient conditions		
Water maximum temperature	80 DEGF	80 DEGF
Air maximum temperature	90 DEGF	90 DEGF

2.4 COMPONENTS

A. General:
   1. Provide pumps capable of handling screened stormwater.
   2. Pumps shall be capable of sustaining full reverse runaway speed without damage.
   3. Submersible motors shall be capable of operating pumps over the entire range of the published pump curve's operating conditions without overloading and without using the service factor.

B. Impeller:
   1. Provide enclosed, solids-handling type, dynamically-balanced impeller in accordance with HI standards.
   2. Provide impeller and volute wear rings as necessary to promote efficient sealing between volute and impeller.
   3. Impeller shall be keyed to the shaft, retained with an expansion ring.

C. Shaft:
   1. Design shaft for a maximum deflection of 0.002 IN at the lower seal as calculated at the design condition.

D. Mechanical Seal:
   1. Seal shaft with double mechanical seals running in an oil filled chamber.
   2. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring.
   3. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion resistant tungsten-carbide seal ring.
   4. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
   5. Hold interface in contact by its own spring system.
   6. Seal lubricant shall be non-hazardous.

E. Bearings:
   1. The pump shaft shall rotate on at least three grease-lubricated bearings.
   2. The upper support bearing, provided for radial forces, shall be a single roller bearing and shall have an insulated outer ring to provide protection against potential bearing damage from electrically induced currents that can be created. The outer ring shall have a plasma-spray technique or oxide-ceramic coating that provides an insulating barrier between the bearing face and the bearing housing of the pump.
   3. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust.
   4. Support shaft on upper and lower permanently lubricated bearings with a minimum ABMA L-10 life of 100,000 HRS.

F. Motors:
   1. Provide pump with FM rated NEMA B motor approved for explosion-proof atmospheres rated as Class 1, Division 2 Group D.
   2. Provide NEMA B induction type motor with a squirrel cage rotor, shell-type design of totally submersible design without loss of watertight integrity to a depth of at least
      65 FT, constructed with epoxy or poly-seal encapsulated windings, air-filled or dielectric oil filled, with Class H insulation rated for 180 DEGC and rated for continuous duty operation.
   3. The stator shall be insulated by the current-UV-dip impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95 PCT.
   4. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals.
   5. A pump memory module shall be provided and mounted in the junction chamber to record pump run time, number of starts as well as contain the motor unit performance and manufacturing data and service history.

6. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.
7. Motor shall be capable of running continuously in an unsubmerged condition while pumping under load without damage to motor or seal.
8. The motor horsepower provided shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through runout.
9. The motor shall be designed and assembled by the same manufacturer as the pump.
10. The motor of the pumps shall be provided with cooling jacket and cooled by the pumped liquid. The impeller back vanes shall pump the cooling liquid with a velocity of at least 1.6 ft/s to avoid sedimentation of small particles in the cooling system. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. Two cooling liquid return ports shall be provided. The internals to the cooling system shall be non- clogging by virtue of their dimensions. The cooling jacket shall be equipped with two flanged and bolted inspection ports of not less than 4"Ø located 180° apart. The cooling system shall provide sufficient cooling for continuous operation whether the pump is submerged in the pumped media or surrounded by air in liquid or ambient temperatures of up to 40 DEGC.
11. Cooling system will provide sufficient cooling for the entire range of pump operating speeds.

G. Cable Entry Seal:
1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.
2. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function.
3. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be acceptable.

H. Power Cables:
1. Provide single power cable which is listed and labeled per NEC requirements and approved for the installation shown on the Drawings. The cable and markings shall conform to NEC requirements and indicate size, listing agency, and suitability for the installation.
2. Power cables shall be intended for use with submersible pumps and for submerged installations.
3. Size cables in accordance with applicable NFPA 70 specifications.
4. The cable shall be multi-conductor type with stainless steel braided shielding, a chlorinated polyethylene rubber outer jacket and tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs.

5. The Low Flow Pump power cable shall be rated for 600 Volts and 90 DEGC (194 DEGF) with a 40 DEGC (104 DEGF) ambient temperature and shall be approved by Factory Mutual (FM).
6. The Main Pump power cable shall be rated for 8.7/15kV and 90 DEGC (194 DEGF) with a 40 DEGC (104 DEGF) ambient temperature and shall be approved by Factory Mutual (FM).
7. Provide minimum length of power cable and control cable to extend from the pump, through the yoke support, up to the support kellems grip and ultimately land in the pump cable termination box.
8. Provide each cable with a strain relief, cord grip, and explosion proof seal installed in accordance with NFPA 70, Article 500.
9. Each pump shall have a single cable connected to it. This cable shall contain both the power and control leads.

I. Temperature Monitors:
1. Three (3) thermal switches shall be installed in the windings, one for each phase of the motor.
2. One (1) PT-100 type thermal probe shall be installed in the stator to provide monitoring of the stator temperature.
3. One (1) thermal sensor shall monitor the lower bearing housing temperature.
4. Should high motor temperature be sensed in the windings, the thermal switch will open, shut the pump down, and generate an alarm signal. Should any one of the thermal switches detect high temperature, it will automatically reset once the stator temperature returns to normal.
5. Should high lower bearing temperature be sensed, the sensor shall generate an alarm signal and shut the pump down.
6. Set temperature of the temperature monitors not higher than 90 PCT of insulation temperature rating.

J. Leak Detection.
1. Two (2) mechanical float switches shall be mounted in the junction chamber to signal if there is water intrusion.
2. Voltage-sensitive solid state leak detection sensors shall not be acceptable.
3. If water is detected inside the seal chamber or the stator chamber, a switch will send out an alarm signal to alarm and to stop the pump. Should more than one pump fail due to over-temp or seal leak, the first pump shall be removed from the sequence of operation. The subsequent pumps, that fail, shall continue to run by SCADA overriding the seal leak and/or over-temp condition of the pump motor protection relay, as shown on the Electrical plans.

K. Coatings:
1. Wet pit applications: Factory applied polyamidoamine epoxy system to the exterior of the pump casing and motor housing shall be as specified in Specification Section 09 96 00.
2. Contractor shall touch-up paint any areas damaged or marred during shipping and delivery of pumps as specified in Specification Section 09 96 00.

L. Pump Guide Bracket and Guide Rails:
1. Provide sliding guide bracket integral to pump unit which properly aligns the pump discharge with the discharge connection elbow for watertight seal during pumping.

2. The pump guide bracket shall guide the pumping unit down the guide rails to the base discharge elbow by guide rail(s).
3. Each pump shall be supplied with two stainless steel guide rails. Guide rails shall be sized to fit the discharge base and the pump guide bracket.
4. The guide rail(s) shall not support any portion of the weight of the pump.
5. Pump shall be designed to allow for removal without entering the wet well and without removal of bolts, nuts or other fastenings.
6. Pump unit shall connect to discharge elbow with a simple downward motion without rotation. The entire weight of the pumping unit shall wedge tightly against the discharge elbow flange forming a seal without the use of bolts, gaskets, or O-rings.
7. Provide lower guide rail bracket and discharge elbow connection which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.
8. No portion of the pump shall bear directly on the floor.

M. Guide Rail Upper and Intermediate Support Brackets:
1. Upper and intermediate guide rail brackets shall be of Type 304 stainless steel construction that will attach to a 24 IN and 36 IN DIA discharge piping for the Low Flow Pumps and Main Pumps, respectively.
2. The upper guide rail bracket shall provide support and align the guide rails at the operating floor level.
3. Intermediate guide rail brackets shall be furnished by the pump vendor at vertical spacing required to stiffen the guide rails and prevent twisting of the guide rails.
4. Guide rail fasteners shall be Type 304 stainless steel.

2.5 ACCESSORIES

A. Deep Lift Cable Yoke:
1. A cable yoke shall be provided for each pump supplied, including spare pumps.
2. The lifting bail on each cable yoke shall be designed to support the entire weight of the pump during vertical lift.
3. Cable yokes shall be ASTM A240 Type 316 Stainless steel with welds meeting AWS D1.6 standards.
4. All fasteners and other hardware on the cable yoke shall be stainless steel.
5. Cable yokes shall be supplied with one Kellems grip per cable potted at the top of the pump.
6. Provide all necessary cable clamps and shackles required for a complete installation.

B. Cable Support System:
1. The cable floor support bracket shall be stainless steel and shall be capable of supporting the entire cable weight for one pump from the cable support flange.
2. Floor cable supports shall be installed on top of the walkway platform for each pump.
3. Floor cable supports shall be secured using stainless steel anchor bolts as sized by the manufacturer.
4. Provide all necessary U-bolts, clamps, cord connectors, strain relief, cable support flanges, and Kellems grips required for a complete installation.
5. All fasteners and other hardware on the cable floor support shall be stainless steel.

6. Provide three (3) additional stainless steel Kellems grips per cable to hang additional cable loop and to provide intermediate cable pick points.

C. Pump Retrieval/Installation Mechanism.
   1. Provide one (1) “Deep Lift” Lifting System per pump size supplied, as manufactured by Xylem/Flygt, for remote submersible pump retrieval and installation.
   2. The lifting mechanism shall automatically engage and disengage the lifting bail on the pump be designed for the capacity of the pump, cable yoke, cables, and guide bracket in vertical lift.
   3. Lifting mechanism shall provide positive indication of lifting pin engagement by a red/green marker.
   4. Each Deep Lift Mechanism shall be provided with a guide bracket to position the Deep Lift Mechanism over the pump’s lifting bail.
   5. Each guide bracket shall be provided with counter weights, counter weight stoppers, and guide stoppers.
   6. The Deep Lift Lifting System and all accessories shall be stainless steel.

D. Pump Monitoring System:
   1. Install two (2) monitoring system central units for the station. Install (1) monitoring base unit per pump installed.
   2. The pump monitoring system shall consist of:
      a. Pump electronic module (PEM) installed in each pump.
      b. Central unit containing configuration and analysis tools, embedded webpages, and base unit terminal connections
      c. Base unit containing a computing processor, memory, and sensor terminal connections.
      d. Two (2) 7” graphical operator panel to enable users to interface with the central unit.
      e. No separate control cable shall be required.
   3. The pump monitoring system shall monitor and record internal pump sensor measurements. The system shall be capable of outputting an alarm to SCADA and of stopping the pump if an abnormal condition is observed, if desired by the end user.
   4. Alarm and operating data shall be stored on the pump monitoring system central unit and base unit.
   5. Each base unit and central unit shall operate on 24 V power.
   6. Each base unit shall have the following connections:
      a. Central Unit:
         1) 24 VDC supply
         2) RS-485 Modbus Slave
         3) Memory USB type A Connection
         4) LAN RJ45
         5) RJ45 connection for HMI
         6) DEVICENET Connection between central unit and base unit
      b. Base Unit:
         1) 24 VDC supply
         2) Twisted pair connection to PEM

3) (1) Digital input for manual alarm, reset, or FM thermal status
4) RS-485 Modbus slave
5) DEVICENET Connection between central unit and base unit
6) Go Relay normally closed
7) Alarm Relay normally open

7. PEM unit shall have built in 3-axis MEMS vibration sensor

E. Controls:
1. See Electrical Design for electrical requirements.
2. Coordinate with LV MCC supplier for Low Flow Pumps and with MV MCC for Main Pumps and provide the following for proper setting of the motor protection/overload relays in the respective MCCs:
   a. Pump Motor Curves
   b. Complete Motor Data
   c. Recommended Overload settings
   d. Recommended current and voltage unbalance settings
   e. Recommended under current/under power setting
3. Coordinate with LV MCC supplier for Low Flow Pumps and with MV MCC for Main Pumps for installation of the pump motor over temperature and moisture leak relay, its display panel, current transformer, and other necessary equipment for the selected pumping equipment. Coordinate and provide the equipment and its wiring scheme for installation in the respective motor control center sections. The display panel, reset button and any data jacks that are required to access the data from this relay shall be installed on the door, so that they can be accessed without opening the motor control center door.
4. Coordinate and provide the ability to accept override signal from SCADA to override the moisture leak and/or overtemperature relay and operate the pump.

2.6 SPARE PARTS

A. Two (2) sets of the following spare parts shall be provided for both the Main Pumps and Low Flow Pumps:
1. Mechanical seals - upper and lower.
2. Cable entry grommets.
3. Motor Bearings.
4. Wear Rings.

B. A complete set of special wrenches, spanners, eyebolts and other special tools shall be furnished sufficient to completely dismantle and reassemble each kind and size of pumping unit. Tools shall be forged steel, case hardened, full finished, and furnished with a metal tool case with a handle and provision for padlocking.

2.7 SOURCE QUALITY CONTROL

A. Factory Pump Testing:
1. Pump testing shall measure and record head pressure (FT) versus discharge flow (GPM) for all pumps being provided as specified in Specification Section 43 21 00.
2. Detailed factory test procedures shall be submitted prior to testing. Contractor shall notify the Engineer at least 21 days before the commencement of the factory tests.
3. Factory tests shall be performed on each pumping unit, including spare pumps, in

accordance with the test code of the current Hydraulic Institute, except as modified herein. The pumps shall be tested in the position that they will be installed.

4. Tests shall be conducted at rated speed to determine the curves of head, electric input kilowatts, and overall efficiency, wire to water, as a function of capacity. A minimum of six points shall be taken, including shutoff. One point shall be as near as possible to each specified condition of head and capacity and the remaining points at capacities necessary to provide a uniform distribution of data. Capacity shall be expressed in gallons per minute and head shall be expressed in feet. Raw test data, calculated results and sufficient information for computation and plotting of the curves shall be submitted to the Engineer with the certified shop test curves.
5. Performance Curves Submittal:
    a. Curves shall be color coded and drawn to such scale that values can be read accurately within 1 PCT.
    b. The efficiency curves submitted shall constitute a guarantee within 1 PCT on the scale, for all deliveries between 3/4 rated capacity and 1-1/4 rated capacity.
    c. The primary and secondary design points shall be identified on the performance curve of each pump submitted.
    d. The performance curve, efficiency curve, horsepower curve, input kilowatt curve, and NPSH curve shall be displayed on a single page using a common x- axis parameter of flow in GPM.
6. All tests shall be witnessed by the manufacturer by a Registered Professional Engineer registered in the State of Illinois. The witnessing Registered Professional Engineer shall sign and seal each copy of the curve and test data sheets. Six (6) copies of the certified test curves along with the certified drive unit test data, shall be furnished to the Engineer for approval.
7. Shipment of the pumping units shall not be made until the factory and witness test data and curves are submitted to and approved by the Engineer.
8. In addition to the hydraulic test, the pump manufacturer shall perform the following factory witness tests on each pump before shipment from factory:
    a. Impeller, motor rating and electrical connections shall first be checked for compliance with the Specifications.
    b. Motor and power cable insulation shall be tested for moisture content or insulation defects with a mega-ohm meter.
    c. Winding resistance factory test for pump motors.
    d. Moisture and temperature detector factory tests and describe acceptance and rejection criteria.
    e. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
    f. Describe tests acceptance and rejection criteria.
    g. The pump shall be run for 30 minutes submerged, a minimum of 6 FT. under water.
    h. After operational test and hydraulic test, the moisture and temperature detector tests as described in Paragraph 2.6.A.8.d and the insulation test Paragraph

2.6.A.8.b shall be performed on each pump again and readings shall be recorded. A written report, stating the foregoing steps have been done, shall be included with the certified test reports.

i. Each pump shall be subjected to a hydrostatic test and certification of the hydrostatic test shall be provided. The hydrostatic pressure shall, in any case, not be less than 200 PCT the shut-off pressure of the pump as shown by the characteristic curve. The minimum test duration time shall be 10 minutes.

j. Certified test reports shall be submitted to the Engineer within two weeks from the completion of the tests. The results shall be certified that the equipment supplied meets the contract requirements.

9. Factory witness test expenses:
   a. The Contractor shall pay all expenses for two representatives of the Department to travel to and from the testing facility and witness the factory tests.
   b. The Contractor shall coordinate with the manufacturer to ensure that the pumps are prepared for testing before the Department representatives arrive at the facility.
   c. The Contractor shall notify the Engineer of a scheduled test date two months prior to said date and shall arrange an exact date not less than two weeks prior to the test.
   d. If, for any reason, any pump requires re-testing; the Contractor shall pay all expenses for two representatives of the Department to travel to and from the testing facility and witness the factory re-tests.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 43 21 00.

B. Permanently install discharge connection elbow in wet well along with discharge piping.

C. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

D. Low voltage MCC supplier, medium voltage switchgear supplier, and SCADA integrator to coordinate with pump manufacturer's MAS 711 controller for installation in panels and display mounting and I/O integration.

3.2 FIELD QUALITY CONTROL

A. See Specification Section 43 21 00.

B. Field Test:
   1. After installation of the pumping units, control equipment and all appurtenances, each unit (including spare main pump and spare low flow pump) shall be subjected to a field running test under actual operating conditions.
   2. Written test procedures shall be submitted two weeks prior to field testing.
   3. The field test wetwell water level shall be at the elevation of the Lead Main Pump ON set point level for all pumps, including the low flow pumps.

a. Water provided for the pump field tests shall be the responsibility of the Contractor.
b. Adequate water volume shall be provided to maintain a constant water level in both wet well halves during the test, including the volume in the discharge piping, discharge channels, and recirculation piping. Coordinate with water required for SCADA testing procedures.
c. Contractor shall legally discharge or dispose of water after the testing is complete.

4. Field tests shall be performed in the presence of and as directed by the Engineer.
5. Tests shall demonstrate that under all conditions of operation each unit:
   a. Has not been damaged during transportation or installation.
   b. Has been properly installed.
   c. Has no physical or mechanical defects.
   d. Has been properly connected.
   e. Is free of overheating of any parts.
   f. Is free of overloading of any parts.
   g. Verification of pump shaft rotation in proper direction.
   h. The pump shall be free of any vibration and cavitation.
6. Hand, off, auto, lead/lag, bump mode of each pump shall be tested from local control station, SCADA panel, and MCC to demonstrate that the pumps and control system operate as specified. Any defects in the equipment or failure to meet the requirements of the Specifications shall be promptly corrected.
   a. Each pump operates as expected at specified levels for on/off operation based on SCADA entered level variable data.
   b. Each pump operates as expected at specified levels for on/off operation based on ball float level switches.
   c. Each pump shall be tested to verify rated flow.
   d. Verify that each pump does not operate from local control station and or from MCC when hand-off-auto switch is in off position.
   e. Each pump start and stop operates as expected manually from MCC and from local control station located at grade level.
   f. Each pump is sequenced as expected for rising and falling water levels in the wet well (this shall be a real water test, and Pump operation may be simulated by not allowing pump to actually run in order to accomplish testing).
   g. Every possible pump auto sequence of each pump shall be tested for lead/lag/standby for rising and falling water levels based on SCADA controls.
   h. Every possible pump auto sequence of each pump shall be tested for lead/lag/standby for rising and falling water levels based on hard wire float mode through float switches.
7. The following shall be checked on start-up:
   a. Current draw and voltage on all legs of each pump shall be observed and recorded to see if there is any imbalance.
   b. Megga-ohm meter testing shall be performed and record reading on each pumps.
   c. Winding resistance test for each phase shall be performed and recorded for each pump.
   d. Pump controls and terminations shall be checked.

e. At a minimum, each pump shall be run in recirculation a minimum of 30 minutes, including all spare pumps.
f. Moisture and temperature detector tests and record results on each pump.
g. Each PLC I/O point shall be verified for proper operation. Analog signals shall be simulated with multimeter at 0,4,8,12,16, and 20 mA levels. Results of I/O checkout shall be witnessed by Engineer. A sign-off sheet shall be generated for each I/O point.

C. Initial Startup and Training.
1. Following successful installation and field testing, the Contractor shall furnish services of the equipment manufacturer's field service representative for one (1) trip of two (2) days to:
a. The services of a qualified representative of the manufacturer shall be provided to instruct on proper installation of the equipment, inspect the completed installation, make any necessary adjustments, participate in the startup of the equipment, participate in the field testing of the equipment, place the equipment in trouble-free operation, and instruct operating personnel in its operation and maintenance.
b. Startup services shall be coordinated with the Department at least one week in advance.
c. Instruct Maintenance Contractor's personnel per Section 01 75 00 for 8 HRS per day at jobsite on operation and maintenance of the equipment.

END OF SECTION

DIVISION 46
WATER AND WASTEWATER EQUIPMENT

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SECTION 46 21 11 - MECHANICAL SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Climber-type mechanically cleaned screens.

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 65 50 – Product Delivery, Storage and Handling
   3. Section 03 15 19 – Anchorage to Concrete
   4. Section 26 24 19 – Motor Control Centers
   5. Section 40 90 05 – Supervisory Control and Data Acquisition (SCADA) Equipment

C. Progress payments will be in accordance with Section 109 of the Standard Specifications.

D. Mechanical equipment specified under this section will be considered 80% complete once “Substantially Complete”, corresponding O&M manuals have been approved by the Engineer, training has been provided to the Department, and O&M manuals have been delivered for each pay item. Substantial Completion is defined as the time at which the Work (or a specified part thereof) specified herein has progressed to the point where, in the opinion of the Engineer, the Work (or a specified part thereof) specified herein is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) specified herein can be utilized for the purposes for which it is intended. Equipment will not be considered 100% complete for each corresponding pay item until Final Acceptance by the Engineer, all incomplete works have been addressed, spare parts have been delivered, Record Drawings have been approve and delivered, and all outstanding issues have been completed.

1.2 BASIS OF PAYMENT

A. The work specified herein shall be paid for at the contract lump sum price for the Item, MECHANICAL SCREEN.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
   3. American Welding Society (AWS).
   4. Steel Structures Painting Council (SSPC).

B. Qualifications:
   1. Supplied by a single manufacturer or supplier.
   2. Manufacturer shall have a minimum of 20 reciprocating rake bar screens with pin rack and cog wheel drive systems of similar size and configuration installed and in

operation in the United States of America within the past 10 years.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Scaled floor plan and sections showing dimensions, weights, structural supports, embedments, clearances, and screen discharge interface.
   3. Schematics, internal wiring diagrams, panel front and internal layouts, field interconnection drawing
   4. Description of project-specific controls and alarming operation.
   5. Bill of materials providing technical descriptions
   6. Model numbers
   7. Minimum screenings lifting capacity.
   8. Minimum gear reducer output torque.
   9. Installation list.

B. Certified factory and field lift test reports.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 PROJECT CONDITIONS

A. Location:
   1. Storm water screening facility.
   2. Open channel interior location.

B. Exposures:
   1. Corrosive environment due to moisture:
      a. Partial submergence.
      b. Splashing.
      c. Potential hydrocarbon gases.

C. Area Weather Conditions:
   1. Operating temperature range: 35 to 80 DEGF.
   2. Relative humidity range: 25 to 100 PCT.

1.6 WARRANTY

A. The equipment supplier shall warrant that its equipment shall be free from defects in material and workmanship; and that it will replace or repair any part or parts which have failed within 12 months from the date of Final Acceptance of the entire Project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are

acceptable:
1. Climber screens:
   a. Vulcan Industries.

B. No like, equivalent or "or-equal" item or substitution is permitted without written approval of the engineer and the substitution meets all of the requirements outlined in this Specification Section.

C. The Vulcan Model Severe Duty Mensch Crawler Screen is the basis of design for this project. Any changes resulting from a substitution proposed by the Contractor shall be constructed at no additional cost to the Contract.

D. Request for Substitution:
   1. In general, exceptions to and deviations from the requirements of the Contract Documents will not be allowed. It is the Contractor's responsibility to note any deviations from Contract requirements at the time of submittal and to make any requests for deviations in writing. In general, substitutions must demonstrate that the proposed substitution is superior to the equipment or material required by the Contract Documents. No exceptions, deviations, or substitutions will be permitted without approval.
   2. Data for items to be submitted for review as substitution shall be collected into one submittal for each item of material or equipment.
   3. Request shall be submitted with other scheduled submittals for the material or equipment allowing time for Engineer to evaluate the additional information required to be submitted. If Contractor requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, the substitution submittal request shall be included in Submittal schedule and submitted as scheduled.

2.2 MATERIALS

A. Climber Screens SRN-01 and SRN-02:
   1. Anchor bolts: 304 stainless steel.
   2. Rake assembly: 304 stainless steel.
   3. Wiper assembly: 304 stainless steel.
   4. Dead plate: 304 stainless steel.
   5. Discharge apron: 304 stainless steel.
   6. Side frames: 304 stainless steel.
   7. Cog wheels: AISI 1045 steel, minimum 50 R.C.
   8. Shafting: 304 stainless steel.
   9. Meshing pin rack: ANSI 316 stainless steel.
   10. Pin rack assembly: ANSI 316 stainless steel.
   11. Pin rack bolts: 304 stainless steel.
   12. Bushings: ANSI 316 stainless steel (molydisufide coated).
   13. Rollers: ANSI 316 stainless steel (molydisufide coated).
   14. Fixed Roller Track: 304 stainless steel.
   15. Safety Cage: 304 stainless steel.
   16. Rake shelf: 304 stainless steel.
   17. Fasteners: 304 stainless steel.
   18. Screen enclosure: None.

19. Main control panel: 304 stainless steel.

2.3 COATINGS

A. Stainless steel and plastic components shall not be painted. The stainless steel structural components shall be passivated after fabrication to remove embedded iron, surface rust and weld burn.

B. All non-stainless steel surfaces shall be blast cleaned to an SSPC-SP6 finish, removing all dirt, rust, scale and foreign materials.

C. Cleaned surfaces shall be shop primed with one (1) coat of Tnemec 69-1212 primer, or equal, to attain a minimum dry film thickness of 2.5 mils. The motor, gear reducer and controls shall have manufacturer's standard paint finish and the motor and gear reducer shall be painted the same color.

2.4 EQUIPMENT

A. Performance and Configuration Requirements:
   1. Climber screens SRN-01 and SRN-02:
      a. Number of Screens: Two (2).
      b. Flow:
         1) Maximum flow rate: 202 MGD (140,000 GPM) each.
         2) Minimum flow rate: 10 MGD (6,940 GPM) each.
         3) Average flow rate: 75 MGD (52,000 GPM) each.
      c. Channel width: 9 FT-7 IN each.
      d. Elevations (FT above mean sea level):
         1) Channel bottom: 566.75.
         2) High water level: 593.67.
         3) Operating floor: 624.83.
         4) Screen room ceiling: 662.00.
         5) Discharge apron top: 634.50.
         6) Discharge apron bottom: 631.92.
      e. Bar clear spacing: 1-1/2 IN.
      f. Operating speed (low): 20 FPM.
      g. Operating speed (high): 40 FPM.
      h. Bar size: 1/2 IN x 4 IN.
      i. Bar shape: Rectangular.
      j. Screen incline: 80 DEG from horizontal.
      k. Number of Motors: Two (2) each.
      l. Motor Power: 2.5/5.0 HP (2-speed).
      m. Minimum rated lifting capacity, excluding weight of rake: 150 LB/FT of rake.
      n. Screen shall not deform with a head differential up to 24 inches.

2.5 ACCESSORIES

A. Access Panels.
   1. Two sets of access panels shall be provided on each side frame to allow personnel to remove and replace the guide shaft rollers and drive shaft rollers without the need to remove the rake assembly from the side frames.
   2. Conduit field installation shall not impede access panel removal.

3. Local Control Panels.
4. Main Control Panels.

2.6 FABRICATION

A. General.
   1. Provide assembly consisting of:
      a. Bar rack.
      b. Traveling rake assembly.
      c. Scraper arm.
      d. Frame assembly.
      e. Drive units.
      f. Appurtenant equipment.
   2. Design mechanism to automatically remove solids from the bar screen and deposit them onto the discharge apron as shown on the Drawings.
   3. Design so that all routine maintenance to the mechanism can be accomplished at operating floor level.
   4. Provide single front cleaning rake assembly operated upstream of bar rack.
      a. Removable in one piece without disassembly of frame.
   5. Provide with positive overload protection against an object too large to bypass:
      a. Motor cutout on high torque.
      b. Excess rotation of rake carriage during overload to actuate magnetic limit switch and deactivate unit.
   6. Mechanism shall be capable of manual reverse operation for removal of oversized objects.
   7. Equipment designs which rely solely on shear pin failure and replacement for overload protection, designs utilizing chains, sprockets, threaded stems, hydraulic cylinders, cables or multiple rakes, designs where screening operation in automatic terminates due to limit switch failure, and designs requiring motor reversal other than for emergency conditions, are explicitly excluded by this Specification.
   8. Factory assemble unit prior to shipment. Screens shall be shipped in complete frame sections that can be bolted together on site to create a single, full-depth screen. Each screen shall consist of no more than four (4) sections.
   9. Bar rake, rake arm, drive motors, and rake stabilizer are the only operating parts allowable to be intermittently or permanently below water surface.

B. Side Frames:
   1. The side frames shall be formed from plate with a minimum of four engineered bends to provide a rigid assembly capable of withstanding all operating forces when installed in accordance with manufacturer's instructions.
   2. The frame shall be manufactured of plate having a minimum thickness of 3/8 IN. The frame shall have a minimum width of 40 IN and extend fully from the bottom of the channel to the top of the bar screen assembly.
   3. Each side frame shall include a fixed roller track to guide and position the rake assembly. Separate roller tracks shall be provided for the drive shaft rollers and the guide shaft rollers.
   4. The side frames shall be provided with precision bolted splices as required for transportation and installation into the screening facility. The splices shall consist

of 3/8 IN thick plates matching the side frame profile. The splice plates and side frames shall be manufactured with mating holes that shall allow the frame sections to be securely fastened together in the field. The quantity and location of side frame splices shall be coordinated between the manufacturer and the installing contractor.

C. Bar Rack and Dead Plate:
   1. The mechanical screen shall be provided with a removable bar rack consisting of equally spaced, parallel bars.
   2. Each bar shall be provided with an arced gusset, constructed of rectangular bars, at the bottom of the bar rack which allows the raking mechanism to engage the bottom most portion of the bar rack prior to reaching the inclined section of the rack. Bar racks that are not provided with arced gussets are not acceptable.
   3. Fasten bars top and bottom.
   4. Bar racks requiring a recess in the bottom of the flow channel shall not be allowed.
   5. Extend bar rack from channel bottom to 8 IN minimum above maximum depth of water in channel.
   6. Provide 1/4 IN thick dead plate continuous from top of bar rack to operating floor.

D. Rake Assembly:
   1. A dual arm rake assembly shall be provided to remove the collected debris from the bar rack. The rake assembly shall consist of fixed upper rake arms and spring-loaded, lower rake arms that pivot to permit movement over lodged or excessively large objects during the raking cycle. Each upper and lower rake arm shall be connected through a two-pin linkage system.
   2. The rake assembly shall be driven by a pair of cogwheels that are specially machined to mesh with a fixed pin rack. A drive shaft and guide shaft, outfitted on each end with rollers, shall travel in fixed roller tracks to position the rake assembly. The guide shaft shall be located below the drive shaft for stability. All shafting shall be of the highest quality in conformance with ASTM specifications.
   3. Provide positive method of holding rake against bar rack during cleaning operation and positive method of holding mechanism away from barricade during re-entry.
   4. Rake shelf must articulate a minimum of 4 IN out of plane of travel and out over discharge during wiping operation.
   5. Furnish design where upper return is controlled by hydraulic shock absorbers. Designs using counterweighted wiper arms and rubber bumpers for shock absorbers are not allowed.
   6. Obstruction to travel:
      a. Four bar linkage rotates rake when traveling into or out of channel.
      b. Rake rotation permits rake shelf to climb over obstruction then remesh with rack to continue cleaning.
      c. Rake rotation permits cog wheels to travel around lowest point of pin rack if grit or debris is encountered during downward travel.
      d. The rake shall be protected from overrotation by the action of the rake arm activating the overrotate limit switch. When the overrotate limit switch is activated, the forward operation will stop. After a short pause, the rake will be reversed for a fixed amount of time and stop. The forward operation will start again. If the cause of the overrotate condition has been cleared, operation will

continue. If the cause of the condition is still present after the first reversal, the rake can enter the reversal mode for two additional attempts before an overrotate condition is generated for SCADA. A total of three attempts total can be performed.

7. Provided with positive overload protection:
   a. High torque motor cutout.
   b. Excess rake rotation actuates magnetic limit switch.

E. Wiper Assembly:
1. A pivoting wiper mechanism shall be positioned at the point of discharge and shall have a replaceable ultra high molecular weight polyethylene (UHMW) wiper blade.
2. During each cycle, the wiper blade shall contact the rake head at its inner surface during upward travel and shall scrape the debris off the end of the rake head and through the discharge chute. The entire wiper mechanism, including the wiper arms, shall be fully contained inside the framework of the bar screen.
3. No moving parts of the wiper mechanism shall extend beyond the framework or the discharge apron.
4. The design shall be such that the rake repositions the wiper mechanism. The wiper mechanism design shall allow the rake assembly to be operated in reverse, through the wiper mechanism, without the need to manually lift the wiper assembly.
5. The grease fittings for the wiper arms shall be extended and secured to the side frames in an area where they can be easily accessed by plant personnel.
6. Shock absorbers shall be provided to cushion the release of the wiper during high-speed operation.

F. Discharge Apron:
1. Provide fully shrouded apron from discharge point to the midline of screenings dumpsters. Elevation of the bottom of the apron shall be as specified above.
2. Apron shall be located at the top of the dead plate and positioned at a 45 degree angle from horizontal.
3. Apron shall be fabricated having a minimum thickness of 1/8 IN plate.

G. Drive Assembly:
1. Each bar screen shall be provided with an integrated drive assembly consisting of dual, fully submersible, explosion-proof, TENV, two-speed electric motors with spring-set motor brakes and gear reducers, rake assembly mounting brackets and one pair of drive cogwheels. The travel speed of the rake assembly shall be a nominal 20 FT per minute. The two-speed drive shall allow the rake assembly to travel at a nominal 20 FT per minute at low speed and 40 FT per minute at high speed.
2. Provide drive assembly including a helical bevel gear type gear reducer coupled to a flange mounted electric motor with an electro-mechanical disc brake or inherent self-stopping gear. Bevel shall be of alloy steel with teeth precision ground and polished after casehardening. Worm gears are not allowed.
3. Gear reducers shall have ball or roller bearings throughout with all moving parts immersed in oil.
4. All ball or roller bearings shall be rated and manufactured by a member of the Antifriction Bearing Manufacturer's Association. At least one bearing on each shaft shall be of the combined radial and thrust type.

5. Gear reducer units shall meet the standards of the American Gear Manufacturers Association for such equipment under moderate shock, 24-hour service with a minimum service factor of 1.25.
6. The output capacity of the gear reducer shall be equal to the motor horsepower less reducer losses at the rated service factor.
7. Shafts shall be of high strength alloy steel ground to required tolerances.
8. The motors shall be UL rated for operation in Division 1, Class 1, Group D environment. The motor shall be a minimum 5.0 horsepower with a service factor of 1.15. Electrical characteristics shall be 230/460 volt, 3 phase, 60 Hertz, Class F insulation, continuous duty rated. Motor shall be fully submersible to a water depth of 30 FT.
9. Drive assemblies using fan-cooled motors contained within external motor enclosures are specifically excluded and shall not be allowed.
10. Motor must operate continuously in forward direction during normal operation, motor reversal and/or stopping during the wiping operation is not acceptable.

H. Cog Wheels:
   1. Two per screen.
   2. Cogwheels shall be pitched to match the pin rack rollers and shall have a nominal diameter of 10 IN. The cogwheels shall be of the involute gear type. Standard sprockets shall not be acceptable.

I. Pin Rack:
   1. Provide pin rack design meeting following minimum requirements:
      a. Rollers and bushings free to rotate on pin bolts to reduce wear between pin rack and cog wheels.
      b. The bar screen shall be provided with a stationary pin rack on each side of the frame. The pin rack shall consist of individual rollers and bushings attached with threaded fasteners to facilitate easy removal without requiring removal of the rake or drive assembly.
      c. Pin, bushing and roller diameter shall conform to ANSI standards.
      d. The rollers and bushings shall be coated with a molydisulfide compound which is heat cured to eliminate metal to metal sliding friction between the roller and bushing. The coating process shall exclude the need for periodic lubrication of the pin rack components.
      e. Pin bolts shall have a minimum diameter of 9/16 IN.
      f. Pin rack designs which require the application of periodic lubrication, or which do not conform to ANSI standards shall be specifically excluded.
      g. Welded chain gear racks not acceptable.
      h. Separate channel tracking for all guide rollers.
      i. Do not utilize side frame flange as roller bearing surface.
      j. Sections individually removable for maintenance or replacement.

J. Pin Rack Lubrication System:
   1. A pin rack lubrication/cleaning system shall be mounted to the rake assembly to allow for periodic lubrication and/or cleaning of the pin racks.
   2. The system shall comprise of an air/oil reservoir, air fill fitting, oil fill fitting, safety relief valve, manual ball valve, pressure gauge, hoses, nozzles and fittings.
   3. The system shall allow personnel to lubricate and/or clean the pin racks from the

operating floor without the need for ladders or scaffolding.

4. The system shall require manual filling of the reservoir with non-toxic lubricating oil or cleanser as well as manually charging the reservoir with air. Air supply shall be supplied by others.

2.7 MAINTENANCE MATERIALS

A. Spare Parts:
   1. Furnish the Department the following spare parts:
      a. Two (2) proximity switches.
      b. Two (2) guide shaft roller bearings.
      c. Two (2) drive shaft roller bearings.
      d. One (1) set of brake discs and spring kit.
      e. One (1) full-width wiper blade.
      f. Two (2) cogwheels.
      g. 20 FT of pins, rollers, and bushings for the pin rack.
   2. All spare parts shall be properly packed in a wooden box, labeled, and stored as directed by the Engineer.

2.8 CONTROLS

A. Local Controls:
   1. One (1) NEMA 7 frame-mounted end of travel proximity switch to park the rake assembly at the top of the bar screen following completion of the cleaning cycle.
      a. Proximity switch shall be single pole, double throw (SPDT) and rated not less than 10 amps at 120 volts AC.
   2. One (1) NEMA 7 rake-mounted proximity switch to prevent damage to the rake assembly when the rake encounters an obstruction that causes excessive rake arm rotation.
      a. Proximity switch shall be single pole, double throw (SPDT) and rated not less than 10 amps at 120 volts AC.
   3. One (1) NEMA 7 local control station with forward-off-reverse and hand-off-auto switches and a mushroom head EMERGENCY STOP push-button.
      a. The forward-off-reverse switch shall be spring return from REVERSE to OFF.
      b. The electrical components on the bar screen shall be pre-wired to the local control station.
      c. The local control station shall be shipped loose and mounted on the side frame by the Contractor.

B. Main Control Panel:
   1. Furnish one (1) main control panel for each bar screen. The main control panel shall be totally enclosed, front access type with top/side/bottom entry. All controls shall be manufactured by a U.L. listed control panel facility and shall bear a U.L. label.
   2. Construction of the main control panel shall be NEMA 4X construction with indicating devices and switches mounted on the front door.
   3. Main control panel wiring shall be neatly cabled and supported in nonflammable wiring raceways. Wiring shall be minimum 16-gauge MTW stranded wire.
   4. The main control panel wiring shall contain all power and control devices shown on the drawings (wiring diagrams), which for the bar screen shall include, but not

be limited to the following:

a. One (1) control power ON-OFF selector switch.
b. One (1) green pilot light for “Screen Run” indication.
c. One (1) red pilot light for “Motor Overload/Overtemp” indication.
d. One (1) red pilot light for “Over Torque” indication.
e. One (1) red pilot light for "Over Rotate" indication.
f. One (1) white pilot light for control power.
g. One (1) momentary “Reset” push-button for over current/over rotate reset.
h. Spare contact for remote indication of screen “Motor Overload/Overtemp“ condition.
i. Spare contact for remote indication of “Over Torque” condition.
j. Spare contact for remote indication of "Over Rotate" condition.
k. Spare contact for remote indication of "Screen Run" condition.
l. Spare contact for remote indication of "Not In Auto" condition.
m. One (1) adjustable repeat cycle timer mounted on DIN rail to automatically initiate operation of the bar screen.
n. Control relays, wiring and circuitry required to implement the control logic.
o. One (1) full voltage, NEMA rated, two-speed reversing starter. The magnetic starter shall be of the heaterless design and provide phase loss protection, short circuit self-protection and thermal memory. The solid-state overload shall be self-powered.
p. One (1) circuit breaker.
q. One (1) 480 VAC to 120 VAC step down control power transformer.
r. One (1) current sensing relay. The current sensing relay shall continuously monitor the motor current to prevent damage to the drive assembly due to a jam obstruction or system malfunction.
s. Screen controls shall accept Run signals from SCADA to run the screens in low and high speeds.
t. One (1) surge arrestor to protect the control circuitry.
u. One (1) elapsed time meter.
v. One (1) annunciator horn.
w. One (1) motor/brake heater.

C. Contractor shall coordinate with MCC supplier and provide minimum circuit ampacity and maximum overcurrent setting in the MCC for the selected mechanical Screens.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field verify channel dimensions prior to fabrication.

3.2 INSTALLATION

A. Vertically and horizontally align, level and plumb units into position.

B. Install discharge over midline of garbage dumpsters supplied by others.

C. Install screen frame on 1 IN thick grout pad at the channel invert and at side frame anchor plates.

3.3 FIELD QUALITY CONTROL

A. Factory Test.
   1. The screen shall be factory assembled and factory run-tested. The main control shall also be factory tested. The main control panel shall also be factory tested with the equipment prior to shipment.
   2. Factory test results shall be assembled into a report that is transmitted to the Engineer. Engineer's approval of the factory test results shall be obtained prior to shipment of equipment to the site.

B. Field Test:
   1. Following installation, Contractor shall furnish services of the equipment manufacturer's field service representative for one (1) trip of two (2) days to:
      a. Inspect equipment covered by this Specification.
      b. Supervise pre-startup adjustments and installation checks.
      c. Conduct initial start-up of equipment and perform operational checks.
      d. Local and remote controls operations and alarming shall be field verified and tested as well as the start/stop signaling between SCADA and the screens in the presence of the Engineer.
      e. Conduct performance tests as follows to verify the lifting capacity of each bar screen:
         1) Operate screen mechanism at a minimum speed of 20 fpm with an imposed load of 1,000 LBS minimum, not including the weight of the rake carriage.
         2) Lift load from the bottom of the channel to a point at the top of the bar rack.
         3) Reverse screen, returning the loaded rack arm to the channel floor.
         4) Repeat for 20 cycles, during which time the structural support members will be checked for deflection or evidence of wear or undue stress to the screen components.
         5) If screen fails test, then:
            a) Modify unit until passes test.
            b) Replace unit with heavier duty model.
      f. Confirm that the rake teeth properly engage the bar rack along the length of the bar rack, that the rake assembly can pivot over debris that is 4 IN in height at the base of the bar rack without jamming, and that the screen can be run continuous for 4 HRS without overheating.
      g. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation.
   2. Staff Training:
      a. Following successful installation and field testing, the Contractor shall furnish services of the equipment manufacturer's field service representative for one (1) trip of two (2) days to:
         1) Instruct Maintenance Contractor's personnel per Section 01 75 00 for 8 HRS at jobsite on operation and maintenance of the equipment.

END OF SECTION

CHAIN LINK FENCE REMOVAL

Description:
This work shall consist of the removal and disposal of existing fence (regardless of type or method of installation) at the locations shown on the plans and as directed by the Engineer. The removal shall include the removal of the fence, posts, post foundations, fittings, gates and accessories.

All holes left by the removal of the fence posts and post foundations shall be filled with crushed stone screenings. The furnishing and placement of the crushed stone screenings will not be paid for separately but shall be considered as incidental to fence removal.

The existing fence shall be carefully removed and properly disposed of. Any part of the fence that is damaged that is not called for to be removed shall be replaced at the Contractor's expense.

All salvageable material shall become the property of the Contractor, and the value of the salvageable material shall be reflected in the unit price.

Method of Measurement:
This work will be measured for payment in lineal foot along the top of the fence from center of post to center of post.

Basis of Payment:
This work will be paid for at the contract unit price per lineal foot for CHAIN LINK FENCE REMOVAL. The price shall include all labor, materials, and equipment necessary to complete the work described herein and as shown in the plans. No additional compensation will be allowed.

BOLLARD REMOVAL

Description:
This work shall consist of the complete removal of existing bollards as specified herein, as shown on the plans, and as directed by the engineer.

In addition, any post foundations, cable wires along with all connectors, and related appurtenances shall be removed, disassembled, and disposed of off-site.

Backfill shall be performed in accordance with the applicable portions of Section 208 of the Standard Specifications.

The contractor shall reflect any salvage value of the steel in the unit price of this pay item.

Method of Measurement:
This work will be measured for payment in units of each at the location designated on the plans.

Basis of Payment:
This work shall be paid for at the contract unit price per each for BOLLARD REMOVAL. The price shall include any necessary excavation, backfill, disposal of materials, labor, equipment, and materials to complete the work described herein. No additional compensation will be allowed.

FILL EXISTING STORM SEWERS

Description:
This work shall consist of plugging and filling existing storm sewers as required to construct the pipe abandonment as shown on the plans.

The ends of the pipe shall be securely sealed as described in Section 605 of the Standard Specifications.

The ends of the storm sewer shall be excavated, if necessary, to the bottom flow line and to a minimum of 6 inches inside the barrel of the pipe. The inside of the storm sewer at the excavated ends shall be cleaned of all earth and debris to the satisfaction of the Engineer.

The Contractor shall construct a suitable plug at the opening of the storm sewer consisting of mortared concrete masonry blocks or a Class SI Concrete plug.

The cost of cleaning and plugging pipe ends will not be paid for separately but will be considered as included in the contract unit price for FILL EXISTING STORM SEWERS.

The controlled low-strength material used to fill the storm sewer and the filling operation will be in accordance with Section 593 of the Standard Specifications.

Method of Measurement:
This work will be measured in place and the volume computed in cubic yards.

Basis of Payment:
This work will be paid for at the contract unit price per cubic yard for FILL EXISTING STORM SEWERS.

REMOVE IMPACT ATTENUATORS, NO SALVAGE

Description:
This work shall consist of the complete removal of existing impact attenuators (ALL BARRELS) and their base. This work shall be in accordance with the applicable portions of the Standard Specifications and Supplemental Specifications, as shown in Highway Standard detail 643001-02, the plans and as modified herein.

Method of Measurement:
This work will be measured in units of EACH. All barrels and their base will be considered as one unit.

Basis of Payment:
This work shall be paid for at the contract unit price per EACH for REMOVE IMPACT ATTENUATORS, NO SALVAGE. All labor and materials required to complete this work, including, but not limited to, removal of the existing attenuator & base shall be included for payment under this item.

TEMPORARY CONCRETE BARRIER (TO REMAIN PERMANENTLY)

Description:
This work shall consist of leaving temporary concrete barrier and its appurtenances, including barrier wall reflectors and anchoring hardware, installed at the locations specified in the Plans or as directed by the Engineer, to remain in place at the end of the contract and become property of the Illinois Department of Transportation. The furnishing, placement, and maintenance of the temporary concrete barrier and appurtenances prior to the end of the contract shall be in accordance with the applicable portions of Section 704 of the Standard Specifications. The Engineer will be the sole judge in determining whether the condition of the temporary concrete barrier to remain permanently is acceptable prior to transfer of ownership to the Illinois Department of Transportation.

Method of Measurement:
This work will be measured for payment in feet in place along the centerline of the barrier.

Basis of Payment:
When the temporary concrete barrier is relocated to its final position, this work will be paid for at the contract unit price per foot for TEMPORARY CONCRETE BARRIER (TO REMAIN PERMANENTLY).

PINNING TEMPORARY CONCRETE BARRIER

Description:
This work shall consist of furnishing, installing, maintaining, and removing anchoring pins for securing temporary concrete barrier to the supporting pavement, and restoration of the pavement after removal. Six anchoring pins shall be used to secure each section of temporary concrete barrier at locations described in the plans. Installation and materials shall be in accordance with Articles 704.02 and 704.04 of the Standard Specifications.

Method of Measurement:
This work will be measured for payment as each. Each will be defined as one anchoring pin installed.

Basis of Payment:
This work will be paid for at the contract unit price per each for PINNING TEMPORARY CONCRETE BARRIER.

TEMPORARY CONCRETE BARRIER, TERMINAL SECTION (SPECIAL)

Description:
This work shall consist of connecting temporary concrete barrier to an existing concrete bridge parapet as shown on the plans.

Method of Measurement:
This work will be measured in place in units of EACH for TEMPORARY CONCRETE BARRIER, TERMINAL SECTION (SPECIAL).

Basis of Payment:
This work will be paid for at the contract unit price per EACH for TEMPORARY CONCRETE BARRIER, TERMINAL SECTION (SPECIAL).

CHAIN LINK FENCE AND GATES, 8' (SPECIAL)

Description:
This work shall consist of constructing chain link fence, gates, and accessories according to Section 664 of the Standard Specifications, except as noted below.

The fence and gates shall include barbed wire and shall be installed as shown on the plans, as well as per section 1006.28 (b) of the standard specifications. Where applicable, fence shall be mounted on a concrete retaining wall per the details shown on the plans.

Method of Measurement:
CHAIN LINK FENCE, 8' (SPECIAL) will be measured for payment in feet, along the top of the fence from center to center of end posts, excluding the length occupied by gates.

CHAIN LINK GATES (SPECIAL) will be measured for payment in place for each.

Basis of Payment:
This work will be paid for at the contract unit price per lineal foot for CHAIN LINK FENCE, 8' (SPECIAL). CHAIN LINK GATES (SPECIAL) will be paid for at the contract unit price per each of the size specified on the plans.

SPECIAL DRAINAGE STRUCTURES

Description:
This work shall consist of construction of manholes and catch basins with frame and cover, at the specified locations, in conformance with the plans, standard details and Standard Specification Section 602, except as noted.

Precast concrete structures for manholes and catch basins specified in the plans must be designed to support a 45,000 pound live load distributed over an 18" x 18" area.

Frames, covers, and grates must be rated for a minimum 45,000 pound live load. Acceptable frames and grates are listed below.

- 36-inch Frame & Grate
  - EJ Group, Inc. Product Number 001580033W01
  - Neenah Foundry Company Catalog Number R-3492-C
  - Approved Equal
- 24-inch Frame & Grate
  - Neenah Foundry Company Catalog Number R-3492-1
    - Open grate
  - EJ Group, Inc. Product Number 00287038A01
    - Frame: 1900ZPT
    - Grate: 2870M
  - Approved Equal

Method of Measurement:
This work will be measured in place in units of EACH for CATCH BASIN, TYPE C, WITH SPECIAL FRAME AND LID and MANHOLE, SPECIAL.

Basis of Payment:
This work will be paid for at the contract unit price per EACH for CATCH BASIN, TYPE C, WITH SPECIAL FRAME AND LID and MANHOLE, SPECIAL. The price shall include the frame and cover.

STORM SEWER (WATER MAIN REQUIREMENTS)

Description:
This work consists of constructing storm sewer adjacent to or crossing a water main, at the locations shown on the plans.

Materials:
The material and installation requirements shall be according to the latest edition of the "Standard Specifications for Water and Sewer Main Construction in Illinois", and the applicable portions of Section 550 of the Standard Specifications, which may include concrete collars and encasing pipe with seals if required.

Pipe materials shall meet the requirements of Sections 40 and 41-2.01 of the "Standard Specifications for Water and Sewer Main Construction in Illinois" except PVC pipe will not be allowed. Ductile-Iron pipe shall meet the minimum requirements for thickness class 50.

Encasing of standard type storm sewer, according to the details for water and sewer separation Requirements (vertical separation) in the Standard Drawings, division of the Standard Specifications for Water and Sewer Main Construction in Illinois, may be used for storm sewers crossing water mains.

Method of Measurement:
This work will be measured for payment, complete in place and accepted, in units of feet.

Basis of Payment:
This work will be paid for at the contract unit price per foot, for STORM SEWER (WATER MAIN REQUIREMENTS) of the diameter specified, which price shall include all labor, equipment, tools and incidentals necessary to complete the work as specified.

EROSION CONTROL BLANKET
This Special Provision revises Section 251 of the Standard Specifications for Road and Bridge Construction to eliminate the use of Excelsior Blanket for Erosion Control Blanket.

Delete Article 251.04(a) Excelsior Blanket.

FAILURE TO COMPLETE PLANT CARE AND ESTABLISHMENT WORK ON TIME

Should the Contractor fail to complete the plant care and/or supplemental watering work within the scheduled time frame as specified in the Special Provision for "Tree Planting" and "Supplemental Watering", or within 36 hours notification from the Engineer, or within such extended times as may have been allowed by the Department, the Contractor shall be liable to the Department in the amount of $50.00 per tree/per day, not as penalty but as liquidated damages, for each calendar day or a portion thereof of overrun in the contract time or such extended time as may have been allowed.

In fixing the damages as set out herein, the desire is to establish a mode of calculation for the work since the Department's actual loss, in the event of delay, cannot be predetermined, would be difficult of ascertainment, and a matter of argument and unprofitable litigation. This said mode is an equitable rule for measurement of the Department's actual loss and fairly takes into account the loss of the tree(s) if the watering or plant care is delayed. The Department shall not be required to provide any actual loss in order to recover these liquidated damages provided herein, as said damages are very difficult to ascertain. Furthermore, no provision of this clause shall be construed as a penalty, as such is not the intention of the parties.

A calendar day is every day shown on the calendar and starts at 12:00 midnight and ends at the following 12:00 midnight, twenty four hours later.

PLANTING WOODY PLANTS

This work shall consist of planting woody plants as specified in Section 253 of the Standard Specifications with the following revisions:

Delete Article 253.03 Planting Time and substitute the following:

Spring Planting. This work shall be performed between March 15th and May 31st except that evergreen planting shall be performed between March 15th and April 30th in the northern zone.

Add the following to Article 253.03 (a) (2) and (b):

All plants shall be obtained from Illinois Nurserymen's Association or appropriate state chapter nurseries. All trees and shrubs shall be dug prior to leafing out (bud break) in the spring or when plants have gone dormant in the fall, except for the following species which are only to be dug prior to leafing out in the spring:

- Maple (Acer spp.)
- Buckeye (Aesculus spp.)
- Serviceberry (Amelanchier spp.)
- American Hornbeam (Carpinus caroliniana)
- Hackberry (Celtis occidentalis)
- Hawthorn (Crataegus spp.)
- Black Walnut (Juglans nigra)
- Liriodendron tulipifera (Tuliptree)
- Crabapple (Malus spp.)
- Black Tupelo (Nyssa sylvatica)
- American Hophornbeam (Ostraya virginiana)
- Cherry (Prunus spp.)
- Oak (Quercus spp.)
- Baldcypress (Taxodium distichum)
- American Linden (Tilia americana)

Fall Planting. This work shall be performed between October 1st and November 30th except that evergreen planting shall be performed between August 15th and October 15th.

Planting dates are dependent on species of plant material and weather. Planting might begin or end prior or after above dates as approved by the Engineer. Do not plant when soil is muddy or during frost. No plant material shall be installed prior to the final grade of the planting soil. Trees must be installed first to establish proper layout and to avoid damage to other plantings.

Add the following to Article 253.05 Transportation:

Cover plants during transport. Plant material transported without cover shall be automatically rejected.

Delete the third sentence of Article 253.07 and substitute the following:

The Contractor shall be responsible for all plant layout. The layout must be performed by qualified personnel. The planting locations must be laid out as shown in the landscape plan. This will require the use of an engineer's scale to determine some dimensions. The tree locations must be marked by staking, and bed limits must be painted. The Engineer will contact the Roadside Development Unit at (847) 705-4171 to approve the layout prior to installation. Allow a minimum of seven (7) days prior to installation for approval.

Delete Article 253.08 Excavation of Plant Holes and substitute the following:

Protect structures, utilities, sidewalks, knee walls, noise walls, fences, pavements, utility boxes, other facilities, lawns and existing plants from damage caused by planting operations.

Holes for trees shall be dug at the location indicated by the marking stakes. Holes for shrubs shall be dug within the marked outline of the planting bed. The spacing of plants will be designated on the plans. Spacing shall be measured form center-to–center, and alternate rows shall be staggered.

Excavate with sides vertical, bottom flat but with high center for drainage. Deglaze sides. The planting hole shall be twice the diameter of the root ball if possible, but in no case shall the hole be less than twelve (12) inches wider. Any soil covering the tree's root flair shall be removed to expose the crown, along with any secondary root growth, prior to planting. Remove all excavated subsoil from the site and dispose as specified in Article 202.03. The excavated material shall not be stockpiled on turf or in ditches.

Delete the third and fourth paragraphs of Article 253.10 Planting Procedures and Article 253.10 (a) and substitute the following:

Trees, shrubs, and vines shall be thoroughly watered with a method approved by the Engineer. Approved watering equipment shall be at the site of the work and in operational condition PRIOR TO STARTING the planting operation and DURING all planting operations OR PLANTING WILL NOT BE ALLOWED.

Set plants in the excavated hole with top of ball 2 to 3 inches above finished grade. Add soil as required under ball to achieve plumb. Remove all burlap and wire baskets from top three quarters (3/4) of the root ball. The remaining burlap shall be loosened and scored to provide the root system quick contact with the soil. All ropes or wires shall be removed from the root ball and tree trunk.

The hole shall be half (1/2) filled with soil, firmly packed, then saturated with water. After the water has soaked in, more soil shall be added to the top of the hole, and then the hole shall be saturated again. Maintain plumb during backfilling. Visible root flair shall be left exposed, uncovered by the addition of soil. By mounding up the soil around the hole, create a saucer depression around the tree to hold future water. In most cases, the backfill around the root ball shall be the same soil that was removed from the hole. Where rocks, gravel, heavy clay or other debris are encountered, clean top soil shall be used. Do not backfill excavation with subsoil.

Delete Article 253.11 and substitute the following:

Within 48 hours after planting, mulch shall be placed around all plants in the entire mulched bed or at the base of each tree to its dripline specified to a depth of 4 inches (100 mm). No weed barrier fabric will be required for tree and shrub planting.

The mulch shall consist of wood chips or shredded tree bark free not to exceed two (2) inches in its largest dimension, free of foreign matter, sticks, stones, and clods. A sample and request for material inspection form must be supplied to the Engineer for approval prior to performing any work.

Care shall be taken not to bury leaves, stems, or vines under mulch material. The mulch shall be pulled away 6" from the tree trunk, allowing the root flair at the base of the tree to be exposed and free of mulch contact. All finished mulch areas shall be left smooth and level to maintain uniform surface and appearance. After the mulch placement, any debris or piles of material shall be immediately removed from the right of way, including raking excess mulch out of turf areas.

Delete Article 253.12 Wrapping and substitute the following:

Any paper or cardboard trunk wrap must be removed before placing the tree in the tree hole in order to inspect the condition of the trunks. Within 48 hours, "A layer of commercial screen wire mesh shall be wrapped around the trunk of all deciduous trees. The screen wire shall be secured to itself with staples or single wire strands tied to the mesh. Trees shall be wrapped at time of planting, before the installation of mulch. The lower edge of the screen wire shall be in continuous contact with the ground and shall extend up to the lowest major branch.

Add the following to Article 253.13 Bracing:

Trees required to be braced shall be braced within 24 hours of planting.

Add the following to the first paragraph of Article 253.14 Period of Establishment:

Prior to being accepted, the plants shall endure a period of establishment. This period shall begin as soon as the tree is installed and end in December of the same year.

Delete the last sentence of the first paragraph of Article 253.15 Plant Care and substitute the following:

This may require pruning, cultivating, tightening and repairing supports, repair of wrapping, and furnishing and applying sprays as necessary to keep the plants free of insects and disease. The Contractor shall provide plant care a minimum of every two weeks, or within 3 days following notification by the Engineer. All requirements for plant care shall be considered as included in the cost of the contract.

Delete the first paragraph of Article 253.15 Plant Care (a) and substitute the following:

During plant care additional watering shall be performed once a week during the months of May through December. The contractor shall apply a minimum of 25 gallons of water per tree, 20 gallons per large shrub, 15 gallons per small shrub, and 4 gallons per vine. The Engineer may direct the Contractor to adjust the watering rate and frequency depending upon weather conditions.

Add the following to Article 253.15 Plant Care (d):

The contractor shall inspect all trees, shrubs, and vines for pests and diseases at least every two weeks during the months of initial planting through final acceptance. Contractor must identify and monitor pest and diseases and determine action required to maintain the good appearance, health and, top performance of all plant material. Contractor shall notify the Engineer with their inspection findings and recommendations within twenty-four hours of findings. The recommendations for action by the Contractor must be reviewed and by the Engineer for approval/rejection. All approved corrective activities will be considered as included in the cost of the contract and shall be performed within 48 hours following notification by the Engineer.

Delete Article 253.17 Basis of Payment and substitute the following:

This work will be paid for 75% of the contract unit price each for several kinds and sizes of trees, shrubs, and vines found to be alive and healthy condition by May 31st, as specified in Article 253.14. The remaining 25% of the contract unit price each will be paid for after the successful completion of all required replacement plantings and clean - up work and receipt of the “Final Acceptance of Landscape Work” memorandum from the Bureau of Maintenance. The unit price shall include the cost of all material, equipment, labor, plant care, disposal and incidental required to complete the work as specified herein and to the satisfaction of the Engineer. The placement of Pre-emergent Herbicide shall be paid for at the contract unit price for WEED CONTROL, PRE-EMERGENT HERBICIDE.

REQUIRED INSPECTION OF WOODY PLANT MATERIAL
Delete Article 1081.01(a)(5) and substitute the following:

The place of growth for all material, and subsequent inspection, must be located within 200 miles of the project.

Delete Article 1081.01(c)(1) and substitute the following:

Inspection of plant material will be made at the nursery by the Engineer, or a duly authorized representative of the Department; all plant material must be in the ground of the nursery supplying the material.

The Contractor shall provide the Engineer a minimum of 50 calendar days advance notice of the plant material to be inspected. Written certification by the Nursery will be required certifying that the plants are true to their species and/or cultivar specified in the plans.

The Department reserves the right to place identification seals on any or all plants selected. No trees shall be delivered without IDOT seal. Plant material not installed within 60 days of initial inspection will be required to be re-inspected.

SEEDING, CLASS 4 (MODIFIED)

This work shall consist of preparing the seed bed, placing the seed, and other materials required in the seeding operation in areas as shown in the plans.

All work, materials and equipment shall conform to Section 250 and 1081 of the Standard Specifications except as modified herein.

The Class 4 (Modified) seed mixture shall be supplied in pounds of Pure Live Seed. All native seed species will be local genotype and verified that original seed collection source must originate from a radius of 200 miles from the project site. Fertilizer is not required.

Article 250.07 Seeding Mixtures – Add the following to Table 1:

CLASS – TYPE	SEEDS	PURE LIVE SEED LB/ACRE
4 (Modified) Tall Native Grass		11.0
	Andropogon gerardii (Big Bluestem)	3.0
	Elymus canadensis (Canada Wild Rye)	2.0
	Panicum virgatum (Switchgrass)	2.0
	Sorghastrum nutans (Indian Grass)	4.0
Temporary Cover		20 (lb/acre)
Fall/Winter:	Winter Rye (Secale cereale)	20.0
Spring:	Avena sativa (Annual Oats)	20.0

Variation in the Class 3, 4, 5, or 6 seed quantities or varieties may be allowed in the event of a crop failure or other unforeseen conditions. Quantities of proposed substitutions shall be determined by seed count. The Contractor shall provide for the approval of the Engineer a written description of the proposed changes to the Class 3, 4, 5, or 6 Mixture(s), the reasons for the change, and the name of the seed suppliers who were contacted in an effort to obtain the specified species. Adjustments will be made at no cost to the contract. Approval of substitutes shall in no way waive any requirements of the contract

Seeding Time:

Seeding shall be completed between October 15 to May 15 but not when raining or when the ground is covered with snow, unless prior written approval is received from Engineer. No seed shall be sown when the ground is not in proper condition for seeding. Seeding done outside of this time frame will not be measured for payment unless approved in writing by Engineer in advance.

The Contractor shall schedule work so that final grade is achieved during the specified seeding times. Any seeding installed on or after March 1 must be incorporated into the soil surface, but no deeper than ¼ inch, such as by rangeland type seed drill, harrow, hand rake, or other method approved by the Engineer.

Bagging, Transporting, and Storing Seed:

Seed mixtures of the specified classes shall be thoroughly mixed, labeled ad bagged by the supplier. Purity and germination tests no older than twelve months old must be submitted for all seed supplied to verify quantities of bulk seed required to achieve LB PLS specified.

Seed shall be thoroughly mixed, labeled and bagged by the supplier. Seed shall be bagged, transported, and stored in such a manner to protect it from damage and to maintain the viability of the seed. All seed mixtures shall be brought to the site in clearly labeled and unopened bags.

Seed shall be adequately protected from rain, temperature extremes, rodents, insects, and other such factors that could adversely affect seed viability during transport or while being stored prior to planting. Bags of seed that are leaking, wet, moldy, or otherwise damaged shall be rejected and promptly removed from the site of work. Prior to application, the Engineer must approve the seed mix in the bags on site.

Layout of Seeding:

The Contractor shall be responsible for filed verifying the acreage of the area(s) to be seeded. The amount of seed ordered shall match the area(s) to be seeded during the pending planting season. A minimum of 30 days shall be allowed for seed acquisition, testing, and inspection.

The Contractor shall demarcate all areas to be seeded and estimate quantities of each area to determine the quantity of seed necessary to achieve the specified seed rate per acre. The Contractor shall delineate the perimeter of the seedbed with wooden lathe. The wooden lathe shall remain in place. The contractor shall provide a minimum of seven calendar days notice to the Engineer to allow for review and approval of seeding layout.

Inspection:

The Engineer must witness the delivery of seed with original labels attached in the field. A bag ticket must be affixed to each bag of seed upon delivery, and shall not be removed until the Engineer has reviewed and accepted each bag of seed. The label shall bear the dealer’s guarantee of mixture and year grown, purity and germination, and date of test.

Seed Bed Preparation:

All area(s) to be seeded must be properly prepared prior to planting seed.

Bare earth seeding refers to sowing seed upon soils with no existing vegetative cover. In areas with existing vegetation, the vegetation shall be eradicated as specified or as directed by the Engineer. Seed bed preparation shall not be started until all requirements of Section 212 have been completed. The area to be seeded shall be worked to a minimum depth of 3 in. (75 mm) with a disk, tiller, box rake, or other equipment approved by the Engineer. In areas with heavy soils, tilling or power raking will be required to achieve the proper depth. All soil clods shall be reduced to a size not larger than ½ in. (13 mm) in the largest dimension to create a friable, pulverized topsoil surface suitable for seeding. Dragging the soil surface with the blade of a loader or dozer will not be an acceptable method of seed bed preparation. The prepared surface shall be relatively free of weeds, stones, roots, sticks, debris, rills, gullies, crusting, caking, and compaction. No seed shall be sown until the seed bed has been approved by the Engineer.

Seeding Methods:

No seed shall be sown when wind gusts exceed 25 miles per hour or when the ground is not in a proper condition for seeding, nor shall any seed be sown until the purity test has been completed for the seeds to be used, and said tests show that the seed meets the noxious weed seed requirements. All equipment shall be approved by the Engineer prior to being used. Prior to starting work, seeders shall be calibrated and adjusted to sow seeds at the required seeding rate. Equipment shall be operated in a manner to ensure complete coverage of the entire area to be seeded. The Engineer shall be notified 48 hours prior to beginning the seeding operations so that the Engineer may determine by trial runs that a calibration of the seeder will provide uniform distribution at the specified rate per acre.

Seeding Classes 3, 4, 5, and 6 shall be sown with a broadcast seeder or a rangeland type seed drill.

Hand broadcasting and other methods of sowing seed will be allowed in special circumstances as approved by the Engineer. Special circumstances include but are not necessarily limited to steep slopes (over 1:3 (V:H)), inaccessible areas, wet areas, or other unique situations where the use of the specified equipment is not possible.

Method of Measurement:
SEEDING, CLASS 4 (MODIFIED) will be measured for payment in acres of surface area of seeding for the seed mix type specified.

Basis of Payment:
SEEDING, CLASS 4 (MODIFIED) shall be paid at the Contract unit price per acre. Payment shall be in full for seed, planting, and furnishing all labor to complete the work as set forth above.

SHREDDED BARK MULCH, 3”

Description:
This item shall consist of furnishing, transporting and placing shredded hardwood bark mulch in areas as described on plans and details and as per the direction of the Engineer.

Material:
The Contractor shall supply and install shredded hardwood bark mulch, as required to mulch around trees, shrubs, and herbaceous plants in landscaped areas.

The Contractor shall remove all litter and plant debris before mulching. The Contractor shall repair grade by raking in topsoil as needed, before mulching. Care shall be taken not to bury leaves, stems, or vines under mulch material.

All finished mulch areas shall be left smooth and level to maintain a uniform surface and appearance. All work areas shall be cleaned of debris and mulch, prior to leaving the site.

Hardwood bark mulch shall be clean, finely shredded mixed-hardwood bark, not to exceed two (2) inches in its larges dimension, free of foreign matter, sticks, stones, and clods. All hardwood mulch shall be processed through a hammermill. Hardwood bark not processed through a hammermill shall not be accepted.

A composition report, test report, sample and request for material inspection form shall be supplied to the Engineer for approval prior to performing any work.

Place mulch layer around plants as follows:

Perennials, including: bulbs, ground cover, vines, grasses:
Three (3) inches deep- keep mulch away from crowns of plants.
Shrubs, including shrubs and roses:
Three (3) inches deep- keep mulch away from stems, crown, or neck of shrub.
Trees, shade and ornamental:
Three (3) inches deep- keep mulch away from the trunk of the tree.

Method of Measurement:
This work will be measured for payment in units of SQUARE YARDS of mulch installed, as described herein and which price shall include all labor, materials, equipment and tools necessary to complete the item described above. This item will not be paid by Load Tickets.

Basis of Payment:
This work will be paid for at the contract unit price per square yard for SHREDDED BARK MULCH, 3”.

WATER MAIN RELOCATION GENERAL REQUIREMENTS

Excavation near Existing Structures:
All existing pipes, conduits, cables, poles, pavements, and other structures not designated to be removed by the Contract Documents are to be protected from damage by the Contractor. The temporary support, protection, and maintenance of the structures, shall be furnished by the Contractor at his own expense. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with the owners of such utility structures. Whenever necessary to determine the location of existing underground utility structures, the Contractor, after an examination of available records, shall make all explorations and excavations for such purpose as may be directed by the Engineer.

Unauthorized Excavation:
If the bottom of any excavation is removed beyond the limits directed, it shall be backfilled and compacted to the proper grade with a material suitable to the Engineer and at the Contractor's expense.

Inspection of Pipe and Accessories:
The pipe and accessories shall be inspected for defects prior to lowering into trench. Any defective, damaged or unsound material shall be repaired or replaced as directed by the Engineer. All foreign matter or dirt shall be inspected for defects prior to lowering into position in the trench. Pipe shall be kept clean by means approved by the Engineer during and after laying.

Compacting Trench Backfill:
Method 1 (Compacting in Lifts) as described in Section 550 of the Standard Specifications shall be used to compact the backfill. No jetting will be allowed.

DUCTILE IRON WATER MAIN 20"

Description:
This item shall include the installation of twenty-inch (20") water main at the locations shown on the Plans. The water main shall be Ductile Iron Class 52. Also included in this item is the furnishing and installation of the Standard Joint X MJS Adapter to make the transition from the 24" PCCP to the DIP. All water main to be installed in open cut trenches shall be bedded and encased with granular material as shown in the "Water Main Trench Detail" on the plans.

Materials:
All Ductile Iron Pipe water mains shall be Class 52, cement-lined and tar-coated, meeting the requirements of Specifications ANSI/AWWA C151/A21.51 with "Lock Type" joints meeting the requirements of Specifications ANSI/AWWA C111/ A21.11.

The polyethylene material shall be manufactured and installed in compliance with ANSI/AWWA C105/A21.5.

The bedding and encasement material shall be IDOT gradation CA-11 or CA-13.

Construction Requirements:
This work shall be done in accordance with Section 560 of the Standard Specifications and as modified herein.

Immediately after the adapter the Contractor shall install the 24" X 20" Reducer which will be paid for at the contract unit price for Ductile Iron Water Main Fittings.

Included in the work to be done under this item are the saw-cutting, pavement removal, excavating of the trench, disposing or replacing of the excavated materials, furnishing and placing the bedding materials and encasement aggregate as shown on the plan details, and properly compacting the materials placed into the trench after the pipe has been installed.

The bedding encasement shall be tamped under the haunches and placed around and over the pipes to a depth above the top of the pipe as shown on the details.

If line and grade of water main is changed in the field, the only additional compensation allowed will be for additional volume of trench backfill. No additional compensation will be allowed for any additional excavation.

All pipe shall be cut to its required length in the field by a Powered Mechanical Rotary Saw and the exposed end ground by a mechanical grinding tool to a smooth beveled finish.
All proposed water main will be encased within four (4) mil thick, high-density polyethylene tubing. All fittings shall be encased in a double-layer of polyethylene tubing.

The Contractor shall be responsible for providing to the Broadview-Westchester Joint Water Agency Record Drawing information (location and depth) at fifty foot (50') stations for the entire length of DIP water main: The Cost to provide this information to the Engineer will be included in the cost of this item.

Method of Measurement:
Ductile Iron Water Main, 20" will be measured for payment in feet which length includes the Standard Joint X MJS Adapter**.**

Basis of Payment:
This item shall be paid for at the Contract unit price per foot for DUCTILE IRON WATER MAIN 20", and shall include all cost for labor, material and equipment necessary to complete this work as described in these special provision. Payment for the polyethylene encasement will not be paid for separately but will be included in the cost of this items. The furnishing of necessary trench backfill will be paid for according to Article 208.04. The furnishing and installation of the pipe bedding and encasement will not be paid for separately but will be included in the cost of this item.

DUCTILE IRON WATER MAIN FITTINGS

Description:
This item shall pertain to the furnishing and installation of all necessary ductile iron water main fittings as shown on the plans or as directed by the Engineer. All fittings shall be encased in a double-layer of polyethylene tubing.

Materials:
All pipe fittings and special castings shall be ductile iron conforming to ANSI/AWWA C153/A21.53 and ANSI/AWWA C111/A21.11 specifications and shall meet the minimum requirements of Class 150 Ductile Iron Pipe. If certain fittings are not manufactured in ductile iron, cast iron fittings shall be acceptable. Mechanical joint type fittings shall be used.

The polyethylene material shall be manufactured and installed in compliance with ANSI/AWWA C105/A21.5.

Construction Requirements:
Unless listed under other Contract items, all bends, crosses, tees, sleeves of all types, reducers, plugs or caps, and other fittings required to assemble and secure the proposed water mains along the route shown on the Plans shall be included under this item

The costs for furnishing and installing the standard joint accessories (gland, gasket, and bolts) for these fittings shall be included in the Contract unit price for this item and shall not be paid for separately.

All fittings shall be manufactured in the USA. The manufacturer will furnish a certificate acknowledging the same to the Engineer.

The Contractor shall maintain a list of fittings installed and shall provide an invoiced listing of the body casting and accessories weights of these fittings to be used for determining the payment for this item. All concrete blocking to be furnished and installed shall be considered included in the work under this item.

All bolts on mechanical joints and flange joints shall have corrosion protection caps. The bolts shall have sufficient lengths to accommodate the installation of the corrosion protection caps.

All mechanical-joint fittings on bends or tees are to have wedge-type thrust restraint glands. The furnishing and installing of these types of thrust restraint glands shall be included in the cost of this item.

A reaction or thrust blocking shall be provided at each bend and tee. Anchorage may also be made to the water main pipe with rods and clamps. The size and shape of the thrust blocking or the number and details of the anchor rods shall be as approved by the Engineer. Reaction or thrust blocking will not be paid for separately but will be included in the cost of this item.

Method of Measurement:
All Ductile Iron Water Main Fittings provided on the project will be measured for payment per pound of weight of the fittings.

Basis of Payment:
This item shall be paid for at the Contract unit price per pound for DUCTILE IRON WATER MAIN FITTINGS, and shall include all cost for labor, material and equipment necessary to complete this work as described in these special provision.

WATER MAIN REMOVAL, 24"

Description:
This item shall include the removal of the existing 24" diameter PCCP pipe that will be in conflict with the proposed pump station improvements. This work shall not be done until the relocated water main is installed and operational. The cost for all required saw-cutting work shall be will be included in the price for this item.

Construction Requirements:
This work shall be done in accordance with Article 551.03 except as modified below:

The item to be removed shall be 24" diameter PCCP pipe instead of storm sewers.

There will be no salvage value for the existing pipe.

Method of Measurement:
Water Main Removal, 24"will be measured for payment in feet**.**

Basis of Payment:
This item shall be paid for at the Contract unit price per foot for WATER MAIN REMOVAL 24", and shall include all cost for labor, material and equipment necessary to complete this work as described in these special provision. The furnishing of necessary trench backfill will be paid for according to Article 208.04.

CAP EXISTING WATER MAIN

Description:
This item pertains to the cutting and capping of the existing water main. Once the new water main is installed and operational, the existing main shall be cut and a cap installed on the new water main at the locations shown on the Plans, or as directed by the Engineer.

Construction Requirements:
The Broadview-Westchester Joint Water Agency must be given three (3) days advance notice of any work to be done by the Contractor that will involve the Agency's existing water system. The Agency's approval must be obtained prior to any such work being undertaken by the Contractor. The Contractor shall have all necessary fittings and equipment required at the job site prior to the actual shut down being made. Once the shut-down is made, the Contractor shall work straight through until the caps have been installed and the water mains can be placed back into service, regardless of the time required to place the existing water main back into service. The shut-down period for capping of the existing water main shall not exceed eighteen (18) hours.

The Broadview-Westchester Joint Water Agency will offer assistance in any necessary shut downs of existing water mains; however, it will be the Contractor's responsibility to provide the necessary labor and equipment for making these shut downs.

This item will include the cost to remove and dispose of existing water main pipe, cutting of the main, furnishing and installation of caps and any other material necessary to complete the work. The water main fittings will be paid for separately under their respective Contract Pay Item. This item shall include all other work that must be performed at each location by the Contractor and that is not included under the various Contract Pay Items listed in the Schedule of Prices and described in these Specifications.

Note that the connection and cutting and capping of the existing main for each location shall be performed separately. The following is the schedule of Disconnections

1) Water Main Disconnection by Pressure Connection #2
2) Water Main Disconnection by Pressure Connection #3.
3) Water Main Disconnection by connection to existing 24" main on east side of Existing Pump Station.

Method of Measurement:
Cutting and Capping of the Existing Water Main will be measured for payment per each location where the work is completed.

Basis for Payment:
Payment for this item shall be at the Contract Unit Price per each for CAP EXISTING WATER MAIN, which price shall include all costs for furnishing labor, materials and equipment necessary for exposing the water system mains at each location, shutting down the existing mains, cutting and removing the piping installing the fittings and performing any other additional incidental work not included under other Contract items in order to properly complete the necessary disconnection in accordance with the details shown on the Plans and in the Specifications.

PRESSURE TESTING AND DISINFECTION

Description:

This item shall pertain to the pressure testing and disinfection of the newly installed water main prior to placing the new water main into service.

Construction Requirements:

The new water mains or any valved sections of it shall be subject to a hydrostatic pressure test in basic compliance with Section 41-2.13 of the "Standard Specifications for Water and Sewer Main Construction in Illinois". The pipe shall be subjected to a hydrostatic pressure of one hundred fifty (150) pounds per square inch.

Each valved section of the mains shall be individually tested. All joints showing visible leaks shall be repaired until tight. Any cracked or defective pipe, fitting, or valves discovered in consequence of this pressure test shall be removed and replaced by the Contractor with sound material and the test shall be repeated.

Suitable means shall be provided by the Contractor for determining the quantity of water lost by leakage under the specified test pressure. Allowable leakage shall not be greater than that computed by the following table:

Diameter of Pipe	Allowable Leakage in Gal/Hr/1,000 Ft
20 Inch	1.66

Leakage is defined as the quantity of water to be supplied in the newly laid pipe or any valved section of it necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

After satisfactory completion of the hydrostatic testing, the piping shall be flushed to remove any solutions, debris, or contaminated materials that may have lodged within the piping. The Contractor will be responsible for providing a mechanism for the main to be flushed through. The flow velocity of the water in the piping during the flushing shall be not less than three feet per second (see Table 9 of the DIPRA Installation Guide for gpm required per pipe size) and shall be a maximum velocity sufficient to deliver clear, debris-free water at the discharge point. Water mains shall be disinfected by or under the direction of an experienced professional chlorination technician retained by the Contractor, in a manner acceptable to the Engineer and the State Department of Health. After the chlorination process, water samples shall be collected at each of the sampling taps and submitted to the laboratory for bacteriological examination of two (2) separate days. If the chlorination fail to result in approval, the chlorination procedures shall be repeated until satisfactory results are obtained. Sampling taps shall not be paid for as a separate item, but shall be incidental to the Contract. The sections of pipe and fittings used on the shut-down connections shall be spray chlorinated with a 50 p.p.m. solution of chlorine.

Method of Measurement:
This work will be measured for payment on a lump sum basis.

Basis of Payment:
Payment for this item shall be at the Contract lump sum price for PRESSURE TESTING AND DISINFECTION which price shall include all cost for furnishing the labor and equipment necessary to pressure test and disinfect the proposed water mains in accordance with the Specifications.

VALVE VAULTS TO BE ABANDONED

Description:
This item pertains to the abandonment of the existing valve vaults, including the valves that are located on the section of water main to be removed.

Construction Requirements:
This item shall consist of the removal of valve vaults and valves at locations shown on the plans or as directed by the Engineer. It shall also be the responsibility of the contractor to seal all pipes at both ends that connect to other structures with brick and mortar. The void left by the removal of the structure will be filled with trench backfill and compacted.

Method of Measurement:
This work will be measured for payment on an each basis.

Basis of Payment:
Payment shall be at the Contract unit price per each for VALVE VAULTS TO BE ABANDONED, and shall include all cost for labor, material and equipment necessary to complete this work as described in these special provisions. The furnishing of necessary trench backfill will be paid for according to Article 208.04.

PRESSURE CONNECTION TO EXISTING WATER MAIN

Description:
At the location shown on the Plans, the proposed twenty-inch (20”) water main shall be connected to the existing PCCP twenty four inch (24”) water main using a stainless steel mechanical tapping sleeve and valve.

Materials:
The valve shall be manufactured to meet all applicable requirements of AWWA Standards for resilient seated gate valves, C509-80, C500, and C504. Valve seats shall be bubble-tight (zero leakage) at 200 psi water working pressure. Valves shall have non-rising stems, opening by turning left and provided with a two inch (2") square nut, with arrow cast into the flange metal to indicate direction of opening. Each valve shall have its maker’s name, pressure rating, and year in which manufactured cast onto the body. Prior to shipment from the factory, each valve shall be tested with hydrostatic pressure to equal that specified by AWWA Standard 504 for Class 150 valves.

The tapping sleeve shall be 304 Stainless Steel per ASTM 240.

Construction Requirements:
The tapping sleeve and valve shall be enclosed in an 8’ diameter precast concrete vault as shown on the Plans. The valve vault shall be manufactured in accordance with A.S.T.M. C-478, with a reinforced concrete flat slab top, IDOT Standard 602601. Steps shall be installed in the vault to allow for safe entry and exit for personnel working within the vault.

Openings shall be cast into the lower barrel section of the vault to allow for the water main to pass through the vault. These openings shall be large enough so that no part of the barrel section rests directly on the water main. The void between the water main and the barrel section shall be filled with cement brick and mortar. A coat of mortar, one-half inch (1/2”) thick shall be applied to the inside and outside surfaces of the brick and mortar areas. The frame shall be centered over the gate valve as directed by the engineer. The cast iron lid shall have the word "WATER" cast in raised letters for each vault. Within each valve vault, as indicated on the Plans, one inch (1”) diameter brass corporation stops are to be installed on each side of the new gate valve and shall be manufactured in accordance with AWWA C-800 and ASTM B-62 specifications. The inlet side of the corporation assembly is to be machined with AWWA threads, the outlet shall have standard threading to attach flared one inch (1”) diameter copper tubing.

Each valve shall have a smooth unobstructed waterway free from any sediment pockets. The cast iron valve gate shall have a replaceable, internally reinforced, specially contoured, molded rubber seat ring attached to the face of the gate with self-locking stainless steel screws, ASTM D2000, 4AA, 730. The bronze stem nut shall be integrally cast in the cast iron gate to prevent building, twisting, or angling. An anti-friction washer shall be located above the thrust collar portion of the stem to reduce friction and to provide a more effective conversion of operating torque into seating loads. Stuffing boxes shall have "O" ring seals with two (2) rings, one (1) located above the thrust collar and one (1) located below. The space between the "O" rings is to be filled with a lubricant to reduce operating torque and wear. The stem shall be made of rolled bronze, integral with the thrust collar. The exterior of the valve shall be coated with an asphaltic varnish. The interior of the valve and the valve gate shall be covered with a thermosetting epoxy coating, approved for potable water handling.

Method of Measurement:
Pressure Connections to Existing Water Mains will be measured for payment per each location where the work is completed.

Basis of Payment:
Payment for this item shall be at the Contract unit price per each for PRESSURE CONNECTION TO EXISTING MAIN and shall include all cost for labor, material and equipment necessary to complete this work as described in these special provisions.

MAINTENANCE OF ROADWAYS (D-1)
Effective: September 30, 1985 Revised: November 1, 1996

Beginning on the date that work begins on this project, the Contractor shall assume responsibility for normal maintenance of all existing roadways within the limits of the improvement. This normal maintenance shall include all repair work deemed necessary by the Engineer, but shall not include snow removal operations. Traffic control and protection for maintenance of roadways will be provided by the Contractor as required by the Engineer.

If items of work have not been provided in the contract, or otherwise specified for payment, such items, including the accompanying traffic control and protection required by the Engineer, will be paid for in accordance with Article 109.04 of the Standard Specifications.

AGGREGATE FOR CONCRETE BARRIER (D-1)
Effective: February 11, 2004 Revised: January 24, 2008

Add the following paragraph to Article 637.02 of the Standard Specifications:

"The coarse aggregate to be used in the concrete barrier walls shall conform to the requirement for coarse aggregate used in Class BS concrete according to Article 1004.01(b), paragraph 2."

AGGREGATE SUBGRADE IMPROVEMENT (D-1)
Effective: February 22, 2012 Revised: April 1, 2016

Add the following Section to the Standard Specifications:

"SECTION 303. AGGREGATE SUBGRADE IMPROVEMENT

303.01 Description. This work shall consist of constructing an aggregate subgrade improvement.

303.02 Materials. Materials shall be according to the following.

Item	Article/Section
(a) Coarse Aggregate	1004.07
(b) Reclaimed Asphalt Pavement (RAP) (Notes 1, 2 and 3)	1031

Note 1. Crushed RAP, from either full depth or single lift removal, may be mechanically blended with aggregate gradation CS 01 but shall not exceed 40 percent by weight of the total product. The top size of the Coarse RAP shall be less than 4 in. (100 mm) and well graded.

Note 2. RAP having 100 percent passing the 1 1/2 in (37.5 mm) sieve and being well graded, may be used as capping aggregate in the top 3 in. (75 mm) when aggregate gradation CS 01 is used in lower lifts. When RAP is blended with any of the coarse aggregates, the blending shall be done with mechanically calibrated feeders. The final product shall not contain more than 40 percent by weight of RAP.

Note 3. The RAP used for aggregate subgrade improvement shall be according to the current Bureau of Materials and Physical Research Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications".

303.03 Equipment. The vibratory machine shall be according to Article 1101.01, or as approved by the Engineer. The calibration for the mechanical feeders shall have an accuracy of ± 2.0 percent of the actual quantity of material delivered.

303.04 Soil Preparation. The stability of the soil shall be according to the Department's Subgrade Stability Manual for the aggregate thickness specified.

303.05 Placing Aggregate. The maximum nominal lift thickness of aggregate gradation CS 01 shall be 24 in. (600 mm).

303.06 Capping Aggregate. The top surface of the aggregate subgrade shall consist of a minimum 3 in. (75 mm) of aggregate gradations CA 06 or CA 10. When Reclaimed Asphalt Pavement (RAP) is used, it shall be crushed and screened where 100 percent is passing the 1 1/2 in. (37.5 mm) sieve and being well graded. RAP that has been fractionated to size will not be permitted for use in capping. Capping aggregate will not be required when the aggregate subgrade improvement is used as a cubic yard pay item for undercut applications. When RAP is blended with any of the coarse aggregates, the blending shall be done with mechanically calibrated feeders.

303.07 Compaction. All aggregate lifts shall be compacted to the satisfaction of the Engineer. If the moisture content of the material is such that compaction cannot be obtained, sufficient water shall be added so that satisfactory compaction can be obtained.

303.08 Finishing and Maintenance of Aggregate Subgrade Improvement. The aggregate subgrade improvement shall be finished to the lines, grades, and cross sections shown on the plans, or as directed by the Engineer. The aggregate subgrade improvement shall be maintained in a smooth and compacted condition.

303.09 Method of Measurement. This work will be measured for payment according to Article 311.08.

303.10 Basis of Payment. This work will be paid for at the contract unit price per cubic yard (cubic meter) for AGGREGATE SUBGRADE IMPROVEMENT or at the contract unit price per square yard (square meter) for AGGREGATE SUBGRADE IMPROVEMENT, of the thickness specified.

Add the following to Section 1004 of the Standard Specifications:

"**1004.07 Coarse Aggregate for Aggregate Subgrade Improvement.** The aggregate shall be according to Article 1004.01 and the following.

(a) Description. The coarse aggregate shall be crushed gravel, crushed stone, or crushed concrete. The top 12 inches of the aggregate subgrade improvement shall be 3 inches of capping material and 9 inches of crushed gravel, crushed stone or crushed concrete. In applications where greater than 36 inches of subgrade material is required, rounded gravel, meeting the CS01 gradation, may be used beginning at a depth of 12 inches below the bottom of pavement.

(b) Quality. The coarse aggregate shall consist of sound durable particles reasonably free of deleterious materials. Non-mechanically blended RAP may be allowed up to a maximum of 5.0 percent.

(c) Gradation.

(1) The coarse aggregate gradation for total subgrade thicknesses of 12 in. (300 mm) or greater shall be CS 01.

Grad No.	COARSE AGGREGATE SUBGRADE GRADATIONS Sieve Size and Percent Passing				
	8”	6”	4”	2”	#4
CS 01	100	97 ± 3	90 ± 10	45 ± 25	20 ± 20

Grad No.	COARSE AGGREGATE SUBGRADE GRADATIONS (Metric)				
	Sieve Size and Percent Passing				
	200 mm	150 mm	100 mm	50 mm	4.75 mm
CS 01	100	97 ± 3	90 ± 10	45 ± 25	20 ± 20

(2) The 3 in. (75 mm) capping aggregate shall be gradation CA 6 or CA 10.

COARSE AGGREGATE FOR BACKFILL, TRENCH BACKFILL AND BEDDING (D-1)
Effective: November 1, 2011 Revised: November 1, 2013

This work shall be according to Section 1004.05 of the Standard Specifications except for the following:

Reclaimed Asphalt Pavement (RAP) maybe blended with gravel, crushed gravel, crushed stone crushed concrete, crushed slag, chats, crushed sand stone or wet bottom boiler slag. The RAP used shall be according to the current Bureau of Materials and Physical Research Policy Memorandum, “Reclaimed Asphalt Pavement (RAP) for Aggregate Applications”. The RAP shall be uniformly graded and shall pass the 1.0 in. (25 mm) screen. When RAP is blended with any of the coarse aggregate listed above, the blending shall be done mechanically with calibrated feeders. The feeders shall have an accuracy of $\pm$ 2.0 percent of the actual quantity of material delivered. The final blended product shall not contain more than 40 percent by weight RAP.

The coarse aggregate listed above shall meet CA 6 and CA 10 gradations prior to being blended with the processed and uniformly graded RAP. Gradation deleterious count shall not exceed 10% of total RAP and 5% of other by total weight.

EMBANKMENT II (D-1)
Effective: March 1, 2011 Revised: November 1, 2013

Description. This work shall be according to Section 205 of the Standard Specifications except for the following.

Material. Reclaimed asphalt shall not be used within the ground water table or as a fill if ground water is present. The RAP used shall be according to the current Bureau of Materials and Physical Research Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications". Gradation deleterious count shall not exceed 10% of total RAP and 5% of other by total weight.

CONSTRUCTION REQUIREMENTS

Samples. Embankment material shall be sampled and tested before use. The contractor shall identify embankment sources, and provide equipment as the Engineer requires, for the collection of samples from those sources. Samples will be furnished to the Geotechnical Engineer a minimum of three weeks prior to use in order that laboratory tests for compaction can be performed. Embankment material placement cannot begin until tests are completed.

Placing Material. In addition to Article 202.03, broken concrete, reclaimed asphalt with no expansive aggregate, or uncontaminated dirt and sand generated from construction or demolition activities shall be placed in 6 inches (150 mm) lifts and disked with the underlying lift until a uniform homogenous material is formed. This process also applies to the overlaying lifts. The disk must have a minimum blade diameter of 24 inches (600 mm).

When embankments are to be constructed on hillsides or existing slopes that are steeper than 3H:1V, steps shall be keyed into the existing slope by stepping and benching as shown in the plans or as directed by the Engineer.

Compaction. Soils classification for moisture content control will be determined by the Soils Inspector using visual field examination techniques and the IDH Textural Classification Chart.

When tested for density in place each lift shall have a maximum moisture content as follows.

a) A maximum of 110 percent of the optimum moisture for all forms of clay soils.

b) A maximum of 105 percent of the optimum moisture for all forms of clay loam soils.

Stability. The requirement for embankment stability in article 205.04 will be measured with a Dynamic Cone Penetrometer (DCP) according to the test method in the IDOT Geotechnical Manual. The penetration rate must be equal or less than 1.5 inches (38 mm) per blow.

Basis of Payment. This work will not be paid separately but will be considered as included in the various items of excavation.

FRICTION AGGREGATE (D-1)
Effective: January 1, 2011 Revised: April 29, 2016

Revise Article 1004.03(a) of the Standard Specifications to read:

"**1004.03 Coarse Aggregate for Hot-Mix Asphalt (HMA).** The aggregate shall be according to Article 1004.01 and the following.

(a) Description. The coarse aggregate for HMA shall be according to the following table.

Use	Mixture	Aggregates Allowed
Class A	Seal or Cover	Allowed Alone or in Combination [5/]: Gravel Crushed Gravel Carbonate Crushed Stone Crystalline Crushed Stone Crushed Sandstone Crushed Slag (ACBF) Crushed Steel Slag Crushed Concrete
HMA Low ESAL	Stabilized Subbase or Shoulders	Allowed Alone or in Combination [5/]: Gravel Crushed Gravel Carbonate Crushed Stone Crystalline Crushed Stone Crushed Sandstone Crushed Slag (ACBF) Crushed Steel Slag[1/] Crushed Concrete
HMA High ESAL Low ESAL	Binder IL-19.0 or IL-19.0L SMA Binder	Allowed Alone or in Combination [5/ 6/]: Crushed Gravel Carbonate Crushed Stone[2/] Crystalline Crushed Stone Crushed Sandstone Crushed Slag (ACBF) Crushed Concrete[3/]

<table>
<tr><th>Use</th><th>Mixture</th><th colspan="2">Aggregates Allowed</th></tr>
<tr><td>HMA
High ESAL
Low ESAL</td><td>C Surface and
Leveling Binder
IL-9.5 or IL-9.5L

SMA
Ndesign 50
Surface</td><td colspan="2"><u>Allowed Alone or in Combination</u> [5/]: Crushed Gravel
Carbonate Crushed Stone[2/] Crystalline Crushed Stone Crushed Sandstone
Crushed Slag (ACBF) Crushed Steel Slag[4/]
Crushed Concrete[3/]</td></tr>
<tr><td rowspan="5">HMA
High ESAL</td><td rowspan="5">D Surface and
Leveling Binder
IL-9.5

SMA
Ndesign 50
Surface</td><td colspan="2"><u>Allowed Alone or in Combination</u> [5/]: Crushed Gravel
Carbonate Crushed Stone (other than Limestone)[2/]
Crystalline Crushed Stone Crushed Sandstone Crushed Slag (ACBF)
Crushed Steel Slag[4/] Crushed Concrete[3/]</td></tr>
<tr><td colspan="2"><u>Other Combinations Allowed:</u></td></tr>
<tr><td>Up to...</td><td>With...</td></tr>
<tr><td>25% Limestone</td><td>Dolomite</td></tr>
<tr><td>50% Limestone</td><td>Any Mixture D aggregate other than Dolomite</td></tr>
<tr><td>75% Limestone</td><td>Crushed Slag (ACBF) or Crushed Sandstone</td></tr>
<tr><td rowspan="4">HMA
High ESAL</td><td rowspan="4">E Surface
IL-9.5

SMA
Ndesign 80
Surface</td><td colspan="2"><u>Allowed Alone or in Combination</u> [5/ 6/]:

Crystalline Crushed Stone Crushed Sandstone Crushed Slag (ACBF) Crushed Steel Slag

No Limestone.</td></tr>
<tr><td colspan="2"><u>Other Combinations Allowed:</u></td></tr>
<tr><td>Up to...</td><td>With...</td></tr>
</table>

<table>
<tr><th>Use</th><th>Mixture</th><th colspan="2">Aggregates Allowed</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td>50% Dolomite[2/]</td><td>Any Mixture E aggregate</td></tr>
<tr><td>75% Dolomite[2/]</td><td>Crushed Sandstone, Crushed Slag (ACBF), Crushed Steel Slag, or Crystalline Crushed Stone</td></tr>
<tr><td>75% Crushed Gravel[2/] or Crushed Concrete[3/]</td><td>Crushed Sandstone, Crystalline Crushed Stone, Crushed Slag (ACBF), or Crushed Steel Slag</td></tr>
<tr><td rowspan="4">HMA
High ESAL</td><td rowspan="4">F Surface
IL-9.5

SMA
Ndesign 80
Surface</td><td colspan="2"><u>Allowed Alone or in Combination</u> [5/ 6/]:

Crystalline Crushed Stone
Crushed Sandstone
Crushed Slag (ACBF)
Crushed Steel Slag
No Limestone.</td></tr>
<tr><td colspan="2"><u>Other Combinations Allowed</u>:</td></tr>
<tr><td>Up to...</td><td>With...</td></tr>
<tr><td>50% Crushed Gravel[2/], Crushed Concrete[3/], or Dolomite[2/]</td><td>Crushed Sandstone, Crushed Slag (ACBF), Crushed Steel Slag, or Crystalline Crushed Stone</td></tr>
</table>

1/ Crushed steel slag allowed in shoulder surface only.

2/ Carbonate crushed stone (limestone) and/or crushed gravel shall not be used in SMA Ndesign 80. In SMA Ndesign 50, carbonate crushed stone shall not be blended with any of the other aggregates allowed alone in Ndesign 50 SMA binder or Ndesign 50 SMA surface.

3/ Crushed concrete will not be permitted in SMA mixes. 4/

Crushed steel slag shall not be used as leveling binder.

5/ When combinations of aggregates are used, the blend percent measurements shall be by volume."

6/ Combining different types of aggregate will not be permitted in SMA Ndesign 80."

GROUND TIRE RUBBER (GTR) MODIFIED ASPHALT BINDER (D-1)
Effective: June 26, 2006 Revised: April 1, 2016

Add the following to the end of article 1032.05 of the Standard Specifications:

"(c) Ground Tire Rubber (GTR) Modified Asphalt Binder. A quantity of 10.0 to 14.0 percent GTR (Note 1) shall be blended by dry unit weight with a PG 64-28 to make a GTR 70-28 or a PG 58-28 to make a GTR 64-28. The base PG 64-28 and PG 58-28 asphalt binders shall meet the requirements of Article 1032.05(a). Compatible polymers may be added during production. The GTR modified asphalt binder shall meet the requirements of the following table.

Test	Asphalt Grade GTR 70-28	Asphalt Grade GTR 64-28
Flash Point (C.O.C.), AASHTO T 48, °F (°C), min.	450 (232)	450 (232)
Rotational Viscosity, AASHTO T 316 @ 275 °F (135 °C), Poises, Pa·s, max.	30 (3)	30 (3)
Softening Point, AASHTO T 53, °F (°C), min.	135 (57)	130 (54)
Elastic Recovery, ASTM D 6084, Procedure A (sieve waived) @ 77 °F, (25 °C), aged, ss, 100 mm elongation, 5 cm/min., cut immediately, %, min.	65	65

Note 1. GTR shall be produced from processing automobile and/or light truck tires by the ambient grinding method. GTR shall not exceed 1/16 in. (2 mm) in any dimension and shall contain no free metal particles or other materials. A mineral powder (such as talc) meeting the requirements of AASHTO M 17 may be added, up to a maximum of four percent by weight of GTR to reduce sticking and caking of the GTR particles. When tested in accordance with Illinois modified AASHTO T 27, *a* 50 g sample of the GTR shall conform to the following gradation requirements:

Sieve Size	Percent Passing
No. 16 (1.18 mm)	100
No. 30 (600 □m)	95 □ 5
No. 50 (300 □m)	> 20

Add the following to the end of Note 1. of article 1030.03 of the Standard Specifications:

"A dedicated storage tank for the Ground Tire Rubber (GTR) modified asphalt binder shall be provided. This tank must be capable of providing continuous mechanical mixing throughout by continuous agitation and recirculation of the asphalt binder to provide a uniform mixture. The tank shall be heated and capable of maintaining the temperature of the asphalt binder at 300 □F to 350 □F (149 □C to 177 □C). The asphalt binder metering systems of dryer drum plants shall be calibrated with the actual GTR modified asphalt binder material with an accuracy of □ 0.40 percent."

Revise 1030.02(c) of the Standard Specifications to read:

"(c) RAP Materials (Note 5) ..... 1031"

Add the following note to 1030.02 of the Standard Specifications:

Note 5. When using reclaimed asphalt pavement and/or reclaimed asphalt shingles, the maximum asphalt binder replacement percentage shall be according to the most recent special provision for recycled materials.

HMA MIXTURE DESIGN REQUIREMENTS (D-1)
Effective: January 1, 2013 Revised: January 1, 2018

1) DESIGN COMPOSITION AND VOLUMETRIC REQUIREMENTS

Revise the table in Article 406.06(d) of the Standard Specifications to read:

"MINIMUM COMPACTED LIFT THICKNESS	
Mixture Composition	Thickness, in. (mm)
IL-4.75	3/4 (19)
SMA-9.5, IL-9.5, IL-9.5L	1 1/2 (38)
SMA-12.5	2 (50)
IL-19.0, IL-19.0L	2 1/4 (57)"

Revise the table in Article 1004.03(c) of the Standard Specifications to read:

"Use	Size/Application	Gradation No.
Class A-1, 2, & 3	3/8 in. (10 mm) Seal	CA 16
Class A-1	1/2 in. (13 mm) Seal	CA 15
Class A-2 & 3	Cover	CA 14
HMA High ESAL	IL-19.0 IL-9.5	CA 11 1/ CA 16, CA 13 3/
HMA Low ESAL	IL-19.0L IL-9.5L Stabilized Subbase or Shoulders	CA 11 1/ CA 16
SMA 2/	1/2 in. (12.5mm) Binder & Surface IL 9.5 Surface	CA13 3/, CA14 or CA16 CA16, CA 13 3/

1/ CA 16 or CA 13 may be blended with the gradations listed.
2/ The coarse aggregates used shall be capable of being combined with stone sand, slag sand, or steel slag sand meeting the FA/FM 20 gradation and mineral filler to meet the approved mix design and the mix requirements noted herein.
3/ CA 13 shall be 100 percent passing the 1/2 in. (12.5mm) sieve.

Revise Article 1004.03(e) of the Supplemental Specifications to read:

"(e) Absorption. For SMA the coarse aggregate shall also have water absorption ≤ 2.0 percent."

Revise the last paragraph of Article 1102.01 (a) (5) of the Standard Specifications to read:

"IL-4.75 and Stone Matrix Asphalt (SMA) mixtures which contain aggregate having absorptions greater than or equal to 2.0 percent, or which contain steal slag sand, shall have minimum surge bin storage plus haul time of 1.5 hours."

Revise the nomenclature table in Article 1030.01 of the Standard Specifications to read:

"High ESAL	IL-19.0 binder; IL-9.5 surface; IL-4.75; SMA-12.5, SMA-9.5
Low ESAL	IL-19.0L binder; IL-9.5L surface; Stabilized Subbase (HMA)[1/]; HMA Shoulders[2/]

1/ Uses 19.0L binder mix.

2/ Uses 19.0L for lower lifts and 9.5L for surface lift."

Revise Article 1030.02 of the Standard Specifications and Supplemental Specifications to read:

"**1030.02 Materials.** Materials shall be according to the following.

Item	Article/Section
(a) Coarse Aggregate	1004.03
(b) Fine Aggregate	1003.03
(c) RAP Material	1031
(d) Mineral Filler	1011
(e) Hydrated Lime	1012.01
(f) Slaked Quicklime (Note 1)	
(g) Performance Graded Asphalt Binder (Note 2)	1032
(h) Fibers (Note 3)	
(i) Warm Mix Asphalt (WMA) Technologies (Note 4)	

Note 1. Slaked quicklime shall be according to ASTM C 5.

Note 2. The asphalt binder shall be an SBS PG 76-28 when the SMA is used on a full-depth asphalt pavement and SBS PG 76-22 when used as an overlay, except where modified herein. The asphalt binder shall be an Elvaloy or SBS PG 76-22 for IL-4.75, except where modified herein. The elastic recovery shall be a minimum of 80.

Note 3. A stabilizing additive such as cellulose or mineral fiber shall be added to the SMA mixture according to Illinois Modified AASHTO M 325. The stabilizing additive shall meet the Fiber Quality Requirements listed in Illinois Modified AASHTO M 325. Prior to approval and use of fibers, the Contractor shall submit a notarized certification by the producer of these materials stating they meet these requirements. Reclaimed Asphalt Shingles (RAS) may be used in Stone Matrix Asphalt (SMA) mixtures designed with an SBA polymer modifier as a fiber additive if the mix design with RAS included meets AASHTO T305 requirements. The RAS shall be from a certified source that produces either Type I or Type 2. Material shall meet requirements noted herein and the actual dosage rate will be determined by the Engineer.

Note 4. Warm mix additives or foaming processes shall be selected from the current Bureau of Materials and Physical Research Approved List, "Warm Mix Asphalt Technologies"."

Revise Article 1030.04(a)(1) of the Standard Specifications and the Supplemental Specifications to read:

"(1) High ESAL Mixtures. The Job Mix Formula (JMF) shall fall within the following limits.

High ESAL, MIXTURE COMPOSITION (% PASSING) 1/										
Sieve Size	IL-19.0 mm		SMA 4/ IL-12.5 mm		SMA 4/ IL-9.5 mm		IL-9.5 mm		IL-4.75 mm	
	min	max	min	max	min	max	min	max	min	max
1 1/2 in (37.5 mm)										
1 in. (25 mm)		100								
3/4 in. (19 mm)	90	100		100						
1/2 in. (12.5 mm)	75	89	80	100		100		100		100
3/8 in. (9.5 mm)				65	90	100	90	100		100
#4 (4.75 mm)	40	60	20	30	36	50	34	69	90	100
#8 (2.36 mm)	20	42	16	24 5/	16	32 5/	34 6/	52 2/	70	90
#16 (1.18 mm)	15	30					10	32	50	65
#30 (600 μm)			12	16	12	18				
#50 (300 μm)	6	15					4	15	15	30
#100 (150 μm)	4	9					3	10	10	18
#200 (75 μm)	3	6	7.0	9.0 3/	7.5	9.5 3/	4	6	7	9 3/
Ratio Dust/Asphalt Binder		1.0		1.5		1.5		1.0		1.0

1/ Based on percent of total aggregate weight.
2/ The mixture composition shall not exceed 44 percent passing the #8 (2.36 mm) sieve for surface courses with Ndesign = 90.
3/ Additional minus No. 200 (0.075 mm) material required by the mix design shall be mineral filler, unless otherwise approved by the Engineer.
4/ The maximum percent passing the #635 (20 μm) sieve shall be ≤ 3 percent.
5/ When establishing the Adjusted Job Mix Formula (AJMF) the percent passing the #8 (2.36 mm) sieve shall not be adjusted above the percentage stated on the table.
6/ When establishing the Adjusted Job Mix Formula (AJMF) the percent passing the #8 (2.36 mm) sieve shall not be adjusted below 34 percent.

Revise Article 1030.04(b)(1) of the Standard Specifications to read:

"(1) High ESAL Mixtures. The target value for the air voids of the HMA shall be 4.0 percent and for IL-4.75 it shall be 3.5 percent at the design number of gyrations. The VMA

and VFA of the HMA design shall be based on the nominal maximum size of the aggregate in the mix, and shall conform to the following requirements.

VOLUMETRIC REQUIREMENTS High ESAL				
	Voids in the Mineral Aggregate (VMA), % minimum			Voids Filled with Asphalt Binder (VFA), %
Ndesign	IL-19.0	IL-9.5	IL-4.75 1/	
50	13.5	15.0	18.5	65 – 78 2/
70				65 - 75
90				

1/ Maximum Draindown for IL-4.75 shall be 0.3 percent 2/

VFA for IL-4.75 shall be 72-85 percent"

Replace Article 1030.04(b)(3) of the Standard Specifications with the following:

"(3) SMA Mixtures.

Volumetric Requirements SMA 1/			
Ndesign	Design Air Voids Target %	Voids in the Mineral Aggregate (VMA), % min.	Voids Filled with Asphalt (VFA), %
80 4/	3.5	17.0 2/ 16.0 3/	75 - 83

1/ Maximum draindown shall be 0.3 percent. The draindown shall be determined at the JMF asphalt binder content at the mixing temperature plus 30 °F.

2/ Applies when specific gravity of coarse aggregate is ≥ 2.760.

3/ Applies when specific gravity of coarse aggregate is < 2.760. 4/

Blending of different types of aggregate will not be permitted.

For surface course, the coarse aggregate can be crushed steel slag, crystalline crushed stone or crushed sandstone. For binder course, coarse aggregate shall be crushed stone (dolomite), crushed gravel, crystalline crushed stone, or crushed sandstone.

Add to the end of Article 1030.05 (d) (2) a. of the Standard Specifications:

"During production, the Contractor shall test SMA mixtures for draindown according to AASHTO T305 at a frequency of 1 per day of production."

Delete last sentence of the second paragraph of Article 1102.01(a) (4) b. 2.

Add to the end of Article 1102.01 (a) (4) b. 2.:

"As an option, collected dust (baghouse) may be used in lieu of manufactured mineral filler according to the following:

(a.) Sufficient collected dust (baghouse) is available for production of the SMA mix for the entire project.

(b.) A mix design was prepared based on collected dust (baghouse).

2) DESIGN VERIFICATION AND PRODUCTION

Revise Article 1030.04 (d) of the Standard Specifications to read:

"(d) Verification Testing. High ESAL, IL-4.75, and SMA mix designs submitted for verification will be tested to ensure that the resulting mix designs will pass the required criteria for the Hamburg Wheel Test (IL mod AASHTO T-324) and the Tensile Strength Test (IL mod AASHTO T-283). The Department will perform a verification test on gyratory specimens compacted by the Contractor. If the mix fails the Department's verification test, the Contractor shall make the necessary changes to the mix and resubmit compacted specimens to the Department for verification. If the mix fails again, the mix design will be rejected.

All new and renewal mix designs will be required to be tested, prior to submittal for Department verification and shall meet the following requirements:

(1) Hamburg Wheel Test criteria. The maximum allowable rut depth shall be 0.5 in. (12.5 mm). The minimum number of wheel passes at the 0.5 in. (12.5 mm) rut depth criteria shall be based on the high temperature binder grade of the mix as specified in the mix requirements table of the plans.

Illinois Modified AASHTO T 324 Requirements [1/]

Asphalt Binder Grade	# Repetitions	Max Rut Depth (mm)
PG 70 -XX (or higher)	20,000	12.5
PG 64 -XX (or lower)	10,000	12.5

1/ When produced at temperatures of 275 ± 5 °F (135 ± 3 °C) or less, loose Warm Mix Asphalt shall be oven aged at 270 ± 5 °F (132 ± 3 °C) for two hours prior to gyratory compaction of Hamburg Wheel specimens.

Note: For SMA Designs (N-80) the maximum rut depth is 6.0 mm at 20,000 repetitions.
For IL 4.75mm Designs (N-50) the maximum rut depth is 9.0mm at 15,000 repetitions.

(2) Tensile Strength Criteria. The minimum allowable conditioned tensile strength shall be 60 psi (415 kPa) for non-polymer modified performance graded (PG) asphalt binder and 80 psi (550 kPa) for polymer modified PG asphalt binder. The maximum allowable unconditioned tensile strength shall be 200 psi (1380 kPa)."

Production Testing. Revise first paragraph of Article 1030.06(a) of the Standard Specifications to read:

"(a) High ESAL, IL-4.75, WMA, and SMA Mixtures. For each contract, a 300 ton (275 metric tons) test strip, except for SMA mixtures it will be 400 ton (363 metric ton), will be required at the beginning of HMA production for each mixture at the beginning of each construction year according to the Manual of Test Procedures for Materials "Hot Mix Asphalt Test Strip Procedures". At the request of the Producer, the Engineer may waive the test strip if previous construction during the current construction year has demonstrated the constructability of the mix using Department test results."

Add the following after the sixth paragraph in Article 1030.06 (a) of the Standard Specifications:

"The Hamburg Wheel test shall also be conducted on all HMA mixtures from a sample taken within the first 500 tons (450 metric tons) on the first day of production or during start up with a split reserved for the Department. The mix sample shall be tested according to the Illinois Modified AASHTO T 324 and shall meet the requirements specified herein. Mix production shall not exceed 1500 tons (1350 metric tons) or one day's production, whichever comes first, until the testing is completed and the mixture is found to be in conformance. The requirement to cease mix production may be waived if the plant produced mixture demonstrates conformance prior to start of mix production for a contract.

If the mixture fails to meet the Hamburg Wheel criteria, no further mixture will be accepted until the Contractor takes such action as is necessary to furnish a mixture meeting the criteria"

Method of Measurement:

Add the following after the fourth paragraph of Article 406.13 (b):

"The plan quantities of SMA mixtures shall be adjusted using the actual approved binder and surface Mix Design's G_{mb}."

Basis of Payment.

Replace the fourth paragraph of Article 406.14 of the Standard Specifications with the following:

"Stone matrix asphalt will be paid for at the contract unit price per ton (metric ton) for POLYMERIZED HOT-MIX ASPHALT SURFACE COURSE, STONE MATRIX ASPHALT, of the mixture composition and Ndesign specified; and POLYMERIZED HOT-MIX ASPHALT BINDER COURSE, STONE MATRIX ASPHALT, of the mixture composition and Ndesign specified."

PUBLIC CONVENIENCE AND SAFETY (D-1)
Effective: May 1, 2012 Revised: July 15, 2012

Add the following to the end of the fourth paragraph of Article 107.09:

"If the holiday is on a Saturday or Sunday, and is legally observed on a Friday or Monday, the length of Holiday Period for Monday or Friday shall apply."

Add the following sentence after the Holiday Period table in the fourth paragraph of Article 107.09:

"The Length of Holiday Period for Thanksgiving shall be from 5:00 AM the Wednesday prior to 11:59 PM the Sunday After"

Delete the fifth paragraph of Article 107.09 of the Standard Specifications:

"On weekends, excluding holidays, roadways with Average Daily Traffic of 25,000 or greater, all lanes shall be open to traffic from 3:00 P.M. Friday to midnight Sunday except where structure construction or major rehabilitation makes it impractical."

RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES (D-1)
Effective: November 1, 2012 Revise: January 1, 2018

Revise Section 1031 of the Standard Specifications to read:

"SECTION 1031. RECLAIMED ASPHALT PAVEMENT AND RECLAIMED ASPHALT SHINGLES

1031.01 Description. Reclaimed asphalt pavement and reclaimed asphalt shingles shall be according to the following.

(a) Reclaimed Asphalt Pavement (RAP). RAP is the material resulting from cold milling or crushing an existing hot-mix asphalt (HMA) pavement. RAP will be considered processed FRAP after completion of both crushing and screening to size. The Contractor shall supply written documentation that the RAP originated from routes or airfields under federal, state, or local agency jurisdiction.

(b) Reclaimed Asphalt Shingles (RAS). Reclaimed asphalt shingles (RAS). RAS is from the processing and grinding of preconsumer or post-consumer shingles. RAS shall be a clean and uniform material with a maximum of 0.5 percent unacceptable material, as defined in Central Bureau of Materials Policy Memorandum, "Reclaimed Asphalt Shingle (RAS) Sources", by weight of RAS. All RAS used shall come from a Central Bureau of Materials approved processing facility where it shall be ground and processed to 100 percent passing the 3/8 in. (9.5 mm) sieve and 90 percent passing the #4 (4.75 mm) sieve. RAS shall meet the testing requirements specified herein. In addition, RAS shall meet the following Type 1 or Type 2 requirements.

(1) Type 1. Type 1 RAS shall be processed, preconsumer asphalt shingles salvaged from the manufacture of residential asphalt roofing shingles.

(2) Type 2. Type 2 RAS shall be processed post-consumer shingles only, salvaged from residential, or four unit or less dwellings not subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP).

1031.02 Stockpiles. RAP and RAS stockpiles shall be according to the following.

(a) RAP Stockpiles. The Contractor shall construct individual, sealed RAP stockpiles meeting one of the following definitions. Additional processed RAP (FRAP) shall be stockpiled in a separate working pile, as designated in the QC Plan, and only added to the sealed stockpile when test results for the working pile are complete and are found to meet tolerances specified herein for the original sealed FRAP stockpile. Stockpiles shall be sufficiently separated to prevent intermingling at the base. All stockpiles (including unprocessed RAP and FRAP) shall be identified by signs indicating the type as listed below (i.e. “Non- Quality, FRAP -#4 or Type 2 RAS”, etc…).

(1) Fractionated RAP (FRAP). FRAP shall consist of RAP from Class I, HMA (High and Low ESAL) or equivalent mixtures. The coarse aggregate in FRAP shall be crushed aggregate and may represent more than one aggregate type and/or quality, but shall be at least C quality. All FRAP shall be processed prior to testing and sized into fractions with the separation occurring on or between the #4 (4.75 mm) and 1/2 in. (12.5 mm) sieves. Agglomerations shall be minimized such that 100 percent of the RAP in the coarse fraction shall pass the maximum sieve size specified for the mix the FRAP will be used in.

(2) Restricted FRAP (B quality) stockpiles shall consist of RAP from Class I, HMA (High ESAL), or HMA (High ESAL). If approved by the Engineer, the aggregate from a maximum 3.0 in. (75 mm) single combined pass of surface/binder milling will be classified as B quality. All millings from this application will be processed into FRAP as described previously.

(3) Conglomerate. Conglomerate RAP stockpiles shall consist of RAP from Class I, HMA (High and Low ESAL) or equivalent mixtures. The coarse aggregate in this RAP shall be crushed aggregate and may represent more than one aggregate type and/or quality, but shall be at least C quality. This RAP may have an inconsistent gradation and/or asphalt binder content prior to processing. All conglomerate RAP shall be processed (FRAP) prior to testing. Conglomerate RAP stockpiles shall not contain steel slag or other expansive material as determined by the Department.

(4) Conglomerate “D” Quality (DQ). Conglomerate DQ RAP stockpiles shall consist of RAP from HMA shoulders, bituminous stabilized subbases or HMA (Low ESAL)/HMA (Low ESAL) IL-19.0L binder mixture. The coarse aggregate in this RAP may be crushed or round but shall be at least D quality. This RAP may have an inconsistent gradation and/or asphalt binder content. Conglomerate DQ RAP stockpiles shall not contain steel slag or other expansive material as determined by the Department.

(5) Non-Quality. RAP stockpiles that do not meet the requirements of the stockpile categories listed above shall be classified as “Non-Quality”.

RAP or FRAP containing contaminants, such as earth, brick, sand, concrete, sheet asphalt, bituminous surface treatment (i.e. chip seal), pavement fabric, joint sealants, plant cleanout etc., will be unacceptable unless the contaminants are removed to the satisfaction of the Engineer. Sheet asphalt shall be stockpiled separately.

(b) RAS Stockpiles. Type 1 and Type 2 RAS shall be stockpiled separately and shall be sufficiently separated to prevent intermingling at the base. Each stockpile shall be signed indicating what type of RAS is present.

However, a RAS source may submit a written request to the Department for approval to blend mechanically a specified ratio of Type 1 RAS with Type 2 RAS. The source will not be permitted to change the ratio of the blend without the Department prior written approval. The Engineer's written approval will be required, to mechanically blend RAS with any fine aggregate produced under the AGCS, up to an equal weight of RAS, to improve workability. The fine aggregate shall be "B Quality" or better from an approved Aggregate Gradation Control System source. The fine aggregate shall be one that is approved for use in the HMA mixture and accounted for in the mix design and during HMA production.

Records identifying the shingle processing facility supplying the RAS, RAS type, and lot number shall be maintained by project contract number and kept for a minimum of three years.

1031.03 Testing. FRAP and RAS testing shall be according to the following.

(a) FRAP Testing. When used in HMA, the FRAP shall be sampled and tested either during processing or after stockpiling. It shall also be sampled during HMA production.

(1) During Stockpiling. For testing during stockpiling, washed extraction samples shall be run at the minimum frequency of one sample per 500 tons (450 metric tons) for the first 2000 tons (1800 metric tons) and one sample per 2000 tons (1800 metric tons) thereafter. A minimum of five tests shall be required for stockpiles less than 4000 tons (3600 metric tons).

(2) Incoming Material. For testing as incoming material, washed extraction samples shall be run at a minimum frequency of one sample per 2000 tons (1800 metric tons) or once per week, whichever comes first.

(3) After Stockpiling. For testing after stockpiling, the Contractor shall submit a plan for approval to the District proposing a satisfactory method of sampling and testing the RAP/FRAP pile either in-situ or by restockpiling. The sampling plan shall meet the minimum frequency required above and detail the procedure used to obtain representative samples throughout the pile for testing.

Before extraction, each field sample of FRAP, shall be split to obtain two samples of test sample size. One of the two test samples from the final split shall be labeled and stored for Department use. The Contractor shall extract the other test sample according to Department procedure. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

(b) RAS Testing. RAS shall be sampled and tested during stockpiling according to Central Bureau of Materials Policy Memorandum, "Reclaimed Asphalt Shingle (RAS) Sources". The Contractor shall also sample as incoming material at the HMA plant.

(1) During Stockpiling. Washed extraction and testing for unacceptable materials shall be run at the minimum frequency of one sample per 200 tons (180 metric tons) for the first 1000 tons (900 metric tons) and one sample per 1000 tons (900 metric tons) thereafter. A minimum of five samples are required for stockpiles less than 1000 tons (900 metric tons). Once a ≤ 1000 ton (900 metric ton), five-sample/test stockpile has been established it shall be sealed. Additional incoming RAS shall be in a separate working pile as designated in the Quality Control plan and only added to the sealed stockpile when the test results of the working pile are complete and are found to meet the tolerances specified herein for the original sealed RAS stockpile.

(2) Incoming Material. For testing as incoming material at the HMA plant, washed extraction shall be run at the minimum frequency of one sample per 250 tons (227 metric tons). A minimum of five samples are required for stockpiles less than 1000 tons (900 metric tons). The incoming material test results shall meet the tolerances specified herein.

The Contractor shall obtain and make available all test results from start of the initial stockpile sampled and tested at the shingle processing facility in accordance with the facility's QC Plan.

Before extraction, each field sample shall be split to obtain two samples of test sample size. One of the two test samples from the final split shall be labeled and stored for Department use. The Contractor shall extract the other test sample according to Department procedures. The Engineer reserves the right to test any sample (split or Department-taken) to verify Contractor test results.

1031.04 Evaluation of Tests. Evaluation of test results shall be according to the following.

(a) Evaluation of FRAP Test Results. All test results shall be compiled to include asphalt binder content, gradation and, when applicable (for slag), Gmm. A five test average of results from the original pile will be used in the mix designs. Individual extraction test results run thereafter, shall be compared to the average used for the mix design, and will be accepted if within the tolerances listed below.

Parameter	FRAP
No. 4 (4.75 mm)	□ 6 %
No. 8 (2.36 mm)	□ 5 %
No. 30 (600 □m)	□ 5 %
No. 200 (75 □m)	□ 2.0 %
Asphalt Binder	□ 0.3 %
Gmm	□ 0.03 1/

1/ For stockpile with slag or steel slag present as determined in the current Manual of Test Procedures Appendix B 21, “Determination of Reclaimed Asphalt Pavement Aggregate Bulk Specific Gravity”.

If any individual sieve and/or asphalt binder content tests are out of the above tolerances when compared to the average used for the mix design, the FRAP stockpile shall not be used in Hot-Mix Asphalt unless the FRAP representing those tests is removed from the stockpile. All test data and acceptance ranges shall be sent to the District for evaluation.

The Contractor shall maintain a representative moving average of five tests to be used for Hot-Mix Asphalt production.

With the approval of the Engineer, the ignition oven may be substituted for extractions according to the ITP, “Calibration of the Ignition Oven for the Purpose of Characterizing Reclaimed Asphalt Pavement (RAP)” or Illinois Modified AASHTO T-164-11, Test Method A.

(b) Evaluation of RAS Test Results. All of the test results, with the exception of percent unacceptable materials, shall be compiled and averaged for asphalt binder content and gradation. A five test average of results from the original pile will be used in the mix designs. Individual test results run thereafter, when compared to the average used for the mix design, will be accepted if within the tolerances listed below.

Parameter	RAS
No. 8 (2.36 mm)	± 5 %
No. 16 (1.18 mm)	± 5 %
No. 30 (600 µm)	± 4 %
No. 200 (75 µm)	± 2.5 %
Asphalt Binder Content	± 2.0 %

If any individual sieve and/or asphalt binder content tests are out of the above tolerances when compared to the average used for the mix design, the RAS shall not be used in Hot-Mix Asphalt unless the RAS representing those tests is removed from the stockpile. All test data and acceptance ranges shall be sent to the District for evaluation.

(c) Quality Assurance by the Engineer. The Engineer may witness the sampling and splitting conduct assurance tests on split samples taken by the Contractor for quality control testing a minimum of once a month.

The overall testing frequency will be performed over the entire range of Contractor samples for asphalt binder content and gradation. The Engineer may select any or all split samples for assurance testing. The test results will be made available to the Contractor as soon as they become available.

The Engineer will notify the Contractor of observed deficiencies.

Differences between the Contractor's and the Engineer's split sample test results will be considered acceptable if within the following limits.

Test Parameter	Acceptable Limits of Precision	
% Passing: 1/	FRAP	RAS
1/2 in.	5.0%	
No. 4	5.0%	
No. 8	3.0%	4.0%
No. 30	2.0%	4.0%
No. 200	2.2%	4.0%
Asphalt Binder Content	0.3%	3.0%
Gmm	0.030	

1/ Based on washed extraction.

In the event comparisons are outside the above acceptable limits of precision, the Engineer will immediately investigate.

(d) Acceptance by the Engineer. Acceptable of the material will be based on the validation of the Contractor's quality control by the assurance process.

1031.05 Quality Designation of Aggregate in RAP and FRAP.

(a) RAP. The aggregate quality of the RAP for homogeneous, conglomerate, and conglomerate "D" quality stockpiles shall be set by the lowest quality of coarse aggregate in the RAP stockpile and are designated as follows.

(1) RAP from Class I, HMA (High ESAL), or (Low ESAL) IL-9.5L surface mixtures are designated as containing Class B quality coarse aggregate.

(2) RAP from HMA (Low ESAL) IL-19.0L binder mixture is designated as Class D quality coarse aggregate.

(3) RAP from Class I, HMA (High ESAL) binder mixtures, bituminous base course mixtures, and bituminous base course widening mixtures are designated as containing Class C quality coarse aggregate.

(4) RAP from bituminous stabilized subbase and BAM shoulders are designated as containing Class D quality coarse aggregate.

(b) FRAP. If the Engineer has documentation of the quality of the FRAP aggregate, the Contractor shall use the assigned quality provided by the Engineer.

If the quality is not known, the quality shall be determined as follows. Fractionated RAP stockpiles containing plus #4 (4.75 mm) sieve coarse aggregate shall have a maximum tonnage of 5,000 tons (4,500 metric tons). The Contractor shall obtain a representative sample witnessed by the Engineer. The sample shall be a minimum of 50 lb (25 kg). The sample shall be extracted according to Illinois Modified AASHTO T 164 by a consultant laboratory prequalified by the Department for the specified testing. The consultant laboratory shall submit the test results along with the recovered aggregate to the District Office. The cost for this testing shall be paid by the Contractor. The District will forward the sample to the Central Bureau of Materials Aggregate Lab for MicroDeval Testing, according to ITP 327. A maximum loss of 15.0 percent will be applied for all HMA applications. The fine aggregate portion of the fractionated RAP shall not be used in any HMA mixtures that require a minimum of "B" quality aggregate or better, until the coarse aggregate fraction has been determined to be acceptable thru a MicroDeval Testing.

1031.06 Use of FRAP and/or RAS in HMA. The use of FRAP and/or RAS shall be the Contractor's option when constructing HMA in all contracts.

(a) FRAP. The use of FRAP in HMA shall be as follows.

(1) Coarse Aggregate Size (after extraction). The coarse aggregate in all FRAP shall be equal to or less than the nominal maximum size requirement for the HMA mixture to be produced.

(2) Steel Slag Stockpiles. FRAP stockpiles containing steel slag or other expansive material, as determined by the Department, shall be homogeneous and will be approved for use in HMA (High ESAL and Low ESAL) mixtures regardless of lift or mix type.

(3) Use in HMA Surface Mixtures (High and Low ESAL). FRAP stockpiles for use in HMA surface mixtures (High and Low ESAL) shall have coarse aggregate that is Class B quality or better. FRAP shall be considered equivalent to limestone for frictional considerations unless produced/screened to minus 3/8 inch.

(4) Use in HMA Binder Mixtures (High and Low ESAL), HMA Base Course, and HMA Base Course Widening. FRAP stockpiles for use in HMA binder mixtures (High and Low ESAL), HMA base course, and HMA base course widening shall be FRAP in which the coarse aggregate is Class C quality or better.

(5) Use in Shoulders and Subbase. FRAP stockpiles for use in HMA shoulders and stabilized subbase (HMA) shall be FRAP, Restricted FRAP, conglomerate, or conglomerate DQ.

(b) RAS. RAS meeting Type 1 or Type 2 requirements will be permitted in all HMA applications as specified herein.

(c) FRAP and/or RAS Usage Limits. Type 1 or Type 2 RAS may be used alone or in conjunction with FRAP in HMA mixtures up to a maximum of 5.0 percent by weight of the total mix.

When FRAP is used alone or FRAP is used in conjunction with RAS, the percent of virgin asphalt binder replacement (ABR) shall not exceed the amounts indicated in the table below for a given N Design.

Max Asphalt Binder Replacement for FRAP with RAS Combination

HMA Mixtures 1/ 2/ 4/	Maximum % ABR		
Ndesign	Binder/Leveling Binder	Surface	Polymer Modified 3/
30L	50	40	30
50	40	35	30
70	40	30	30
90	40	30	30
4.75 mm N-50			40
SMA N-80			30

1/ For Low ESAL HMA shoulder and stabilized subbase, the percent asphalt binder replacement shall not exceed 50 % of the total asphalt binder in the mixture.

2/ When the binder replacement exceeds 15 % for all mixes, except for SMA and IL-4.75, the high and low virgin asphalt binder grades shall each be reduced by one grade (i.e. 25 % binder replacement using a virgin asphalt binder grade of PG64-22 will be reduced to a PG58-28). When constructing full depth HMA and the ABR is less than 15 %, the required virgin asphalt binder grade shall be PG64-28.

3/ When the ABR for SMA or IL-4.75 is 15 % or less, the required virgin asphalt binder shall be SBS PG76-22 and the elastic recovery shall be a minimum of 80. When the ABR for SMA or IL-4.75 exceeds 15%, the virgin asphalt binder grade shall be SBS PG70-28 and the elastic recovery shall be a minimum of 80.

4/ When FRAP or RAS is used alone, the maximum percent asphalt binder replacement designated on the table shall be reduced by 10 %.

1031.07 HMA Mix Designs. At the Contractor's option, HMA mixtures may be constructed utilizing RAP/FRAP and/or RAS material meeting the detailed requirements specified herein.

(a) FRAP and/or RAS. FRAP and /or RAS mix designs shall be submitted for verification. If additional FRAP or RAS stockpiles are tested and found to be within tolerance, as defined under "Evaluation of Tests" herein, and meet all requirements herein, the additional FRAP or RAS stockpiles may be used in the original design at the percent previously verified.

(b) RAS. Type 1 and Type 2 RAS are not interchangeable in a mix design.

The RAP, FRAP and RAS stone specific gravities (Gsb) shall be according to the "Determination of Aggregate Bulk (Dry) Specific Gravity (Gsb) or Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS)" procedure in the Department's Manual of Test Procedures for Materials.

1031.08 HMA Production. HMA production utilizing FRAP and/or RAS shall be as follows.

To remove or reduce agglomerated material, a scalping screen, gator, crushing unit, or comparable sizing device approved by the Engineer shall be used in the RAS and FRAP feed system to remove or reduce oversized material. .

If during mix production, corrective actions fail to maintain FRAP, RAS or QC/QA test results within control tolerances or the requirements listed herein the Contractor shall cease production of the mixture containing FRAP or RAS and conduct an investigation that may require a new mix design.

(a) RAS. RAS shall be incorporated into the HMA mixture either by a separate weight depletion system or by using the RAP weigh belt. Either feed system shall be interlocked with the aggregate feed or weigh system to maintain correct proportions for all rates of production and batch sizes. The portion of RAS shall be controlled accurately to within ± 0.5 percent of the amount of RAS utilized. When using the weight depletion system, flow indicators or sensing devices shall be provided and interlocked with the plant controls such that the mixture production is halted when RAS flow is interrupted.

(b) HMA Plant Requirements. HMA plants utilizing FRAP and/or RAS shall be capable of automatically recording and printing the following information.

(1) Dryer Drum Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Accumulated weight of dry aggregate (combined or individual) in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

d. Accumulated dry weight of RAS and FRAP in tons (metric tons) to the nearest 0.1 ton (0.1 metric ton).

e. Accumulated mineral filler in revolutions, tons (metric tons), etc. to the nearest 0.1 unit.

f. Accumulated asphalt binder in gallons (liters), tons (metric tons), etc. to the nearest 0.1 unit.

g. Residual asphalt binder in the RAS and FRAP material as a percent of the total mix to the nearest 0.1 percent.

h. Aggregate RAS and FRAP moisture compensators in percent as set on the control panel. (Required when accumulated or individual aggregate and RAS and FRAP are printed in wet condition.)

i. When producing mixtures with FRAP and/or RAS, a positive dust control system shall be utilized.

j. Accumulated mixture tonnage.

k. Dust Removed (accumulated to the nearest 0.1 ton (0.1 metric ton))

(2) Batch Plants.

a. Date, month, year, and time to the nearest minute for each print.

b. HMA mix number assigned by the Department.

c. Individual virgin aggregate hot bin batch weights to the nearest pound (kilogram).

d. Mineral filler weight to the nearest pound (kilogram).

f. RAS and FRAP weight to the nearest pound (kilogram).

g. Virgin asphalt binder weight to the nearest pound (kilogram).

h. Residual asphalt binder in the RAS and FRAP material as a percent of the total mix to the nearest 0.1 percent.

The printouts shall be maintained in a file at the plant for a minimum of one year or as directed by the Engineer and shall be made available upon request. The printing system will be inspected by the Engineer prior to production and verified at the beginning of each construction season thereafter.

1031.09 RAP in Aggregate Surface Course and Aggregate Wedge Shoulders, Type B. The use of RAP or FRAP in aggregate surface course and aggregate shoulders shall be as follows.

(a) Stockpiles and Testing. RAP stockpiles may be any of those listed in Article 1031.02, except "Non-Quality" and "FRAP". The testing requirements of Article 1031.03 shall not apply. RAP used shall be according to the current Central Bureau of Materials Policy Memorandum, "Reclaimed Asphalt Pavement (RAP) for Aggregate Applications".

(b) Gradation. The RAP material shall meet the gradation requirements for CA 6 according to Article 1004.01(c), except the requirements for the minus No. 200 (75 µm) sieve shall not apply. The sample for the RAP material shall be air dried to constant weight prior to being tested for gradation."

GENERAL ELECTRICAL REQUIREMENTS (D-1)
Effective: June 1, 2016

This special provision replaces Articles 801.01 – 801.07, 801.09 – 801-16 of the Standard Specifications.

Definition. Codes, standards, and industry specifications cited for electrical work shall be by definition the latest adopted version thereof, unless indicated otherwise.

Materials by definition shall include electrical equipment, fittings, devices, motors, appliances, fixtures, apparatus, all hardware and appurtenances, and the like, used as part of, or in connection with, electrical installation.

Standards of Installation. Materials shall be installed according to the manufacturer's recommendations, the NEC, OSHA, the NESC, and AASHTO's Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

All like materials shall be from the same manufacturer. Listed and labeled materials shall be used whenever possible. The listing shall be according to UL or an approved equivalent.

Safety and Protection. Safety and protection requirements shall be as follows.

Safety. Electrical systems shall not be left in an exposed or otherwise hazardous condition. All electrical boxes, cabinets, pole handholes, etc. which contain wiring, either energized or non- energized, shall be closed or shall have covers in place and be locked when possible, during nonworking hours.

Protection. Electrical raceway or duct openings shall be capped or otherwise sealed from the entrance of water and dirt. Wiring shall be protected from mechanical injury.

Equipment Grounding Conductor. All electrical systems, materials, and appurtenances shall be grounded. Good ground continuity throughout the electrical system shall be assured, even though every detail of the requirements is not specified or shown. Electrical circuits shall have a continuous insulated equipment grounding conductor. When metallic conduit is used, it shall be bonded to the equipment grounding conductor, but shall not be used as the equipment grounding conductor.

Detector loop lead-in circuits, circuits under 50 volts, and runs of fiber optic cable will not require an equipment grounding conductor.

Where connections are made to painted surfaces, the paint shall be scraped to fully expose metal at the connection point. After the connection is completed, the paint system shall be repaired to the satisfaction of the Engineer.

Bonding of all boxes and other metallic enclosures throughout the wiring system to the equipment grounding conductor shall be made using a splice and pigtail connection. Mechanical connectors shall have a serrated washer at the contact surface.

All connections to structural steel or fencing shall be made with exothermic welds. Care shall be taken not to weaken load carrying members. Where connections are made to epoxy coated reinforcing steel, the epoxy coating shall be sufficiently removed to facilitate a mechanical connection. The epoxy coating shall be repaired to the satisfaction of the Engineer. Where connections are made to insulated conductors, the connection shall be wrapped with at least four layers of electrical tape extended 6 in. (150 mm) onto the conductor insulation.

Submittals. At the preconstruction meeting, the Contractor shall submit a written listing of manufacturers for all major electrical and mechanical items. The list of manufacturers shall be binding, except by written request from the Contractor and approval by the Engineer. The request shall include acceptable reasons and documentation for the change.

Major items shall include, but not limited to the following:

Type of Work (discipline)	Item
All Electrical Work	Electric Service Metering Emergency Standby System Transformers Cable Unit Duct Splices Conduit Surge Suppression System
Lighting	Tower Pole Luminaire Foundation Breakaway Device Controllers Control Cabinet and Peripherals
ITS	Controller Cabinet and Peripherals CCTV Cameras Camera Structures Ethernet Switches Detectors Detector Loop Fiber Optic Cable

Within 30 calendar days after contract execution, the Contractor shall submit, for approval, one copy each of the manufacturer's product data (for standard products and components) and detailed shop drawings (for fabricated items). Submittals for the materials for each individual pay item shall be complete in every respect. Submittals which include multiple pay items shall have all submittal material for each item or group of items covered by a particular specification, grouped together and the applicable pay item identified. Various submittals shall, when taken together, form a complete coordinated package. A partial submittal will be returned without review unless prior written permission is obtained from the Engineer.

The submittal shall be properly identified by route, section, county, and contract number.

The Contractor shall have reviewed the submittal material and affixed his/her stamp of approval, with date and signature, for each individual item. In case of subcontractor submittal, both the subcontractor and the Contractor shall review, sign, and stamp their approval on the submittal.

Illegible print, incompleteness, inaccuracy, or lack of coordination will be grounds for rejection.

Items from multiple disciplines shall not be combined on a single submittal and transmittal. Items for lighting, signals, surveillance and CCTV must be in separate submittals since they may be reviewed by various personnel in various locations.

The Engineer will review the submittals for conformance with the design concept of the project according to Article 105.04 and the following. The Engineer will stamp the drawings indicating their status as "Approved", "Approved as Noted", "Disapproved", or "Information Only". Since the Engineer's review is for conformance with the design concept only, it shall be the Contractor's responsibility to coordinate the various items into a working system as specified. The Contractor shall not be relieved from responsibility for errors or omissions in the shop, working, or layout drawings by the Engineer's approval thereof. The Contractor shall still be in full compliance with contract and specification requirements.

All submitted items reviewed and marked "Disapproved" or "Approved as Noted" shall be resubmitted by the Contractor in their entirety, unless otherwise indicated within the submittal comments.

Work shall not begin until the Engineer has approved the submittal. Material installed prior to approval by the Engineer, will be subject to removal and replacement at no additional cost to the Department.

Unless otherwise approved by the Engineer, all of the above items shall be submitted to the Engineer at the same time. Each item shall be properly identified by route, section, and contract number.

Certifications. When certifications are specified and are available prior to material manufacture, the certification shall be included in the submittal information. When specified and only available after manufacture, the submittal shall include a statement of intent to furnish certification. All certificates shall be complete with all appropriate test dates and data.

Authorized Project Delay. See Article 801.08

Maintenance Transfer and Preconstruction Inspection:

General. Before performing any excavation, removal, or installation work (electrical or otherwise) at the site, the Contractor shall request a maintenance transfer and preconstruction site inspection, to be held in the presence of the Engineer and a representative of the party or parties responsible for maintenance of any lighting and/or traffic control systems which may be affected by the work. The request for the maintenance transfer and preconstruction inspection shall be made no less than seven (7) calendar days prior to the desired inspection date. The maintenance transfer and preconstruction inspection shall:

Establish the procedures for formal transfer of maintenance responsibility required for the construction period.

Establish the approximate location and operating condition of lighting and/or traffic control systems which may be affected by the work

Marking of Existing Cable Systems. The party responsible for maintenance of any existing lighting and/or traffic control systems at the project site will, at the Contractor's request, mark and/or stake, once per location, all underground cable routes owned or maintained by the State. A project may involve multiple "locations" where separated electrical systems are involved (i.e. different controllers). The markings shall be taken to have a horizontal tolerance of at least 304.8 mm (one (1) foot) to either side.. The request for the cable locations and marking shall be made at the same time the request for the maintenance transfer and preconstruction inspection is made. The Contractor shall exercise extreme caution where existing buried cable runs are involved. The markings of existing systems are made strictly for assistance to the Contractor and this does not relieve the Contractor of responsibility for the repair or replacement of any cable run damaged in the course of his work, as specified elsewhere herein. Note that the contractor shall be entitled to only one request for location marking of existing systems and that multiple requests may only be honored at the contractor's expense. No locates will be made after maintenance is transferred, unless it is at the contractor's expense.

Condition of Existing Systems. The Contractor shall conduct an inventory of all existing electrical system equipment within the project limits, which may be affected by the work, making note of any parts which are found broken or missing, defective or malfunctioning. Megger and load readings shall be taken for all existing circuits which will remain in place or be modified. If a circuit is to be taken out in its entirety, then readings do not have to be taken. The inventory and test data shall be reviewed with and approved by the Engineer and a record of the inventory shall be submitted to the Engineer for the record. Without such a record, all systems transferred to the Contractor for maintenance during construction shall be returned at the end of construction in complete, fully operating condition."

Marking Proposed Locations for Highway Lighting System. The Contractor shall mark or stake the proposed locations of all poles, cabinets, junction boxes, pull boxes, handholes, cable routes, pavement crossings, and other items pertinent to the work. A proposed location inspection by the Engineer shall be requested prior to any excavation, construction, or installation work after all proposed installation locations are marked. Any work installed without location approval is subject to corrective action at no additional cost to the Department.

Inspection of electrical work. Inspection of electrical work shall be according to Article 105.12 and the following.

Before any splice, tap, or electrical connection is covered in handholes, junction boxes, light poles, or other enclosures, the Contractor shall notify and make available such wiring for the Engineer's inspection.

Maintenance and Responsibility During Construction.

Lighting Operation and Maintenance Responsibility. The scope of work shall include the assumption of responsibility for the continuing operation and maintenance of the existing, proposed, temporary, sign and navigation lighting, or other lighting systems and all appurtenances affected by the work as specified elsewhere herein. Maintenance of lighting systems is specified elsewhere and will be paid for separately

The proposed lighting system must be operational prior to opening the roadway to traffic unless temporary lighting exists which is designed and installed to properly illuminate the roadway.

Energy and Demand Charges. The payment of basic energy and demand charges by the electric utility for existing lighting which remains in service will continue as a responsibility of the Owner, unless otherwise indicated. Unless otherwise indicated or required by the Engineer duplicate lighting systems (such as temporary lighting and proposed new lighting) shall not be operated simultaneously at the Owner's expense and lighting systems shall not be kept in operation during long daytime periods at the Owner's expense. Upon written authorization from the Engineer to place a proposed new lighting system in service, whether the system has passed final acceptance or not, (such as to allow temporary lighting to be removed), the Owner will accept responsibility for energy and demand charges for such lighting, effective the date of authorization. All other energy and demand payments to the utility shall be the responsibility of the Contractor until final acceptance.

Damage to Electrical Systems. Should damage occur to any existing electrical systems through the Contractor's operations, the Engineer will designate the repairs as emergency or non-emergency in nature.

Emergency repairs shall be made by the Contractor, or as determined by the Engineer, the Department, or its agent. Non-emergency repairs shall be performed by the Contractor within six working days following discovery or notification. All repairs shall be performed in an expeditious manner to assure all electrical systems are operational as soon as possible. The repairs shall be performed at no additional cost to the Department.

Lighting. An outage will be considered an emergency when three or more lights on a circuit or three successive lights are not operational. Knocked down materials, which result in a danger to the motoring public, will be considered an emergency repair.

Temporary aerial multi-conductor cable, with grounded messenger cable, will be permitted if it does not interfere with traffic or other operations, and if the Engineer determines it does not require unacceptable modification to existing installations.

Testing. Before final inspection, the electrical work shall be tested. Tests may be made progressively as parts of the work are completed, or may be made when the work is complete. Tests shall be made in the presence of the Engineer. Items which fail to test satisfactorily shall be repaired or replaced. Tests shall include checks of control operation, system voltages, cable insulation, and ground resistance and continuity.

The forms for recording test readings will be available from the Engineer in electronic format. The Contractor shall provide the Engineer with a written report of all test data including the following:

- Voltage Tests
- Amperage Tests
- Insulation Resistance Tests
- Continuity tests
- Detector Loop Tests

Lighting systems. The following tests shall be made.

(1) Voltage Measurements. Voltages in the cabinet from phase to phase and phase to neutral, at no load and at full load, shall be measured and recorded. Voltage readings at the last termination of each circuit shall be measured and recorded.

(2) Insulation Resistance. Insulation resistance to ground of each circuit at the cabinet, with all loads connected, shall be measured and recorded.

On tests of new cable runs, the readings shall exceed 50 megohms for phase and neutral conductors with a connected load over 20 A, and shall exceed 100 megohms for conductors with a connected load of 20 A or less.

On tests of cable runs which include cables which were existing in service prior to this contract, the resistance readings shall be the same or better than the readings recorded at the maintenance transfer at the beginning of the contract. Measurements shall be taken with a megohm meter approved by the Engineer.

(3) Loads. The current of each circuit, phase main, and neutral shall be measured and recorded. The Engineer may direct reasonable circuit rearrangement. The current readings shall be within ten percent of the connected load based on material ratings.

(4) Ground Continuity. Resistance of the system ground as taken from the farthest extension of each circuit run from the controller (i.e. check of equipment ground continuity for each circuit) shall be measured and recorded. Readings shall not exceed 2.0 ohms, regardless of the length of the circuit.

(5) Resistance of Grounding Electrodes. Resistance to ground of all grounding electrodes shall be measured and recorded. Measurements shall be made with a ground tester during dry soil conditions as approved by the Engineer. Resistance to ground shall not exceed 10 ohms.

ITS. The following test shall be made in addition to the lighting system test above.

Detector Loops. Before and after permanently securing the loop in the pavement, the resistance, inductance, resistance to ground, and quality factor for each loop and lead-in circuit shall be tested. The loop and lead-in circuit shall have an inductance between 20 and 2500 microhenries. The resistance to ground shall be a minimum of 50 megohms under any conditions of weather or moisture. The quality factor (Q) shall be 5 or greater.

Fiber Optic Systems. Fiber optic testing shall be performed as required in the fiber optic cable special provision and the fiber optic splice special provision.

All test results shall be furnished to the Engineer seven working days before the date the inspection is scheduled.

Contract Guarantee. The Contractor shall provide a written guarantee for all electrical work provided under the contract for a period of six months after the date of acceptance with the following warranties and guarantees.

(a) The manufacturer's standard written warranty for each piece of electrical material or apparatus furnished under the contract. The warranty for light emitting diode (LED) modules, including the maintained minimum luminance, shall cover a minimum of 60 months from the date of delivery.

(b) The Contractor's written guarantee that, for a period of six months after the date of final acceptance of the work, all necessary repairs to or replacement of said warranted material or apparatus for reasons not proven to have been caused by negligence on the part of the user or acts of a third party shall be made by the Contractor at no additional cost to the Department.

(c) The Contractor's written guarantee for satisfactory operation of all electrical systems furnished and constructed under the contract for a period of six months after final acceptance of the work.

The warranty for an uninterruptable power supply (UPS) shall cover a minimum of two years from date the equipment is placed in operation; however, the batteries of the UPS shall be warranted for full replacement for a minimum of five years.

Record Drawings. Alterations and additions to the electrical installation made during the execution of the work shall be neatly and plainly marked in red by the Contractor on the full-size set of record drawings kept at the Engineer's field office for the project. These drawings shall be updated on a daily basis and shall be available for inspection by the Engineer during the course of the work. The record drawings shall include the following:

- Cover Sheet
- Summary of Quantities, electrical items only
- Legends, Schedules and Notes
- Plan Sheet
- Pertinent Details
- Single Line Diagram
- Other useful information useful to locate and maintain the systems.

Any modifications to the details shall be indicated. Final quantities used shall be indicated on the Summary of Quantities. Foundation depths used shall also be listed.

As part of the record drawings, the Contractor shall inventory all materials, new or existing, on the project and record information on inventory sheets provided by the Engineer.

The inventory shall include:

- Location of Equipment, including rack, chassis, slot as applicable.
- Designation of Equipment
- Equipment manufacturer
- Equipment model number
- Equipment Version Number
- Equipment Configuration
    - Addressing, IP or other
    - Settings, hardware or programmed
- Equipment Serial Number

The following electronic inventory forms are available from the Engineer:

- Lighting Controller Inventory
- Lighting Inventory
- Light Tower Inspection Checklist
- ITS Location Inventory

The information shall be entered in the forms; handwritten entries will not be acceptable; except for signatures. Electronic file shall also be included in the documentation.

When the work is complete, and seven days before the request for a final inspection, the set of contract drawings, stamped "**RECORD DRAWINGS**", shall be submitted to the Engineer for review and approval and shall be stamped with the date and the signature of the Contractor's supervising Engineer or electrician. The record drawings shall be submitted in PDF format on CDROM as well as hardcopy's for review and approval.

In addition to the record drawings, PDF copies of the final catalog cuts which have been Approved and Approved as Noted with applicable follow-up shall be submitted along with the record drawings. The PDF files shall clearly indicate either by filename or PDF table of contents the respective pay item number. Specific part or model numbers of items which have been selected shall be clearly visible. Hard copies of the catalog are not required with this submittal.

The Contractor shall provide two sets of electronically produced drawings in a moisture proof pouch to be kept on the inside door of the controller cabinet or other location approved by the Engineer. These drawings shall show the final as-built circuit orientation(s) of the project in the form of a single line diagram with all luminaires numbered and clearly identified for each circuit.

Final documentation shall be submitted as a complete submittal package, i.e. record drawings, test results, inventory, etc. shall be submitted at the same time. Partial piecemeal submittals will be rejected without review. A total of five hardcopies and CDROMs of the final documentation shall be submitted.

GPS Documentation. In addition to the specified record drawings, the Contactor shall record GPS coordinates of the following electrical components being installed, modified or being affected in other ways by this contract:

- All light poles and light towers.
- Handholes and vaults.
- Junction Boxes
- Conduit roadway crossings.
- Controllers.
- Control Buildings.
- Structures with electrical connections, i.e. DMS, lighted signs.
- Electric Service locations.
- CCTV Camera installations.
- Roadway Surveillance installations.
- Fiber Optic Splice Locations.
- Fiber Optic Cables. Coordinates shall be recorded along each fiber optic cable route every 200 feet.
- All fiber optic slack locations shall be identified with quantity of slack cable included. When sequential cable markings are available, those markings shall be documented as cable marking into enclosure and marking out of enclosure.

Datum to be used shall be North American 1983.

Data shall be provided electronically and in print form. The electronic format shall be compatible with MS Excel. Latitude and Longitude shall be in decimal degrees with a minimum of 6 decimal places. Each coordinate shall have the following information:

1. District
2. Description of item
3. Designation
4. Use
5. Approximate station
6. Contract Number
7. Date
8. Owner
9. Latitude
10. Longitude
11. Comments

A spreadsheet template will be available from the Engineer for use by the Contractor.

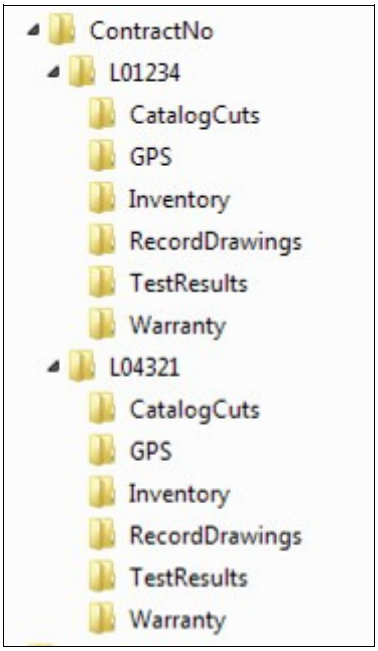
Prior to the collection of data, the contractor shall provide a sample data collection of at least six data points of known locations to be reviewed and verified by the Engineer to be accurate within 20 feet. Upon verification, data collection can begin. Data collection can be made as construction progresses, or can be collected after all items are installed. If the data is unacceptable the contractor shall make corrections to the data collection equipment and or process and submit the data for review and approval as specified. **Data collection prior to the submittal and review of the sample data of existing data points will be unacceptable and rejected.**

Accuracy. Data collected is to be mapping grade. A handheld mapping grade GPS device shall be used for the data collection. The receiver shall support differential correction and data shall have minimum 5 meter accuracy after post processing.

GPS receivers integrated into cellular communication devices, recreational and automotive GPS devices are not acceptable.

The GPS shall be the product of an established major GPS manufacturer having been in the business for a minimum of 6 years."

The documents on the CD shall be organized by the Electrical Maintenance Contract Management System (EMCMS) location designation. If multiple EMCMS locations are within the contract, separate folders shall be utilized for each location as follows:



Extraneous information not pertaining to the specific EMCMS location shall not be included in that particular folder and sub-folder.

The inspection will not be made until after the delivery of acceptable record drawings, specified certifications, and the required guarantees.

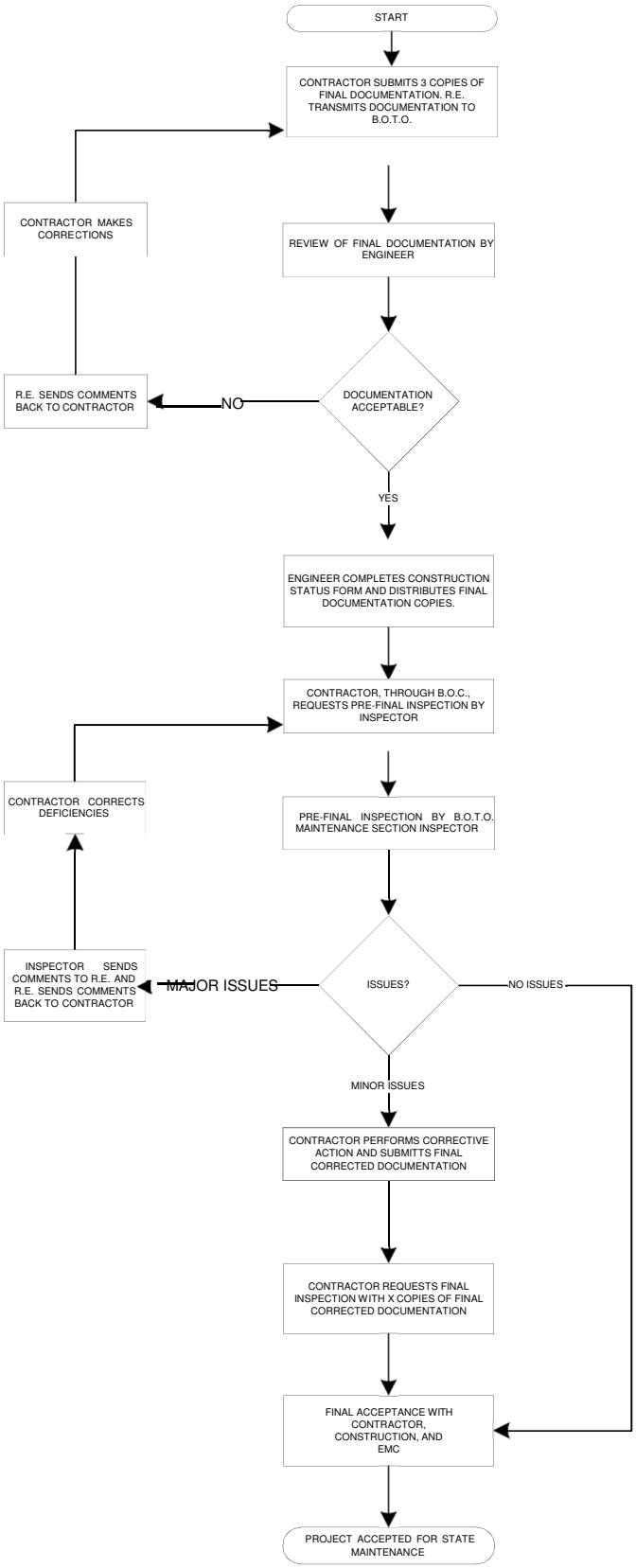
The Final Acceptance Documentation Checklist shall be completed and is contained elsewhere herein.

All CD's shall be labeled as illustrated in the CD Label Template contained herein.

Acceptance. Acceptance of electrical work will be given at the time when the Department assumes the responsibility to protect and maintain the work according to Article 107.30 or at the time of final inspection.

When the electrical work is complete, tested, and fully operational, the Contractor shall schedule an inspection for acceptance with the Engineer no less than seven working days prior to the desired inspection date. The Contractor shall furnish the necessary labor and equipment to make the inspection.

A written record of the test readings taken by the Contractor according to Article 801.13 shall be furnished to the Engineer seven working days before the date the inspection is scheduled. Inspection will not be made until after the delivery of acceptable record drawings, specified certifications, and the required guarantees.


START
CONTRACTOR SUBMITS 3 COPIES OF FINAL DOCUMENTATION. R.E. TRANSMITS DOCUMENTATION TO B.O.T.O.
REVIEW OF FINAL DOCUMENTATION BY ENGINEER
DOCUMENTATION ACCEPTABLE?
NO
R.E. SENDS COMMENTS BACK TO CONTRACTOR
CONTRACTOR MAKES CORRECTIONS
YES
ENGINEER COMPLETES CONSTRUCTION STATUS FORM AND DISTRIBUTES FINAL DOCUMENTATION COPIES.
CONTRACTOR, THROUGH B.O.C., REQUESTS PRE-FINAL INSPECTION BY INSPECTOR
PRE-FINAL INSPECTION BY B.O.T.O. MAINTENANCE SECTION INSPECTOR
ISSUES?
MAJOR ISSUES
INSPECTOR SENDS COMMENTS TO R.E. AND R.E. SENDS COMMENTS BACK TO CONTRACTOR
CONTRACTOR CORRECTS DEFICIENCIES
NO ISSUES
MINOR ISSUES
CONTRACTOR PERFORMS CORRECTIVE ACTION AND SUBMITTS FINAL CORRECTED DOCUMENTATION
CONTRACTOR REQUESTS FINAL INSPECTION WITH X COPIES OF FINAL CORRECTED DOCUMENTATION
FINAL ACCEPTANCE WITH CONTRACTOR, CONSTRUCTION, AND EMC
PROJECT ACCEPTED FOR STATE MAINTENANCE

Final Acceptance Documentation Checklist

LOCATION	
Route	Common Name
Limits	Section
Contract #	County
Controller Designation(s)	EMC Database Location Number(s)

ITEM	Contractor (Verify)	Resident Engineer (Verify)
Record Drawings -Four hardcopies (11" x 17") -Scanned to two CD-ROMs	☐ ☐	☐ ☐
Field Inspection Tests -Voltage -Amperage -Cable Insulation Resistance -Continuity -Controller Ground Rod Resistance (Four Hardcopies & scanned to two CD's)	☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐
GPS Coordinates -Excel file (Check Special Provisions, Excel file scanned to two CD's)	☐	☐
Job Warranty Letter (Four Hardcopies & scanned to two CD's)	☐	☐
Catalog Cut Submittals -Approved & Approved as Noted (Scanned to two CD's)	☐	☐
Lighting Inventory Form (Four Hardcopies & scanned to two CD's)	☐	☐
Lighting Controller Inventory Form (Four Hardcopies & scanned to two CD's)	☐	☐
Light Tower Inspection Form (If applicable, Four Hardcopies & scanned to two CD's)	☐	☐

Four Hardcopies & scanned to two CD's shall be submitted for all items above. The CD ROM shall be labeled as shown in the example contained herein.

General Notes:

Record Drawings – The record drawings should contain contract cover sheet, summary of quantities showing all lighting pay item sheets, proposed lighting plans and lighting detail sheets. Submit hardcopies 11 x 17 size. Include the original "red-ink" copy. The red-ink markup should be neatly drawn. Record drawings copies should be legible. Blurred copies will not be acceptable. Temporary lighting plans and removal lighting plans should not be part of the set.

Field Inspection Tests – Testing should be done for proposed cables. Testing shall be per standard specifications. Forms shall be neatly filled out.

GPS Coordinates – Check special provisions "General Electrical Requirements". Submit electronic "EXCEL" file.

Job Warranty Letter – See standard specifications.

Cutsheet Submittal – See special provisions "General Electrical Requirements". Scan Approved and Approved as Noted cutsheets.

Lighting Inventory Form – Inventory form should include only proposed light poles, proposed light towers, proposed combination (traffic/light pole) lighting and proposed underpass luminaires.

Lighting Controller Inventory Form – Form should be filled out for only proposed lighting controllers.

Light Tower Safety Inspection Form – Form should be filled out for each proposed light tower.

CD LABEL FORMAT TEMPLATE.

Label must be printed; hand written labels are unacceptable and will be rejected.

KEEPING THE EXPRESSWAY OPEN TO TRAFFIC (D-1)
Effective: March 22, 1996 Revised: January 21, 2015

Whenever work is in progress on or adjacent to an expressway, the Contractor shall provide the necessary traffic control devices to warn the public and to delineate the work zone as required in these Special Provisions, the Standard Specifications, the State Standards and the District Freeway details. All Contractors' personnel shall be limited to these barricaded work zones and shall not cross the expressway.

The Contractor shall request and gain approval from the Illinois Department of Transportation's Expressway Traffic Operations Engineer at www.idotlcs.com twenty-four (24) hours in advance of all daily lane, ramp and shoulder closures and 7 days in advance of all permanent and weekend closures on all Freeways and/or Expressways in District One. This advance notification is calculated based on workweek of Monday through Friday and shall not include weekends or Holidays.

Location: i-290; Wolf to Central (3-Lane Section)

WEEK NIGHT	TYPE OF CLOSURE	ALLOWABLE CLOSURE HOURS		
Sunday - Thursday	1-Lane	10:00 PM	to	5:00 AM
	2-Lane	11:59 PM	to	5:00 AM
Friday	1-Lane	11:00 PM (Fri)	to	6:00 AM (Sat)
	2-Lane	11:59 PM (Fri)	to	6:00 AM (Sat)
Saturday	1-Lane	11:00 PM (Sat)	to	8:00 AM (Sun)
	2-Lane	11:59 PM (Sat)	to	8:00 AM (Sun)

In addition to the hours noted above, temporary shoulder and non-system interchange partial ramp closures are allowed weekdays between 9:00 AM. and 3:00 P.M. and between 7:00 P.M. and 5:00 AM.

Narrow Lanes and permanent shoulder closures will not be allowed between Dec. 1st and April 1st.

All daily lane closures shall be removed during adverse weather conditions such as rain, snow, and/or fog and as determined by the Engineer. Also, the contractor shall promptly remove their lane closures when Maintenance forces are out for snow and ice removal.

Additional lane closure hour restrictions may have to be imposed to facilitate the flow of traffic to and from major sporting events and/or other events.

All lane closure signs shall not be erected any earlier than one-half (1/2) hour before the starting hours listed above. Also, these signs should be taken down within one-half (1/2) hour after the closure is removed.

The Contractor will be required to cooperate with all other contractors when erecting lane closures on the expressway. All lane closures (includes the taper lengths) without a three (3) mile gap between each other, in one direction of the expressway, shall be on the same side of the pavement. Lane closures on the same side of the pavement with a one (1) mile or less gap between the end of one work zone and the start of taper of next work zone should be connected. The maximum length of any lane closure on the project and combined with any adjacent projects shall be three (3) miles. Gaps between successive permanent lane closures shall be no less than two (2) miles in length.

Private vehicles shall not be parked in the work zone. Contractor's equipment and/or vehicles shall not be parked on the shoulders or in the median during non-working hours. The parking of equipment and/or vehicles on State right-of-way will only be permitted at the locations approved by the Engineer.

Check barricades shall be placed every 1000' within a lane closure to prevent vehicles from driving through closed lanes.

Temporary ramp closures for service interchanges will only be permitted at night during the restricted hours listed for temporary one-lane closures within the project limits. However, no two (2) adjacent entrance and exit ramps in one direction of the expressway shall be closed at the same time.

Should the Contractor fail to completely open, and keep open, the ramps to traffic in accordance with the above limitations, the Contractor shall be liable to the Department for liquidated damages as noted under the Special Provision, "Failure to Open Traffic Lanes to Traffic".

FAILURE TO OPEN TRAFFIC LANES TO TRAFFIC (D-1)
Effective: March 22, 1996 Revised: February 9, 2005

Should the Contractor fail to completely open and keep open all the traffic lanes to traffic in accordance with the limitations specified under the Special Provisions for "Keeping the Expressway Open to Traffic", the Contractor shall be liable to the Department for the amount of:

One lane or ramp blocked = $**3,000**

Two lanes blocked = $**6,000**

Not as a penalty but as liquidated and ascertained damages for each and every 15 minute interval or a portion thereof that a lane is blocked outside the allowable time limitations. Such damages may be deducted by the Department from any monies due the Contractor. These damages shall apply during the contract time and during any extensions of the contract time.

TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS) (D-1)
Effective: March 8, 1996 Revised: April 1, 2019

Description. This work shall include furnishing, installing, maintaining, replacing, relocating, and removing all traffic control devices used for the purpose of regulating, warning, or directing traffic. Traffic control and protection shall be provided as called for in the plans, applicable Highway Standards, District One Expressway details, Standards and Supplemental Specifications, these Special Provisions, or as directed by the Engineer.

General. The governing factor in the execution and staging of work for this project is to provide the motoring public with the safest possible travel conditions on the expressway through the construction zone. The Contractor shall arrange his operations to keep the closing of lanes and/or ramps to a minimum.

The Contractor shall be responsible for the proper location, installation, and arrangement of all traffic control devices. Special attention shall be given to existing warning signs and overhead guide signs during all construction operations. Warning signs and existing guide signs with down arrows shall be kept consistent with the barricade placement at all times. The Contractor shall immediately remove, completely cover, or turn from the motorist's view all signs which are inconsistent with lane assignment patterns.

The Contractor shall coordinate all traffic control work on this project with adjoining or overlapping projects, including barricade placement necessary to provide a uniform traffic detour pattern. When directed by the Engineer, the Contractor shall remove all traffic control devices that were furnished, installed, or maintained by him under this contract, and such devices shall remain the property of the Contractor. All traffic control devices shall remain in place until specific authorization for relocation or removal is received from the Engineer.

Additional requirements for traffic control devices shall be as follows.

(a) Traffic Control Setup and Removal. The setting and removal of barricades for the taper portion of a lane closure shall be done under the protection of a vehicle with a truck/trailer mounted attenuator and arrow board per State Standard 701428 and Section 701 of the Standard Specifications. Failure to meet this requirement will be subject to a Traffic Control Deficiency. The deficiency will be calculated as outlined in Article 105.03 of the Standard Specifications. Truck/trailer mounted attenuators shall comply with Article 1106.02(g) or shall meet the requirements of NCHRP 350 Test Level 3 with vehicles used in accordance with manufacturer’s recommendations and requirements.

(b) Sign Requirements

(1) Sign Maintenance. Prior to the beginning of construction operations, the Contractor will be provided a sign log of all existing signs within the limits of the construction zone. The Contractor is responsible for verifying the accuracy of the sign log. Throughout the duration of this project, all existing traffic signs shall be maintained by the Contractor. All provisions of Article 107.25 of the Standard Specifications shall apply.

(2) Work Zone Speed Limit Signs. Work zone speed limit signs shall be installed as required in Article 701.14(b) and as shown in the plans and Highway Standards. Based upon the exiting posted speed limit, work zone speed limits shall be established and signed as follows.

a. Existing Speed Limit of 55mph or higher. The initial work zone speed limit assembly, located approximately 4200' before the closure, and shall be 55mph as shown in 701400. Additional work zone 45mph assemblies shall be used as required according to Article 701.14(b) and as shown in the Highway Standards and plans. WORK ZONE SPEED LIMIT 55 PHOTO ENFORCED assemblies may be omitted when this assembly would normally be placed within 1500 feet of the END WORK ZONE SPEED LIMIT sign. If existing speed limit is over 65mph then additional signage should be installed per 701400.

b. Existing Speed Limit of 45mph. The advance 55mph work zone speed limit assembly shown in 701400 shall be replaced with a 45mph assembly. Additional work zone 45mph assemblies shall be used as required according to Article 701.14(b) and as shown in the Highway Standards and plans. WORK ZONE SPEED LIMIT 55 PHOTO ENFORCED assemblies shall be eliminated in all cases. END WORK ZONE SPEED LIMIT signs are required.

(3) Exit Signs. The exit gore signs as shown in Standard 701411 shall be a minimum size of 48 inch by 48 inch with 12 inch capital letters and a 20 inch arrow. EXIT OPEN AHEAD signs shown in Standard 701411 shall be a minimum size of 48 inch by 48 inch with 8 inch capital letters.

(4) Uneven Lanes Signs. The Contractor shall furnish and erect "UNEVEN LANES" signs (W8-11) on both sides of the expressway, at any time when the elevation difference between adjacent lanes open to traffic equals or exceeds one inch. Signs shall be placed 500' in advance of the drop-off, within 500' of every entrance, and a minimum of every mile.

(c) Drums/Barricades. Check barricades shall be placed in work areas perpendicular to traffic every 1000', one per lane and per shoulder, to prevent motorists from using work areas as a traveled way. Check barricades shall also be placed in advance of each open patch, or excavation, or any other hazard in the work area, the first at the edge of the open traffic lane and the second centered in the closed lane. Check barricades, either Type I or II, or drums shall be equipped with a flashing light.

To provide sufficient lane widths (10' minimum) for traffic and also working room, the Contractor shall furnish and install vertical barricades, in lieu of Type II or drums, along the cold milling and asphalt paving operations. The vertical barricades shall be placed at the same spacing as the drums.

(d) Vertical Barricades. Vertical barricades shall not be used in lane closure tapers, lane shifts, exit ramp gores, or staged construction projects lasting more than 12 hours. Also, vertical barricades shall not be used as patch barricades or check barricades. Special attention shall be given, and ballast provided per manufacture's specification, to maintain the vertical barricades in an upright position and in proper alignment.

(e) Temporary Concrete Barrier Wall. Prismatic barrier wall reflectors shall be installed on both the face of the wall next to traffic, and the top of sections of the temporary concrete barrier wall as shown in Standard 704001. The color of these reflectors shall match the color of the edgelines (yellow on the left and crystal or white on the right). If the base of the temporary concrete barrier wall is 12 inches or less from the travel lane, then the lower slope of the wall shall also have a 6 inch wide temporary pavement marking edgeline (yellow on the left and white on the right).

(f) Flaggers. One flagger will be required for each separate activity of an operation that requires frequent construction vehicles to enter or leave a work zone to or from a lane open to traffic. Temporary traffic control and flagger position shall be according to District One Detail TC-18 – Expressway Flagging, or as directed by the Engineer.

(g) Full Expressway Closures. Full Expressway Closures will only be permitted for a maximum of 15 minutes during the allowable hours listed in the Keeping the Expressway Open to Traffic Special Provision. During Full Expressway Closures, the Contractor will be required to close off all lanes except one, using Freeway Standard Closures. The Contractor will be required to provide one changeable message sign to be placed at the direction of the Engineer. The sign shall display a message as directed by the Engineer. A Maintenance of Traffic Plan shall be submitted to the District One Expressway Traffic Control Supervisor 14 days in advance of the planned work; including all stage changes. The Maintenance of Traffic Plan shall include, but not be limited to: lane and ramp closures, existing geometrics, and equipment and material location. The District One Expressway Traffic Control Supervisor (847-705-4151) shall be contacted at least 3 working days in advance of the proposed road closure and will coordinate the closure operation with police forces.

Method of Measurement. This item of work will be measured on a lump sum basis for furnishing, installing, maintaining, replacing, relocating, and removing traffic control devices required in the plans and these Special Provisions. Traffic control and protection required under Standards 701101, 701400, 701401, 701402, 701406, 701411, 701416, 701426, 701428, 701446, 701901 and District details TC-8, TC-9, TC-17, TC-18 and TC-25 will be included with this item.

Basis of Payment.

(a) This work will be paid for at the contract lump sum price for TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS). This price shall be payment in full for all labor, materials, transportation, handling, and incidental work necessary to furnish, install, maintain, replace, relocate, and remove all Expressway traffic control devices required in the plans and specifications.

In the event the sum total value of all the work items for which traffic control and protection is required is increased or decreased by more than ten percent (10□), the contract bid price for TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS) will be adjusted as follows:

Adjusted contract price = .25P + .75P [1±(X-0.1)]

Where: "P" is the bid unit price for Traffic Control and Protection

Where: "X" = $\dfrac{\text{Difference between original and final sum total value of all work items for which traffic control and protection is required}}{\text{Original sum total value of all work items for which traffic control and protection is required.}}$

The value of the work items used in calculating the increase and decrease will include only items that have been added to or deducted from the contract under Article 104.02 of the Standard Specifications and only items which require use of Traffic Control and Protection.

Temporary traffic control costs due to delay will be paid for according to the Compensable Delay Costs (BDE) Special Provision.

(b) The Engineer may require additional traffic control be installed in accordance with standards and/or designs other than those included in the plans. In such cases, the standards and/or designs will be made available to the Contractor at least one week in advance of the change in traffic control. Payment for any additional traffic control required will be in accordance with Article 109.04 of the Standard Specifications.

(c) Revisions in the phasing of construction or maintenance operations, requested by the Contractor, may require traffic control to be installed in accordance with standards and/or designs other than those included in the plans. Revisions or modifications to the traffic control shown in the contract shall be submitted by the Contractor for approval by the Engineer. No additional payment will be made for a Contractor requested modification.

(d) Temporary concrete barrier wall will be measured and paid for according to Section 704.

(e) Impact attenuators, temporary bridge rail, and temporary rumble strips will be paid for separately.

(f) Temporary pavement markings shown on the Standard will be measured and paid for according to Section 703 and Section 780.

(g) All pavement marking removal will be measured and paid for according to Section 703 or Section 783.

(h) Temporary pavement marking on the lower slope of the temporary concrete barrier wall will be measured and paid for as TEMPORARY PAVEMENT MARKING, 6".

(i) All barrier wall reflectors will be measured and paid for according to Section 782.

(j) The Changeable Message Sign required for Full Expressway Closures shall not be paid for separately.

TEMPORARY INFORMATION SIGNING (D-1)
Effective: November 13, 1996 Revised: January 2, 2007

Description.
This work shall consist of furnishing, installing, maintaining, relocating for various states of construction and eventually removing temporary informational signs. Included in this item may be ground mount signs, skid mount signs, truss mount signs, bridge mount signs, and overlay sign panels which cover portions of existing signs.

Materials.
Materials shall be according to the following Articles of Section 1000 - Materials:

	Item	Article/Section
a.)	Sign Base (Notes 1 & 2)	1090
b.)	Sign Face (Note 3)	1091
c.)	Sign Legends	1092
d.)	Sign Supports	1093
e.)	Overlay Panels (Note 4)	1090.02

Note 1. The Contractor may use 5/8 inch (16 mm) instead of 3/4 inch (19 mm) thick plywood.
Note 2. Type A sheeting can be used on the plywood base.
Note 3. All sign faces shall be Type A except all orange signs shall meet the requirements of Article 1106.01.
Note 4. The overlay panels shall be 0.08 inch (2 mm) thick.

GENERAL CONSTRUCTION REQUIRMENTS

Installation.
The sign sizes and legend sizes shall be verified by the Contractor prior to fabrication.

Signs which are placed along the roadway and/or within the construction zone shall be installed according to the requirements of Article 701.14 and Article 720.04. The signs shall be 7 ft (2.1 m) above the near edge of the pavement and shall be a minimum of 2 ft (600 mm) beyond the edge of the paved shoulder. A minimum of two (2) posts shall be used.

The attachment of temporary signs to existing sign structures or sign panels shall be approved by the Engineer. Any damage to the existing signs due to the Contractor's operations shall be repaired or signs replaced, as determined by the Engineer, at the Contractor's expense.

Signs which are placed on overhead bridge structures shall be fastened to the handrail with stainless steel bands. These signs shall rest on the concrete parapet where possible. The Contractor shall furnish mounting details for approval by the Engineer.

Method of Measurement.

This work shall be measured for payment in square feet (square meters) edge to edge (horizontally and vertically).

All hardware, posts or skids, supports, bases for ground mounted signs, connections, which are required for mounting these signs will be included as part of this pay item.

Basis Of Payment.
This work shall be paid for at the contract unit price per square foot (square meter) for TEMPORARY INFORMATION SIGNING.

SPEED DISPLAY TRAILER (D-1)
Effective: April 1, 2015 Revised: January 1, 2017

Revise the third paragraph of Article 701.11 of the Standard Specifications to read:

"When not being utilized to inform and direct traffic, sign trailers, speed display trailers, arrow boards, and portable changeable message boards shall be treated as nonoperating equipment."

Add the following to Article 701.15 of the Standard Specifications:

"(m) Speed Display Trailer. A speed display trailer is used to enhance safety of the traveling public and workers in work zones by alerting drivers of their speed, thus deterring them from driving above the posted work zone speed limit."

Whenever the speed display trailer is not in use, it shall be considered non-operating equipment and shall be stored according to Article 701.11."

Add the following to Article 701.20 of the Standard Specifications:

"(k) "Speed Display Trailer will NOT be paid for by separate pay item, but its costs shall be included in the contract unit price of the various traffic control pay items.

Add the following to Article 1106.02 of the Standard Specifications:

"(o) Speed Display Trailer. The speed display trailer shall consist of a LED speed indicator display with self-contained, one-direction radar mounted on an orange see-through trailer. The height of the display and radar shall be such that it will function and be visible when located behind concrete barrier.

The speed measurement shall be by radar and provide a minimum detection distance of 1000 ft (300 m). The radar shall have an accuracy of ±1 mile per hour.

The speed indicator display shall face approaching traffic and shall have a sign legend of "YOUR SPEED" immediately above or below the speed display. The digital speed display shall show two digits (00 to 99) in mph. The color of the changeable message legend shall be a yellow legend on a black background. The minimum height of the numerals shall be 18 in. (450 mm), and the nominal legibility distance shall be at least 750 ft (250 m).

The speed indicator display shall be equipped with a violation alert that flashes the displayed detected speed when the posted limit is exceeded. The speed indicator shall have a maximum speed cutoff. On roadway facilities with a normal posted speed limit greater than or equal to 45 mph, the detected speeds of vehicles traveling more than 25mph over the work zone speed limit shall not be displayed. On facilities with normal posted speed limit of less than 45 mph, the detected speeds of vehicles traveling more than 15 mph over the work zone speed limit shall not be displayed. On any roadway facility if detected speeds are less than 25 mph, speed shall not be displayed. The display shall include automatic dimming for nighttime operation.

The speed indicator measurement and display functions shall be equipped with the power supply capable of providing 24 hours of uninterrupted service."

TRAFFIC CONTROL PLAN (D-1)
Effective: September 30, 1985 Revised: January 1, 2007

Traffic Control shall be according to the applicable sections of the Standard Specifications, the Supplemental Specifications, the "Illinois Manual on Uniform Traffic Control Devices for Streets and Highways", any special details and Highway Standards contained in the plans, and the Special Provisions contained herein.

Special attention is called to Article 107.09 of the Standard Specifications and the following Highway Standards, Details, Quality Standard for Work Zone Traffic Control Devices, Recurring Special Provisions and Special Provisions contained herein, relating to traffic control.

The Contractor shall contact the District One Bureau of Traffic at least 72 hours in advance of beginning work.

STANDARDS:

701106-02	OFF-ROAD OPERATIONS, MULTILANE, MORE THAN 15' (4.5 M) AWAY
701400-09	APPROACH TO LANE CLOSURE, FREEWAY / EXPRESSWAY
701401-12	LANE CLOSURE, FREEWAY / EXPRESSWAY
701411-09	LANE CLOSURE, MULTILANE, AT ENTRANCE OR EXIT RAMP, FOR SPEEDS >= 45 MPH
701428-01	TRAFFIC CONTROL, SETUP AND REMOVAL, FREEWAY / EXPRESSWAY
701446-09	TWO LANE CLOSURE, FREEWAY / EXPRESSWAY
701901-08	TRAFFIC CONTROL DEVICES
704001-08	TEMPORARY CONCRETE BARRIER
720001-01	SIGN PANEL MOUNTING DETAILS
720006-04	SIGN PANEL AND BARRIER WALL REFLECTOR MOUNTING DETAILS
782006	GUARDRAIL AND BARRIER WALL REFLECTOR MOUNTING DETAILS
TC-8	FREEWAY ENTRANCE AND EXISTING RAMP CLOSURE DETAILS
TC-9	TRAFFIC CONTROL DETAILS FOR FREEWAY SINGLE & MULTI-LANE WEAVE
TC-12	MULTI-LANE FREEWAY PAVEMENT MARKING DETAILS
TC-17	TRAFFIC CONTROL DETAILS FOR FREEWAY SHOULDER CLOSURES AND PARTIAL RAMP CLOSURES
TC-18	SIGNING FOR FLAGGING OPERATIONS AT WORK ZONE OPENINGS

DETAILS:

SPECIAL PROVISIONS:

MAINTENCE OF ROADWAYS (D-1)

AGGREGATE FOR CONCRETE BARRIER (D-1)

KEEPING THE EXPRESSWAY OPEN TO TRAFFIC (D-1)

FAILURE TO OPEN TRAFFIC LANES TO TRAFFIC (D-1)

TRAFFIC CONTROL AND PROTECTION (EXPRESSWAYS) (D-1)

TEMPORARY INFORMATION SIGNING (D-1)

SPEED DISPLAY TRAILER (D-1)

EQUIPMENT PARKING AND STORAGE (BDE)

LIGHTS ON BARRICADES (BDE)

PAVEMENT MARKING REMOVAL (BDE)

TEMPORARY PAVEMENT MARKING (BDE)

TRAFFIC CONTROL DEVICES – CONES (BDE)

TRAFFIC SPOTTERS (BDE)

PINNING TEMPORARY CONCRETE BARRIER

TEMPORARY CONCRETE BARRIER (TO REMAIN PERMANENTLY)

BITUMINOUS MATERIALS COST ADJUSTMENTS (BDE)
Effective: November 2, 2006 Revised: August 1, 2017

Description. Bituminous material cost adjustments will be made to provide additional compensation to the Contractor, or credit to the Department, for fluctuations in the cost of bituminous materials when optioned by the Contractor. The bidder shall indicate with their bid whether or not this special provision will be part of the contract.

The adjustments shall apply to permanent and temporary hot-mix asphalt (HMA) mixtures, bituminous surface treatments (cover and seal coats), and preventative maintenance type surface treatments that are part of the original proposed construction, or added as extra work and paid for by agreed unit prices. The adjustments shall not apply to bituminous prime coats, tack coats, crack filling/sealing, joint filling/sealing, or extra work paid for at a lump sum price or by force account.

Method of Adjustment. Bituminous materials cost adjustments will be computed as follows.

$CA = (BPI_P - BPI_L) \times (\%AC_V / 100) \times Q$

Where: CA = Cost Adjustment, $.
BPI_P = Bituminous Price Index, as published by the Department for the month the work is performed, $/ton ($/metric ton).
BPI_L = Bituminous Price Index, as published by the Department for the month prior to the letting for work paid for at the contract price; or for the month the agreed unit price letter is submitted by the Contractor for extra work paid for by agreed unit price, $/ton ($/metric ton).
$\%AC_V$ = Percent of virgin Asphalt Cement in the Quantity being adjusted. For HMA mixtures, the % AC_V will be determined from the adjusted job mix formula. For bituminous materials applied, a performance graded or cutback asphalt will be considered to be 100% AC_V and undiluted emulsified asphalt will be considered to be 65% AC_V.
Q = Authorized construction Quantity, tons (metric tons) (see below).

For HMA mixtures measured in square yards: Q, tons = A x D x (G_{mb} x 46.8) / 2000. For HMA mixtures measured in square meters: Q, metric tons = A x D x (G_{mb} x 1) / 1000. When computing adjustments for full-depth HMA pavement, separate calculations will be made for the binder and surface courses to account for their different G_{mb} and % AC_V.

For bituminous materials measured in gallons: Q, tons = V x 8.33 lb/gal x SG / 2000
For bituminous materials measured in liters: Q, metric tons = V x 1.0 kg/L x SG / 1000

Where: A = Area of the HMA mixture, sq yd (sq m).
D = Depth of the HMA mixture, in. (mm).
G_{mb} = Average bulk specific gravity of the mixture, from the approved mix design.
V = Volume of the bituminous material, gal (L).
SG = Specific Gravity of bituminous material as shown on the bill of lading.

Basis of Payment. Bituminous materials cost adjustments may be positive or negative but will only be made when there is a difference between the BPI_L and BPI_P in excess of five percent, as calculated by:

Percent Difference = $\{(BPI_L - BPI_P) \div BPI_L\} \times 100$

Bituminous materials cost adjustments will be calculated for each calendar month in which applicable bituminous material is placed; and will be paid or deducted when all other contract requirements for the work placed during the month are satisfied. The adjustments shall not apply during contract time subject to liquidated damages for completion of the entire contract.

COMPENSABLE DELAY COSTS (BDE)
Effective: June 2, 2017 Revised: April 1, 2019

Revise Article 107.40(b) of the Standard Specifications to read:

"(b) Compensation. Compensation will not be allowed for delays, inconveniences, or damages sustained by the Contractor from conflicts with facilities not meeting the above definition; or if a conflict with a utility in an unanticipated location does not cause a shutdown of the work or a documentable reduction in the rate of progress exceeding the limits set herein. The provisions of Article 104.03 notwithstanding, compensation for delays caused by a utility in an unanticipated location will be paid according to the provisions of this Article governing minor and major delays or reduced rate of production which are defined as follows.

(1) Minor Delay. A minor delay occurs when the work in conflict with the utility in an unanticipated location is completely stopped for more than two hours, but not to exceed two weeks.

(2) Major Delay. A major delay occurs when the work in conflict with the utility in an unanticipated location is completely stopped for more than two weeks.

(3) Reduced Rate of Production Delay. A reduced rate of production delay occurs when the rate of production on the work in conflict with the utility in an unanticipated location decreases by more than 25 percent and lasts longer than seven calendar days."

Revise Article 107.40(c) of the Standard Specifications to read:

"(c) Payment. Payment for Minor, Major, and Reduced Rate of Production Delays will be made as follows.

(1) Minor Delay. Labor idled which cannot be used on other work will be paid for according to Article 109.04(b)(1) and (2) for the time between start of the delay and the minimum remaining hours in the work shift required by the prevailing practice in the area.

Equipment idled which cannot be used on other work, and which is authorized to standby on the project site by the Engineer, will be paid for according to Article 109.04(b)(4).

(2) Major Delay. Labor will be the same as for a minor delay.

Equipment will be the same as for a minor delay, except Contractor-owned equipment will be limited to two weeks plus the cost of move-out to either the Contractor's yard or another job and the cost to re-mobilize, whichever is less. Rental equipment may be paid for longer than two weeks provided the Contractor presents adequate support to the Department (including lease agreement) to show retaining equipment on the job is the most economical course to follow and in the public interest.

(3) Reduced Rate of Production Delay. The Contractor will be compensated for the reduced productivity for labor and equipment time in excess of the 25 percent threshold for that portion of the delay in excess of seven calendar days. Determination of compensation will be in accordance with Article 104.02, except labor and material additives will not be permitted.

Payment for escalated material costs, escalated labor costs, extended project overhead, and extended traffic control will be determined according to Article 109.13."

Revise Article 108.04(b) of the Standard Specifications to read:

"(b) No working day will be charged under the following conditions.

(1) When adverse weather prevents work on the controlling item.

(2) When job conditions due to recent weather prevent work on the controlling item.

(3) When conduct or lack of conduct by the Department or its consultants, representatives, officers, agents, or employees; delay by the Department in making the site available; or delay in furnishing any items required to be furnished to the Contractor by the Department prevents work on the controlling item.

(4) When delays caused by utility or railroad adjustments prevent work on the controlling item.

(5) When strikes, lock-outs, extraordinary delays in transportation, or inability to procure critical materials prevent work on the controlling item, as long as these delays are not due to any fault of the Contractor.

(6) When any condition over which the Contractor has no control prevents work on the controlling item."

Revise Article 109.09(f) of the Standard Specifications to read:

"(f) Basis of Payment. After resolution of a claim in favor of the Contractor, any adjustment in time required for the work will be made according to Section 108. Any adjustment in the costs to be paid will be made for direct labor, direct materials, direct equipment, direct jobsite overhead, direct offsite overhead, and other direct costs allowed by the resolution. Adjustments in costs will not be made for interest charges, loss of anticipated profit, undocumented loss of efficiency, home office overhead and unabsorbed overhead other than as allowed by Article 109.13, lost opportunity, preparation of claim expenses and other consequential indirect costs regardless of method of calculation.

The above Basis of Payment is an essential element of the contract and the claim cost recovery of the Contractor shall be so limited."

Add the following to Section 109 of the Standard Specifications.

"**109.13 Payment for Contract Delay.** Compensation for escalated material costs, escalated labor costs, extended project overhead, and extended traffic control will be allowed when such costs result from a delay meeting the criteria in the following table.

Contract Type	Cause of Delay	Length of Delay
Working Days	Article 108.04(b)(3) or Article 108.04(b)(4)	No working days have been charged for two consecutive weeks.
Completion Date	Article 108.08(b)(1) or Article 108.08(b)(7)	The Contractor has been granted a minimum two week extension of contract time, according to Article 108.08.

Payment for each of the various costs will be according to the following.

(a) Escalated Material and/or Labor Costs. When the delay causes work, which would have otherwise been completed, to be done after material and/or labor costs have increased, such increases will be paid. Payment for escalated material costs will be limited to the increased costs substantiated by documentation furnished by the Contractor. Payment for escalated labor costs will be limited to those items in Article 109.04(b)(1) and (2), except the 35 percent and 10 percent additives will not be permitted.

(b) Extended Project Overhead. For the duration of the delay, payment for extended project overhead will be paid as follows.

(1) Direct Jobsite and Offsite Overhead. Payment for documented direct jobsite overhead and documented direct offsite overhead, including onsite supervisory and administrative personnel, will be allowed according to the following table.

Original Contract Amount	Supervisory and Administrative Personnel
Up to $5,000,000	One Project Superintendent
Over $ 5,000,000 - up to $25,000,000	One Project Manager, One Project Superintendent or Engineer, and One Clerk
Over $25,000,000 - up to $50,000,000	One Project Manager, One Project Superintendent, One Engineer, and One Clerk
Over $50,000,000	One Project Manager, Two Project Superintendents, One Engineer, and One Clerk

(2) Home Office and Unabsorbed Overhead. Payment for home office and unabsorbed overhead will be calculated as 8 percent of the total delay cost.

(c) Extended Traffic Control. Traffic control required for an extended period of time due to the delay will be paid for according to Article 109.04.

When an extended traffic control adjustment is paid under this provision, an adjusted unit price as provided for in Article 701.20(a) for increase or decrease in the value of work by more than ten percent will not be paid.

Upon payment for a contract delay under this provision, the Contractor shall assign subrogation rights to the Department for the Department's efforts of recovery from any other party for monies paid by the Department as a result of any claim under this provision. The Contractor shall fully cooperate with the Department in its efforts to recover from another party any money paid to the Contractor for delay damages under this provision."

CONCRETE END SECTIONS FOR PIPE CULVERTS (BDE)
Effective: January 1, 2013 Revised: April 1, 2016

Description. This work shall consist of constructing cast-in-place concrete and precast concrete end sections for pipe culverts. These end sections are shown on the plans as Highway Standard 542001 or 542011. This work shall be according to Section 542 of the Standard Specifications except as modified herein.

Materials. Materials shall be according to the following Articles of Division 1000 – Materials of the Standard Specifications.

Item	Article/Section
(a) Portland Cement Concrete (Note 1)	1020
(b) Precast Concrete End Sections (Note 2)	
(c) Coarse Aggregate (Note 3)	1004.05
(d) Structural Steel (Note 4)	1006.04
(e) Anchor Bolts and Rods (Note 5)	1006.09
(f) Reinforcement Bars	1006.10(a)
(g) Nonshrink Grout	1024.02
(h) Chemical Adhesive Resin System	1027
(i) Mastic Joint Sealer for Pipe	1055
(j) Hand Hole Plugs	1042.16

Note 1. Cast-in-place concrete end sections shall be Class SI, except the 14 day mix design shall have a compressive strength of 5000 psi (34,500 kPa) or a flexural strength of (800 psi) 5500 kPa and a minimum cement factor of 6.65 cwt/cu yd (395 kg/cu m).

Note 2. Precast concrete end sections shall be according to Articles 1042.02 and 1042.03(b)(c)(d)(e) of the Standard Specifications. The concrete shall be Class PC according to Section 1020, and shall have a minimum compressive strength of 5000 psi (34,000 kPa) at 28 days.

Joints between precast sections shall be produced with reinforced tongue and groove ends according to the requirements of ASTM C 1577.

Note 3. The granular bedding placed below a precast concrete end section shall be gradation CA 6, CA 9, CA 10, CA 12, CA 17, CA 18, or CA 19.

Note 4. All components of the culvert tie detail shall be galvanized according to the requirements of AASHTO M 111 or M 232 as applicable.

Note 5. The anchor rods for the culvert ties shall be according to the requirements of ASTM F 1554, Grade 105 (Grade 725).

CONSTRUCTION REQUIREMENTS

The concrete end sections may be precast or cast-in-place construction. Toe walls shall be either precast or cast-in-place, and shall be in proper position and backfilled according to the applicable paragraphs of Article 502.10 of the Standard Specifications prior to the installation of the concrete end sections. If soil conditions permit, cast-in-place toe walls may be poured directly against the soil. When poured directly against the soil, the clear cover of the sides and bottom of the toe wall shall be increased to 3 in. (75 mm) by increasing the thickness of the toe wall.

(a) Cast-In-Place Concrete End Sections. Cast-in-place concrete end sections shall be constructed according to the requirements of Section 503 of the Standard Specifications and as shown on the plans.

(b) Precast Concrete End Sections. When the concrete end sections will be precast, shop drawings detailing the slab thickness and reinforcement layout shall be submitted to the Engineer for review and approval.

The excavation and backfilling for precast concrete end sections shall be according to the requirements of Section 502 of the Standard Specifications, except a layer of granular bedding at least 6 in. (150 mm) in thickness shall be placed below the elevation of the bottom of the end section. The granular bedding shall extend a minimum of 2 ft (600 mm) beyond each side of the end section.

Anchor rods connecting precast sections shall be brought to a snug tight condition followed by an additional 2/3 turn on one of the nuts. Match marks shall be provided on the bolt and nut to verify relative rotation between the bolt and the nut.

When individual, precast end sections are placed side-by-side for a multi-pipe culvert installation, a 3 in. (75 mm) space shall be left between adjacent end section walls and the space(s) filled with Class SI concrete.

Method of Measurement. This work will be measured for payment as each, with each end of each culvert being one each.

Basis of Payment. This work will be paid for at the contract unit price per each for CONCRETE END SECTION, STANDARD 542001 or CONCRETE END SECTION, 542011, of the pipe diameter and slope specified.

CONSTRUCTION AIR QUALITY – DIESEL RETROFIT (BDE)
Effective: June 1, 2010 Revised: November 1, 2014

The reduction of emissions of particulate matter (PM) for off-road equipment shall be accomplished by installing retrofit emission control devices. The term "equipment" refers to diesel fuel powered devices rated at 50 hp and above, to be used on the jobsite in excess of seven calendar days over the course of the construction period on the jobsite (including rental equipment).

Contractor and subcontractor diesel powered off-road equipment assigned to the contract shall be retrofitted using the phased in approach shown below. Equipment that is of a model year older than the year given for that equipment's respective horsepower range shall be retrofitted:

Effective Dates	Horsepower Range	Model Year
June 1, 2010 1/	600-749	2002
	750 and up	2006
June 1, 2011 2/	100-299	2003
	300-599	2001
	600-749	2002
	750 and up	2006
June 1, 2012 2/	50-99	2004
	100-299	2003
	300-599	2001
	600-749	2002
	750 and up	2006

1/ Effective dates apply to Contractor diesel powered off-road equipment assigned to the contract.
2/ Effective dates apply to Contractor and subcontractor diesel powered off-road equipment assigned to the contract.

The retrofit emission control devices shall achieve a minimum PM emission reduction of 50 percent and shall be:

a) Included on the U.S. Environmental Protection Agency (USEPA) *Verified Retrofit Technology List* (http://www.epa.gov/cleandiesel/verification/verif-list.htm), or verified by the California Air Resources Board (CARB) (http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm); or

b) Retrofitted with a non-verified diesel retrofit emission control device if verified retrofit emission control devices are not available for equipment proposed to be used on the project, and if the Contractor has obtained a performance certification from the retrofit device manufacturer that the emission control device provides a minimum PM emission reduction of 50 percent.

Note: Large cranes (Crawler mounted cranes) which are responsible for critical lift operations are exempt from installing retrofit emission control devices if such devices adversely affect equipment operation.

Diesel powered off-road equipment with engine ratings of 50 hp and above, which are unable to be retrofitted with verified emission control devices or if performance certifications are not available which will achieve a minimum 50 percent PM reduction, may be granted a waiver by the Department if documentation is provided showing good faith efforts were made by the Contractor to retrofit the equipment.

Construction shall not proceed until the Contractor submits a certified list of the diesel powered off-road equipment that will be used, and as necessary, retrofitted with emission control devices. The list(s) shall include (1) the equipment number, type, make, Contractor/rental company name; and (2) the emission control devices make, model, USEPA or CARB verification number, or performance certification from the retrofit device manufacturer. Equipment reported as fitted with emissions control devices shall be made available to the Engineer for visual inspection of the device installation, prior to being used on the jobsite.

The Contractor shall submit an updated list of retrofitted off-road construction equipment as retrofitted equipment changes or comes on to the jobsite. The addition or deletion of any diesel powered equipment shall be included on the updated list.

If any diesel powered off-road equipment is found to be in non-compliance with any portion of this special provision, the Engineer will issue the Contractor a diesel retrofit deficiency deduction.

Any costs associated with retrofitting any diesel powered off-road equipment with emission control devices shall be considered as included in the contract unit prices bid for the various items of work involved and no additional compensation will be allowed. The Contractor's compliance with this notice and any associated regulations shall not be grounds for a claim.

Diesel Retrofit Deficiency Deduction

When the Engineer determines that a diesel retrofit deficiency exists, a daily monetary deduction will be imposed for each calendar day or fraction thereof the deficiency continues to exist. The calendar day(s) will begin when the time period for correction is exceeded and end with the Engineer's written acceptance of the correction. The daily monetary deduction will be $1,000.00 for each deficiency identified.

The deficiency will be based on lack of diesel retrofit emissions control.

If a Contractor accumulates three diesel retrofit deficiency deductions for the same piece of equipment in a contract period, the Contractor will be shutdown until the deficiency is corrected. Such a shutdown will not be grounds for any extension of the contract time, waiver of penalties, or be grounds for any claim.

DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION (BDE)
Effective: September 1, 2000 Revised: March 2, 2019

FEDERAL OBLIGATION. The Department of Transportation, as a recipient of federal financial assistance, is required to take all necessary and reasonable steps to ensure nondiscrimination in the award and administration of contracts. Consequently, the federal regulatory provisions of 49 CFR Part 26 apply to this contract concerning the utilization of disadvantaged business enterprises. For the purposes of this Special Provision, a disadvantaged business enterprise (DBE) means a business certified by the Department in accordance with the requirements of 49 CFR Part 26 and listed in the Illinois Unified Certification Program (IL UCP) DBE Directory.

STATE OBLIGATION. This Special Provision will also be used by the Department to satisfy the requirements of the Business Enterprise for Minorities, Females, and Persons with Disabilities Act, 30 ILCS 575. When this Special Provision is used to satisfy state law requirements on 100 percent state-funded contracts, the federal government has no involvement in such contracts (not a federal-aid contract) and no responsibility to oversee the implementation of this Special Provision by the Department on those contracts. DBE participation on 100 percent state-funded contracts will not be credited toward fulfilling the Department's annual overall DBE goal required by the US Department of Transportation to comply with the federal DBE program requirements.

CONTRACTOR ASSURANCE. The Contractor makes the following assurance and agrees to include the assurance in each subcontract the Contractor signs with a subcontractor.

> The Contractor, subrecipient, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of contracts funded in whole or in part with federal or state funds. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:
>
> (a) Withholding progress payments;
>
> (b) Assessing sanctions;
>
> (c) Liquidated damages; and/or
>
> (d) Disqualifying the Contractor from future bidding as non-responsible.

OVERALL GOAL SET FOR THE DEPARTMENT. As a requirement of compliance with 49 CFR Part 26, the Department has set an overall goal for DBE participation in its federally assisted contracts. That goal applies to all federal-aid funds the Department will expend in its federally assisted contracts for the subject reporting fiscal year. The Department is required to make a good faith effort to achieve the overall goal. The dollar amount paid to all approved DBE companies performing work called for in this contract is eligible to be credited toward fulfillment of the Department's overall goal.

CONTRACT GOAL TO BE ACHIEVED BY THE CONTRACTOR. This contract includes a specific DBE utilization goal established by the Department. The goal has been included because the Department has determined the work of this contract has subcontracting opportunities that may be suitable for performance by DBE companies. The determination is based on an assessment of the type of work, the location of the work, and the availability of DBE companies to do a part of the work. The assessment indicates, in the absence of unlawful discrimination and in an arena of fair and open competition, DBE companies can be expected to perform **11.00%** of the work. This percentage is set as the DBE participation goal for this contract. Consequently, in addition to the other award criteria established for this contract, the Department will only award this contract to a bidder who makes a good faith effort to meet this goal of DBE participation in the performance of the work. A bidder makes a good faith effort for award consideration if either of the following is done in accordance with the procedures set for in this Special Provision:

(a) The bidder documents enough DBE participation has been obtained to meet the goal or,

(b) The bidder documents a good faith effort has been made to meet the goal, even though the effort did not succeed in obtaining enough DBE participation to meet the goal.

DBE LOCATOR REFERENCES. Bidders shall consult the IL UCP DBE Directory as a reference source for DBE-certified companies. In addition, the Department maintains a letting and item specific DBE locator information system whereby DBE companies can register their interest in providing quotes on particular bid items advertised for letting. Information concerning DBE companies willing to quote work for particular contracts may be obtained by contacting the Department's Bureau of Small Business Enterprises at telephone number (217) 785-4611, or by visiting the Department's website at: http://www.idot.illinois.gov/doing-business/certifications/disadvantaged-business-enterprise-certification/il-ucp-directory/index.

BIDDING PROCEDURES. Compliance with this Special Provision is a material bidding requirement and failure of the bidder to comply will render the bid not responsive.

The bidder shall submit a DBE Utilization Plan (form SBE 2026), and a DBE Participation Statement (form SBE 2025) for each DBE company proposed for the performance of work to achieve the contract goal, with the bid. If the Utilization Plan indicates the contract goal will not be met, documentation of good faith efforts shall also be submitted. The documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor is selected over a DBE for work on the contract. The required forms and documentation must be submitted as a single .pdf file using the "Integrated Contractor Exchange (iCX)" application within the Department's "EBids System".

The Department will not accept a Utilization Plan if it does not meet the bidding procedures set forth herein and the bid will be declared not responsive. In the event the bid is declared not responsive, the Department may elect to cause the forfeiture of the penal sum of the bidder's proposal guaranty and may deny authorization to bid the project if re-advertised for bids.

GOOD FAITH EFFORT PROCEDURES. The contract will not be awarded until the Utilization Plan is approved. All information submitted by the bidder must be complete, accurate and adequately document enough DBE participation has been obtained or document the good faith efforts of the bidder, in the event enough DBE participation has not been obtained, before the Department will commit to the performance of the contract by the bidder. The Utilization Plan will be approved by the Department if the Utilization Plan documents sufficient commercially useful DBE work to meet the contract goal or the bidder submits sufficient documentation of a good faith effort to meet the contract goal pursuant to 49 CFR Part 26, Appendix A. This means the bidder must show that all necessary and reasonable steps were taken to achieve the contract goal. Necessary and reasonable steps are those which, by their scope, intensity and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if they were not successful. The Department will consider the quality, quantity, and intensity of the kinds of efforts the bidder has made. Mere *pro forma* efforts, in other words efforts done as a matter of form, are not good faith efforts; rather, the bidder is expected to have taken genuine efforts that would be reasonably expected of a bidder actively and aggressively trying to obtain DBE participation sufficient to meet the contract goal.

(a) The following is a list of types of action that the Department will consider as part of the evaluation of the bidder's good faith efforts to obtain participation. These listed factors are not intended to be a mandatory checklist and are not intended to be exhaustive. Other factors or efforts brought to the attention of the Department may be relevant in appropriate cases and will be considered by the Department.

(1) Soliciting through all reasonable and available means (e.g. attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBE companies that have the capability to perform the work of the contract. The bidder must solicit this interest within sufficient time to allow the DBE companies to respond to the solicitation. The bidder must determine with certainty if the DBE companies are interested by taking appropriate steps to follow up initial solicitations.

(2) Selecting portions of the work to be performed by DBE companies in order to increase the likelihood that the DBE goals will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the Contractor might otherwise prefer to perform these work items with its own forces.

(3) Providing interested DBE companies with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

(4) a. Negotiating in good faith with interested DBE companies. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBE companies that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBE companies to perform the work.

b. A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBE companies is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also the ability or desire of a bidder to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Bidders are not, however, required to accept higher quotes from DBE companies if the price difference is excessive or unreasonable. In accordance with the above Bidding Procedures, the documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract.

(5) Not rejecting DBE companies as being unqualified without sound reasons based on a thorough investigation of their capabilities. The bidder's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the bidder's efforts to meet the project goal.

(6) Making efforts to assist interested DBE companies in obtaining bonding, lines of credit, or insurance as required by the recipient or Contractor.

(7) Making efforts to assist interested DBE companies in obtaining necessary equipment, supplies, materials, or related assistance or services.

(8) Effectively using the services of available minority/women community organizations; minority/women contractors' groups; local, state, and federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBE companies.

(b) If the Department determines the bidder has made a good faith effort to secure the work commitment of DBE companies to meet the contract goal, the Department will award the contract provided it is otherwise eligible for award. If the Department determines the bidder has failed to meet the requirements of this Special Provision or that a good faith effort has not been made, the Department will notify the responsible company official designated in the Utilization Plan that the bid is not responsive. The notification will also include a statement of reasons for the adverse determination. If the Utilization Plan is not approved because it is deficient as a technical matter, unless waived by the Department, the bidder will be notified and will be allowed no more than a five calendar day period to cure the deficiency.

(c) The bidder may request administrative reconsideration of an adverse determination by emailing the Department at "DOT.DBE.UP@illinois.gov" within the five calendar days after the receipt of the notification of the determination. The determination shall become final if a request is not made on or before the fifth calendar day. A request may provide additional written documentation or argument concerning the issues raised in the determination statement of reasons, provided the documentation and arguments address efforts made prior to submitting the bid. The request will be reviewed by the Department's Reconsideration Officer. The Reconsideration Officer will extend an opportunity to the bidder to meet in person to consider all issues of documentation and whether the bidder made a good faith effort to meet the goal. After the review by the Reconsideration Officer, the bidder will be sent a written decision within ten working days after receipt of the request for reconsideration, explaining the basis for finding that the bidder did or did not meet the goal or make adequate good faith efforts to do so. A final decision by the Reconsideration Officer that a good faith effort was made shall approve the Utilization Plan submitted by the bidder and shall clear the contract for award. A final decision that a good faith effort was not made shall render the bid not responsive.

CALCULATING DBE PARTICIPATION. The Utilization Plan values represent work anticipated to be performed and paid for upon satisfactory completion. The Department is only able to count toward the achievement of the overall goal and the contract goal the value of payments made for the work actually performed by DBE companies. In addition, a DBE must perform a commercially useful function on the contract to be counted. A commercially useful function is generally performed when the DBE is responsible for the work and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. The Department and Contractor are governed by the provisions of 49 CFR Part 26.55(c) on questions of commercially useful functions as it affects the work. Specific counting guidelines are provided in 49 CFR Part 26.55, the provisions of which govern over the summary contained herein.

(a) DBE as the Contractor: 100 percent goal credit for that portion of the work performed by the DBE's own forces, including the cost of materials and supplies. Work that a DBE subcontracts to a non-DBE does not count toward the DBE goals.

(b) DBE as a joint venture Contractor: 100 percent goal credit for that portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work performed by the DBE's own forces.

(c) DBE as a subcontractor: 100 percent goal credit for the work of the subcontract performed by the DBE's own forces, including the cost of materials and supplies, excluding the purchase of materials and supplies or the lease of equipment by the DBE subcontractor from the Contractor or its affiliates. Work that a DBE subcontractor in turn subcontracts to a non-DBE does not count toward the DBE goal.

(d) DBE as a trucker: 100 percent goal credit for trucking participation provided the DBE is responsible for the management and supervision of the entire trucking operation for which it is responsible. At least one truck owned, operated, licensed, and insured by the DBE must be used on the contract. Credit will be given for the following:

(1) The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the contract.

(2) The DBE may also lease trucks from a non-DBE firm, including from an owner-operator. The DBE who leases trucks from a non-DBE is entitled to credit only for the fee or commission is receives as a result of the lease arrangement.

(e) DBE as a material supplier:

(1) 60 percent goal credit for the cost of the materials or supplies purchased from a DBE regular dealer.

(2) 100 percent goal credit for the cost of materials of supplies obtained from a DBE manufacturer.

(3) 100 percent credit for the value of reasonable fees and commissions for the procurement of materials and supplies if not a DBE regular dealer or DBE manufacturer.

CONTRACT COMPLIANCE. Compliance with this Special Provision is an essential part of the contract. The Department is prohibited by federal regulations from crediting the participation of a DBE included in the Utilization Plan toward either the contract goal or the Department's overall goal until the amount to be applied toward the goals has been paid to the DBE. The following administrative procedures and remedies govern the compliance by the Contractor with the contractual obligations established by the Utilization Plan. After approval of the Utilization Plan and award of the contract, the Utilization Plan and individual DBE Participation Statements become part of the contract. If the Contractor did not succeed in obtaining enough DBE participation to achieve the advertised contract goal, and the Utilization Plan was approved and contract awarded based upon a determination of good faith, the total dollar value of DBE work calculated in the approved Utilization Plan as a percentage of the awarded contract value shall become the amended contract goal. All work indicated for performance by an approved DBE shall be performed, managed, and supervised by the DBE executing the DBE Participation Commitment Statement.

(a) NO AMENDMENT. No amendment to the Utilization Plan may be made without prior written approval from the Department's Bureau of Small Business Enterprises. All requests for amendment to the Utilization Plan shall be emailed to the Department at DOT.DBE.UP@illinois.gov.

(b) CHANGES TO WORK. Any deviation from the DBE condition-of-award or contract plans, specifications, or special provisions must be approved, in writing, by the Department as provided elsewhere in the Contract. The Contractor shall notify affected DBEs in writing of any changes in the scope of work which result in a reduction in the dollar amount condition-of-award to the contract. Where the revision includes work committed to a new DBE subcontractor, not previously involved in the project, then a Request for Approval of Subcontractor, Department form BC 260A or AER 260A, must be signed and submitted. If the commitment of work is in the form of additional tasks assigned to an existing subcontract, a new Request for Approval of Subcontractor will not be required. However, the Contractor must document efforts to assure the existing DBE subcontractor is capable of performing the additional work and has agreed in writing to the change.

(c) SUBCONTRACT. The Contractor must provide copies of DBE subcontracts to the Department upon request. Subcontractors shall ensure that all lower tier subcontracts or agreements with DBEs to supply labor or materials be performed in accordance with this Special Provision.

(d) ALTERNATIVE WORK METHODS. In addition to the above requirements for reductions in the condition of award, additional requirements apply to the two cases of Contractor-initiated work substitution proposals. Where the contract allows alternate work methods which serve to delete or create underruns in condition of award DBE work, and the Contractor selects that alternate method or, where the Contractor proposes a substitute work method or material that serves to diminish or delete work committed to a DBE and replace it with other work, then the Contractor must demonstrate one of the following:

(1) The replacement work will be performed by the same DBE (as long as the DBE is certified in the respective item of work) in a modification of the condition of award; or

(2) The DBE is aware its work will be deleted or will experience underruns and has agreed in writing to the change. If this occurs, the Contractor shall substitute other work of equivalent value to a certified DBE or provide documentation of good faith efforts to do so; or

(3) The DBE is not capable of performing the replacement work or has declined to perform the work at a reasonable competitive price. If this occurs, the Contractor shall substitute other work of equivalent value to a certified DBE or provide documentation of good faith efforts to do so.

(e) TERMINATION AND REPLACEMENT PROCEDURES. The Contractor shall not terminate or replace a DBE listed on the approved Utilization Plan, or perform with other forces work designated for a listed DBE except as provided in this Special Provision. The Contractor shall utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the Contractor obtains the Department's written consent as provided in subsection (a) of this part. Unless Department consent is provided for termination of a DBE subcontractor, the Contractor shall not be entitled to any payment for work or material unless it is performed or supplied by the DBE in the Utilization Plan.

As stated above, the Contractor shall not terminate or replace a DBE subcontractor listed in the approved Utilization Plan without prior written consent. This includes, but is not limited to, instances in which the Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. Written consent will be granted only if the Bureau of Small Business Enterprises agrees, for reasons stated in its concurrence document, that the Contractor has good cause to terminate or replace the DBE firm. Before transmitting to the Bureau of Small Business Enterprises any request to terminate and/or substitute a DBE subcontractor, the Contractor shall give notice in writing to the DBE subcontractor, with a copy to the Bureau, of its intent to request to terminate and/or substitute, and the reason for the request. The Contractor shall give the DBE five days to respond to the Contractor's notice. The DBE so notified shall advise the Bureau and the Contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why the Bureau should not approve the Contractor's action. If required in a particular case as a matter of public necessity, the Bureau may provide a response period shorter than five days.

For purposes of this paragraph, good cause includes the following circumstances:

(1) The listed DBE subcontractor fails or refuses to execute a written contract;

(2) The listed DBE subcontractor fails or refuses to perform the work of its subcontract in a way consistent with normal industry standards. Provided, however, that good cause does not exist if the failure or refusal of the DBE subcontractor to perform its work on the subcontract results from the bad faith or discriminatory action of the Contractor;

(3) The listed DBE subcontractor fails or refuses to meet the Contractor's reasonable, nondiscriminatory bond requirements;

(4) The listed DBE subcontractor becomes bankrupt, insolvent, or exhibits credit unworthiness;

(5) The listed DBE subcontractor is ineligible to work on public works projects because of suspension and debarment proceedings pursuant 2 CFR Parts 180, 215 and 1200 or applicable state law.

(6) The Contractor has determined the listed DBE subcontractor is not a responsible contractor;

(7) The listed DBE subcontractor voluntarily withdraws from the projects and provides written notice to the Contractor of its withdrawal;

(8) The listed DBE is ineligible to receive DBE credit for the type of work required;

(9) A DBE owner dies or becomes disabled with the result that the listed DBE subcontractor is unable to complete its work on the contract;

(10) Other documented good cause that compels the termination of the DBE subcontractor. Provided, that good cause does not exist if the Contractor seeks to terminate a DBE it relied upon to obtain the contract so that the Contractor can self-perform the work for which the DBE contractor was engaged or so that the Contractor can substitute another DBE or non-DBE contractor after contract award.

When a DBE is terminated or fails to complete its work on the Contract for any reason, the Contractor shall make a good faith effort to find another DBE to substitute for the original DBE to perform at least the same amount of work under the contract as the terminated DBE to the extent needed to meet the established Contract goal. The good faith efforts shall be documented by the Contractor. If the Department requests documentation under this provision, the Contractor shall submit the documentation within seven days, which may be extended for an additional seven days if necessary at the request of the Contractor. The Department will provide a written determination to the Contractor stating whether or not good faith efforts have been demonstrated.

(f) FINAL PAYMENT. After the performance of the final item of work or delivery of material by a DBE and final payment therefore to the DBE by the Contractor, but not later than 30 calendar days after payment has been made by the Department to the Contractor for such work or material, the Contractor shall submit a DBE Payment Agreement on Department form SBE 2115 to the Resident Engineer. If full and final payment has not been made to the DBE, the DBE Payment Agreement shall indicate whether a disagreement as to the payment required exists between the Contractor and the DBE or if the Contractor believes the work has not been satisfactorily completed. If the Contractor does not have the full amount of work indicated in the Utilization Plan performed by the DBE companies indicated in the Utilization Plan and after good faith efforts are reviewed, the Department may deduct from contract payments to the Contractor the amount of the goal not achieved as liquidated and ascertained damages. The Contractor may request an administrative reconsideration of any amount deducted as damages pursuant to subsection (h) of this part.

(g) ENFORCEMENT. The Department reserves the right to withhold payment to the Contractor to enforce the provisions of this Special Provision. Final payment shall not be made on the contract until such time as the Contractor submits sufficient documentation demonstrating achievement of the goal in accordance with this Special Provision or after liquidated damages have been determined and collected.

(h) RECONSIDERATION. Notwithstanding any other provision of the contract, including but not limited to Article 109.09 of the Standard Specifications, the Contractor may request administrative reconsideration of a decision to deduct the amount of the goal not achieved as liquidated damages. A request to reconsider shall be delivered to the Contract Compliance Section and shall be handled and considered in the same manner as set forth in paragraph (c) of “Good Faith Effort Procedures” of this Special Provision, except a final decision that a good faith effort was not made during contract performance to achieve the goal agreed to in the Utilization Plan shall be the final administrative decision of the Department. The result of the reconsideration process is not administratively appealable to the U.S. Department of Transportation.

DISPOSAL FEES (BDE)
Effective: November 1, 2018

Replace Articles 109.04(b)(5) – 109.04(b)(8) of the Standard Specifications with the following:

"(5) Disposal Fees. When the extra work performed includes paying for disposal fees at a clean construction and demolition debris facility, an uncontaminated soil fill operation or a landfill, the Contractor shall receive, as administrative costs, an amount equal to five percent of the first $10,000 and one percent of any amount over $10,000 of the total approved costs of such fees.

(6) Miscellaneous. No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

(7) Statements. No payment will be made for work performed on a force account basis until the Contractor has furnished the Engineer with itemized statements of the cost of such force account work. Statements shall be accompanied and supported by invoices for all materials used and transportation charges. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from his/her stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

Itemized statements at the cost of force account work shall be detailed as follows.

a. Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman. Payrolls shall be submitted to substantiate actual wages paid if so requested by the Engineer.

b. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.

c. Quantities of materials, prices and extensions.

d. Transportation of materials.

e. Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, and social security tax.

(8) Work Performed by an Approved Subcontractor. When extra work is performed by an approved subcontractor, the Contractor shall receive, as administrative costs, an amount equal to five percent of the total approved costs of such work with the minimum payment being $100.

(9) All statements of the cost of force account work shall be furnished to the Engineer not later than 60 days after receipt of the Central Bureau of Construction form "Extra Work Daily Report". If the statement is not received within the specified time frame, all demands for payment for the extra work are waived and the Department is released from any and all such demands. It is the responsibility of the Contractor to ensure that all statements are received within the specified time regardless of the manner or method of delivery."

EQUIPMENT PARKING AND STORAGE (BDE)
Effective: November 1, 2017

Replace the first paragraph of Article 701.11 of the Standard Specifications with the following.

"**701.11 Equipment Parking and Storage.** During working hours, all vehicles and/or nonoperating equipment which are parked, two hours or less, shall be parked at least 8 ft (2.5 m) from the open traffic lane. For other periods of time during working and for all nonworking hours, all vehicles, materials, and equipment shall be parked or stored as follows.

(a) When the project has adequate right-of-way, vehicles, materials, and equipment shall be located a minimum of 30 ft (9 m) from the pavement.

(b) When adequate right-of-way does not exist, vehicles, materials, and equipment shall be located a minimum of 15 ft (4.5 m) from the edge of any pavement open to traffic.

(c) Behind temporary concrete barrier, vehicles, materials, and equipment shall be located a minimum of 24 in. (600 mm) behind free standing barrier or a minimum of 6 in. (150 mm) behind barrier that is either pinned or restrained according to Article 704.04. The 24 in. or 6 in. measurement shall be from the base of the non-traffic side of the barrier.

(d) Behind other man-made or natural barriers meeting the approval of the Engineer."

FUEL COST ADJUSTMENT (BDE)
Effective: April 1, 2009 Revised: August 1, 2017

Description. Fuel cost adjustments will be made to provide additional compensation to the Contractor, or a credit to the Department, for fluctuations in fuel prices when optioned by the Contractor. The bidder shall indicate with their bid whether or not this special provision will be part of the contract. Failure to indicate "Yes" for any category of work will make that category of work exempt from fuel cost adjustment.

General. The fuel cost adjustment shall apply to contract pay items as grouped by category. The adjustment shall only apply to those categories of work checked "Yes", and only when the cumulative plan quantities for a category exceed the required threshold. Adjustments to work items in a category, either up or down, and extra work paid for by agreed unit price will be subject to fuel cost adjustment only when the category representing the added work was subject to the fuel cost adjustment. Extra work paid for at a lump sum price or by force account will not be subject to fuel cost adjustment. Category descriptions and thresholds for application and the fuel usage factors which are applicable to each are as follows:

(a) Categories of Work.

(1) Category A: Earthwork. Contract pay items performed under Sections 202, 204, and 206 including any modified standard or nonstandard items where the character of the work to be performed is considered earthwork. The cumulative total of all applicable item plan quantities shall exceed 25,000 cu yd (20,000 cu m). Included in the fuel usage factor is a weighted average 0.10 gal/cu yd (0.50 liters/cu m) factor for trucking.

(2) Category B: Subbases and Aggregate Base Courses. Contract pay items constructed under Sections 311, 312 and 351 including any modified standard or nonstandard items where the character of the work to be performed is considered construction of a subbase or aggregate, stabilized or modified base course. The cumulative total of all applicable item plan quantities shall exceed 5000 tons (4500 metric tons). Included in the fuel usage factor is a 0.60 gal/ton (2.50 liters/metric ton) factor for trucking.

(3) Category C: Hot-Mix Asphalt (HMA) Bases, Pavements and Shoulders. Contract pay items constructed under Sections 355, 406, 407 and 482 including any modified standard or nonstandard items where the character of the work to be performed is considered HMA bases, pavements and shoulders. The cumulative total of all applicable item plan quantities shall exceed 5000 tons (4500 metric tons). Included in the fuel usage factor is 0.60 gal/ton (2.50 liters/metric ton) factor for trucking.

(4) Category D: Portland Cement Concrete (PCC) Bases, Pavements and Shoulders. Contract pay items constructed under Sections 353, 420, 421 and 483 including any modified standard or nonstandard items where the character of the work to be performed is considered PCC base, pavement or shoulder. The cumulative total of all applicable item plan quantities shall exceed 7500 sq yd (6000 sq m). Included in the fuel usage factor is 1.20 gal/cu yd (5.94 liters/cu m) factor for trucking.

(5) Category E: Structures. Structure items having a cumulative bid price that exceeds $250,000 for pay items constructed under Sections 502, 503, 504, 505, 512, 516 and 540 including any modified standard or nonstandard items where the character of the work to be performed is considered structure work when similar to that performed under these sections and not included in categories A through D.

(b) Fuel Usage Factors.

English Units

Category	Factor	Units
A - Earthwork	0.34	gal / cu yd
B – Subbase and Aggregate Base courses	0.62	gal / ton
C – HMA Bases, Pavements and Shoulders	1.05	gal / ton
D – PCC Bases, Pavements and Shoulders	2.53	gal / cu yd
E – Structures	8.00	gal / $1000

Metric Units

Category	Factor	Units
A - Earthwork	1.68	liters / cu m
B – Subbase and Aggregate Base courses	2.58	liters / metric ton
C – HMA Bases, Pavements and Shoulders	4.37	liters / metric ton
D – PCC Bases, Pavements and Shoulders	12.52	liters / cu m
E – Structures	30.28	liters / $1000

(c) Quantity Conversion Factors.

Category	Conversion	Factor
B	sq yd to ton	0.057 ton / sq yd / in depth
	sq m to metric ton	0.00243 metric ton / sq m / mm depth
C	sq yd to ton	0.056 ton / sq yd / in depth
	sq m to metric ton	0.00239 m ton / sq m / mm depth
D	sq yd to cu yd	0.028 cu yd / sq yd / in depth
	sq m to cu m	0.001 cu m / sq m / mm depth

Method of Adjustment. Fuel cost adjustments will be computed as follows.

$CA = (FPI_P - FPI_L) \times FUF \times Q$

Where: CA = Cost Adjustment, $
FPI_P = Fuel Price Index, as published by the Department for the month the work is performed, $/gal ($/liter)
FPI_L = Fuel Price Index, as published by the Department for the month prior to the letting for work paid for at the contract price; or for the month the agreed unit price letter is submitted by the Contractor for extra work paid for by agreed unit price, $/gal ($/liter)
FUF = Fuel Usage Factor in the pay item(s) being adjusted
Q = Authorized construction Quantity, tons (metric tons) or cu yd (cu m)

The entire FUF indicated in paragraph (b) will be used regardless of use of trucking to perform the work.

Basis of Payment. Fuel cost adjustments may be positive or negative but will only be made when there is a difference between the FPI_L and FPI_P in excess of five percent, as calculated by:

Percent Difference = $\{(FPI_L - FPI_P) \div FPI_L\} \times 100$

Fuel cost adjustments will be calculated for each calendar month in which applicable work is performed; and will be paid or deducted when all other contract requirements for the items of work are satisfied. The adjustments shall not apply during contract time subject to liquidated damages for completion of the entire contract.

GROOVING FOR RECESSED PAVEMENT MARKINGS (BDE)
Effective: November 1, 2012 Revised: November 1, 2017

Description. This work shall consist of grooving the pavement surface in preparation for the application of recessed pavement markings.

Equipment. Equipment shall be according to the following.

(a) Preformed Plastic Pavement Marking Installations. The grooving equipment shall have a free-floating saw blade cutting head equipped with gang-stacked diamond saw blades. The diamond saw blades shall be of uniform wear and shall produce a smooth textured surface. Any ridges in the groove shall have a maximum height of 15 mils (0.38 mm).

(b) Liquid and Thermoplastic Pavement Marking Installations. The grooving equipment shall be equipped with either a free-floating saw blade cutting head or a free-floating grinder cutting head configuration with diamond or carbide tipped cutters and shall produce an irregular textured surface.

CONSTRUCTION REQUIREMENTS

General. The Contractor shall supply the Engineer with a copy of the pavement marking material manufacturer's recommendations for constructing a groove.

Pavement Grooving Methods. The grooves for recessed pavement markings shall be constructed using the following methods.

(a) Wet Cutting Head Operation. When water is required or used to cool the cutting head, the groove shall be flushed with high pressure water immediately following the cut to avoid build up and hardening of slurry in the groove. The pavement surface shall be allowed to dry for a minimum of 24 hours prior to the final cleaning of the groove and application of the pavement marking material.

(b) Dry Cutting Head Operation. When used on HMA pavements, the groove shall be vacuumed or cleaned by blasting with high-pressure air to remove loose aggregate, debris, and dust generated during the cutting operation. When used on PCC pavements, the groove shall be flushed with high pressure water or shot blasted to remove any PCC particles that may have become destabilized during the grooving process. If high pressure water is used, the pavement surface shall be allowed to dry for a minimum of 24 hours prior to the final cleaning of the groove and application of the pavement marking material.

Pavement Grooving. Grooving shall not cause ravels, aggregate fractures, spalling or disturbance of the joints to the underlying surface of the pavement. Grooves shall be cut into the pavement prior to the application of the pavement marking material. Grooves shall be cut such that the width is 1 in. (25 mm) greater than the width of the pavement marking line as specified on the plans. Grooves for letters and symbols shall be cut in a square or rectangular shape so that the entire marking will fit within the limits of the grooved area. The position of the edge of the grooves shall be a minimum of 2 in. (50 mm) from the edge of all longitudinal joints. The depth of the groove shall not be less than the manufacturer's recommendations for the pavement marking material specified, but shall be installed to a minimum depth of 110 mils (2.79 mm) and a maximum depth of 200 mils (5.08 mm) for pavement marking tapes thermoplastic markings and a minimum depth of 40 mils (1.02 mm) and a maximum depth of 80 mils (2.03 mm) for liquid markings. The cutting head shall be operated at the appropriate speed in order to prevent undulation of the cutting head and grooving at an inconsistent depth.

At the start of grooving operations, a 50 ft (16.7 m) test section shall be installed and depth measurements shall be made at 10 ft (3.3 m) intervals within the test section. The individual depth measurements shall be within the allowable ranges according to this Article. If it is determined the test section has not been grooved at the appropriate depth or texture, adjustments shall be made to the cutting head and another 50 ft (16.7 m) test section shall be installed and checked. This process shall continue until the test section meets the requirements of this Article.

For new HMA pavements, grooves shall not be installed within 10 days of the placement of the final course of pavement.

Final Cleaning. Immediately prior to the application of the pavement marking material or primer sealer, the groove shall be cleaned with high-pressure air blast.

Method of Measurement. This work will be measured for payment in place, in feet (meter) for the groove width specified.

Grooving for letter, numbers and symbols will be measured in square feet (square meters).

Basis of Payment. This work will be paid for at the contract unit price per foot (meter) for GROOVING FOR RECESSED PAVEMENT MARKING of the groove width specified, and per square foot (square meter) for GROOVING FOR RECESSED PAVEMENT MARKING, LETTERS AND SYMBOLS.

The following shall only apply when preformed plastic pavement markings are to be recessed:

Add the following paragraph after the first paragraph of Article 780.07 of the Standard Specifications.

"The markings shall be capable of being applied in a grooved slot on new and existing portland cement concrete and HMA surfaces, by means of a pressure-sensitive, precoated adhesive, or liquid contact cement which shall be applied at the time of installation. A primer sealer shall be applied with a roller and shall cover and seal the entire bottom of the groove. The primer sealer shall be recommended by the manufacturer of the pavement marking material and shall be compatible with the material being used. The Contractor shall install the markings in the groove as soon as possible after the primer sealer cures according to the manufacturer's recommendations. The markings placed in the groove shall be rolled and tamped into the groove with a roller or tamper cart cut to fit the groove and loaded with or weighing at least 200 lb (90kg). Vehicle tires shall not be used for tamping. The Contractor shall roll and tamp the material with a minimum of 6 passes to prevent easy removal or peeling."

HOT-MIX ASPHALT - DENSITY TESTING OF LONGITUDINAL JOINTS (BDE)
Effective: January 1, 2010 Revised: August 1, 2018

Description. This work shall consist of testing the density of longitudinal joints as part of the quality control/quality assurance (QC/QA) of hot-mix asphalt (HMA). Work shall be according to Section 1030 of the Standard Specifications except as follows.

Quality Control/Quality Assurance (QC/QA). Delete the second and third sentence of the third paragraph of Article 1030.05(d)(3) of the Standard Specifications.

Add the following paragraphs to the end of Article 1030.05(d)(3) of the Standard Specifications:

"Longitudinal joint density testing shall be performed at each random density test location. Longitudinal joint testing shall be located at a distance equal to the lift thickness or a minimum of 4 in. (100 mm), from each pavement edge. (i.e. for a 5 in. (125 mm) lift the near edge of the density gauge or core barrel shall be within 5 in. (125 mm) from the edge of pavement.) Longitudinal joint density testing shall be performed using either a correlated nuclear gauge or cores.

a. Confined Edge. Each confined edge density shall be represented by a one-minute nuclear density reading or a core density and shall be included in the average of density readings or core densities taken across the mat which represents the Individual Test.

b. Unconfined Edge. Each unconfined edge joint density shall be represented by an average of three one-minute density readings or a single core density at the given density test location and shall meet the density requirements specified herein. The three one-minute readings shall be spaced 10 ft (3 m) apart longitudinally along the unconfined pavement edge and centered at the random density test location.

When a longitudinal joint sealant (LJS) is applied, longitudinal joint density testing will not be required on the joint(s) sealed."

Revise the Density Control Limits table in Article 1030.05(d)(4) of the Standard Specifications to read:

"Mixture Composition	Parameter	Individual Test (includes confined edges)	Unconfined Edge Joint Density Minimum
IL-4.75	Ndesign = 50	93.0 – 97.4% 1/	91.0%
IL-9.5	Ndesign = 90	92.0 – 96.0%	90.0%
IL-9.5,IL-9.5L	Ndesign < 90	92.5 – 97.4%	90.0%
IL-19.0	Ndesign = 90	93.0 – 96.0%	90.0%
IL-19.0, IL-19.0L	Ndesign < 90	93.0 2/– 97.4%	90.0%
SMA	Ndesign = 50 & 80	93.5 – 97.4%	91.0%"

HOT-MIX ASPHALT – OSCILLATORY ROLLER (BDE)
Effective: August 1, 2018 Revised: November 1, 2018

Add the following to Article 406.03 of the Standard Specifications:

"(j) Oscillatory Roller .....1101.01"

Revise Table 1 and Note 3/ of Table 1 in Article 406.07(a) of the Standard Specifications to read:

"TABLE 1 - MINIMUM ROLLER REQUIREMENTS FOR HMA				
	Breakdown Roller (one of the following)	Intermediate Roller	Final Roller (one or more of the following)	Density Requirement
Level Binder: (When the density requirements of Article 406.05(c) do not apply.)	P 3/	- -	V_S, P 3/, T_B, T_F, 3W, O_T	To the satisfaction of the Engineer.
Binder and Surface 1/ Level Binder 1/: (When the density requirements of Article 406.05(c) apply.)	V_D, P 3/, T_B, 3W, O_T, O_B	P 3/, O_T, O_B	V_S, T_B, T_F, O_T	As specified in Articles: 1030.05(d)(3), (d)(4), and (d)(7).
IL-4.75 and SMA 4/ 5/	T_B, 3W, O_T	- -	T_F, 3W, O_T	
Bridge Decks 2/	T_B	- -	T_F	As specified in Articles 582.05 and 582.06.

3/ A vibratory roller (V_D) or oscillatory roller (O_T or O_B) may be used in lieu of the pneumatic-tired roller on mixtures containing polymer modified asphalt binder."

Add the following to EQUIPMENT DEFINITION in Article 406.07(a) contained in the Errata of the Supplemental Specifications:

"O_T - Oscillatory roller, tangential impact mode. Maximum speed is 3.0 mph (4.8 km/h) or 264 ft/min (80 m/min).

O_B - Oscillatory roller, tangential and vertical impact mode, operated at a speed to produce not less than 10 vertical impacts/ft (30 impacts/m)."

Add the following to Article 1101.01 of the Standard Specifications:

"(h) Oscillatory Roller. The oscillatory roller shall be self-propelled and provide a smooth operation when starting, stopping, or reversing directions. The oscillatory roller shall be able to operate in a mode that will provide tangential impact force with or without vertical impact force by using at least one drum. The oscillatory roller shall be equipped with water tanks and sprinkling devices, or other approved methods, which shall be used to wet the drums to prevent material pickup. The drum(s) amplitude and frequency of the tangential and vertical impact force shall be approximately the same in each direction and meet the following requirements:

(1) The minimum diameter of the drum(s) shall be 42 in. (1070 mm);

(2) The minimum length of the drum(s) shall be 57 in. (1480 mm);

(3) The minimum unit static force on the drum(s) shall be 125 lb/in. (22 N/m); and

(4) The minimum force on the oscillatory drum shall be 18,000 lb (80 kN)."

HOT-MIX ASPHALT – TACK COAT (BDE)
Effective: November 1, 2016

Revise Article 1032.06(a) of the Standard Specifications to read:

"(a) Anionic Emulsified Asphalt. Anionic emulsified asphalts shall be according to AASHTO M 140. SS-1h emulsions used as a tack coat shall have the cement mixing test waived."

LIGHTS ON BARRICADES (BDE)
Effective: January 1, 2018

Revise Article 701.16 of the Standard Specifications to read:

"**701.16 Lights.** Lights shall be used on devices as required in the plans, the traffic control plan, and the following table.

Circumstance	Lights Required
Daylight operations	None
First two warning signs on each approach to the work involving a nighttime lane closure and "ROUGH GROOVED SURFACE" (W8-I107) signs	Flashing mono-directional lights
Devices delineating isolated obstacles, excavations, or hazards at night (Does not apply to patching)	Flashing bi-directional lights
Devices delineating obstacles, excavations, or hazards exceeding 100 ft (30 m) in length at night (Does not apply to widening)	Steady burn bi-directional lights
Channelizing devices for nighttime lane closures on two-lane roads	None
Channelizing devices for nighttime lane closures on multi-lane roads	None
Channelizing devices for nighttime lane closures on multi-lane roads separating opposing directions of traffic	None
Channelizing devices for nighttime along lane shifts on multilane roads	Steady burn mono-directional lights
Channelizing devices for night time along lane shifts on two lane roads	Steady burn bi-directional lights
Devices in nighttime lane closure tapers on Standards 701316 and 701321	Steady burn bi-directional lights
Devices in nighttime lane closure tapers	Steady burn mono-directional lights
Devices delineating a widening trench	None
Devices delineating patches at night on roadways with an ADT less than 25,000	None
Devices delineating patches at night on roadways with an ADT of 25,000 or more	None

Batteries for the lights shall be replaced on a group basis at such times as may be specified by the Engineer."

Delete the fourth sentence of the first paragraph of Article 701.17(c)(2) of the Standard Specifications.

Revise the first paragraph of Article 603.07 of the Standard Specifications to read:

"**603.07 Protection Under Traffic.** After the casting has been adjusted and Class SI concrete has been placed, the work shall be protected by a barricade for at least 72 hours."

MANHOLES, VALVE VAULTS, AND FLAT SLAB TOPS (BDE)
Effective: January 1, 2018 Revised: March 1, 2019

Description. In addition to those manufactured according to the current standards included in this contract, manholes, valve vaults, and flat slab tops manufactured prior to March 1, 2019, according to the previous Highway Standards listed below will be accepted on this contract:

Product	Previous Standards		
Precast Manhole Type A, 4' (1.22 m) Diameter	602401-05	602401-04	602401-03
Precast Manhole Type A, 5' (1.52 m) Diameter	602402-01	602402	602401-03
Precast Manhole Type A, 6' (1.83 m) Diameter	602406-09	602406-08	602406-07
Precast Manhole Type A, 7' (2.13 m) Diameter	602411-07	602411-06	602411-05
Precast Manhole Type A, 8' (2.44 m) Diameter	602416-07	602416-06	602416-05
Precast Manhole Type A, 9' (2.74 m) Diameter	602421-07	602421-06	602421-05
Precast Manhole Type A, 10' (3.05 m) Diameter	602426-01	602426	
Precast Valve Vault Type A, 4' (1.22 m) Diameter	602501-04	602501-03	602501-02
Precast Valve Vault Type A, 5' (1.52 m) Diameter	602506-01	602506	602501-02
Precast Reinforced Concrete Flat Slab Top	602601-05	602601-04	

The following revisions to the Standard Specifications shall apply to manholes, valve vaults, and flat slab tops manufactured according to the current standards included in this contract:

Revise Article 602.02(g) of the Standard Specifications to read:

"(g) Structural Steel (Note 4) 1006.04

Note 4. All components of the manhole joint splice shall be galvanized according to the requirements of AASHTO M 111 or M 232 as applicable."

Add the following to Article 602.02 of the Standard Specifications:

"(s) Anchor Bolts and Rods (Note 5) 1006.09

Note 5. The threaded rods for the manhole joint splice shall be according to the requirements of ASTM F 1554, Grade 55, (Grade 380)."

Revise the second paragraph of Article 1042.10 of the Standard Specifications to read:

"Catch basin Types A, B, C, and D; Manhole Type A; Inlet Types A and B; Drainage Structures Types 1, 2, 3, 4, 5, and 6; Valve Vault Type A; and reinforced concrete flat slab top (Highway Standard 602601) shall be manufactured according to AASHTO M 199 (M 199M), except as shown on the plans. Additionally, catch basins, inlets, and drainage structures shall have a minimum concrete compressive strength of 4500 psi (31,000 kPa) at 28 days and manholes, valve vaults, and reinforced concrete flat slab tops shall have a minimum concrete compressive strength of 5000 psi (34,500 kPa) at 28 days."

PAVEMENT MARKING REMOVAL (BDE)
Effective: July 1, 2016

Revise Article 783.02 of the Standard Specifications to read:

"**783.02 Equipment.** Equipment shall be according to the following.

Item	Article/Section
(a) Grinders (Note 1)	
(b) Water Blaster with Vacuum Recovery	1101.12

Note 1. Grinding equipment shall be approved by the Engineer."

Revise the first paragraph of Article 783.03 of the Standard Specifications to read:

"**783.03 Removal of Conflicting Markings.** Existing pavement markings that conflict with revised traffic patterns shall be removed. If darkness or inclement weather prohibits the removal operations, such operations shall be resumed the next morning or when weather permits. In the event of removal equipment failure, such equipment shall be repaired, replaced, or leased so removal operations can be resumed within 24 hours."

Revise the first and second sentences of the first paragraph of Article 783.03(a) of the Standard Specifications to read:

"The existing pavement markings shall be removed by the method specified and in a manner that does not materially damage the surface or texture of the pavement or surfacing. Small particles of tightly adhering existing markings may remain in place, if in the opinion of the Engineer, complete removal of the small particles will result in pavement surface damage."

Revise the first paragraph of Article 783.04 of the Standard Specifications to read:

"**783.04 Cleaning.** The roadway surface shall be cleaned of debris or any other deleterious material by the use of compressed air or water blast."

Revise the first paragraph of Article 783.06 of the Standard Specifications to read:

"**783.06 Basis of Payment.** This work will be paid for at the contract unit price per each for RAISED REFLECTIVE PAVEMENT MARKER REMOVAL, or at the contract unit price per square foot (square meter) for PAVEMENT MARKING REMOVAL – GRINDING and/or PAVEMENT MARKING REMOVAL – WATER BLASTING."

Delete Article 1101.13 from the Standard Specifications.

PAYMENTS TO SUBCONTRACTORS (BDE)
Effective: November 2, 2017

Add the following to the end of the fourth paragraph of Article 109.11 of the Standard Specifications:

"If reasonable cause is asserted, written notice shall be provided to the applicable subcontractor and/or material supplier and the Engineer within five days of the Contractor receiving payment. The written notice shall identify the contract number, the subcontract or material purchase agreement, a detailed reason for refusal, the value of payment being withheld, and the specific remedial actions required of the subcontractor and/or material supplier so that payment can be made."

PORTLAND CEMENT CONCRETE (BDE)
Effective: November 1, 2017

Revise the Air Content % of Class PP Concrete in Table 1 Classes of Concrete and Mix Design Criteria in Article 1020.04 of the Standard Specifications to read:

"TABLE 1. CLASSES OF CONCRETE AND MIX DESIGN CRITERIA

Class of Conc.	Use	Air Content %
PP	Pavement Patching Bridge Deck Patching (10)	
	PP-1	4.0 - 8.0"
	PP-2	
	PP-3	
	PP-4	
	PP-5	

Revise Note (4) at the end of Table 1 Classes of Concrete and Mix Design Criteria in Article 1020.04 of the Standard Specifications to read:

"(4) For all classes of concrete, the maximum slump may be increased to 7 in (175 mm) when a high range water-reducing admixture is used. For Class SC, the maximum slump may be increased to 8 in. (200 mm). For Class PS, the maximum slump may be increased to 8 1/2 in. (215 mm) if the high range water-reducing admixture is the polycarboxylate type."

PROGRESS PAYMENTS (BDE)
Effective: November 2, 2013

Revise Article 109.07(a) of the Standard Specifications to read:

"(a) Progress Payments. At least once each month, the Engineer will make a written estimate of the quantity of work performed in accordance with the contract, and the value thereof at the contract unit prices. The amount of the estimate approved as due for payment will be vouchered by the Department and presented to the State Comptroller for payment. No amount less than $1000.00 will be approved for payment other than the final payment.

Progress payments may be reduced by liens filed pursuant to Section 23(c) of the Mechanics' Lien Act, 770 ILCS 60/23(c).

If a Contractor or subcontractor has defaulted on a loan issued under the Department's Disadvantaged Business Revolving Loan Program (20 ILCS 2705/2705-610), progress payments may be reduced pursuant to the terms of that loan agreement. In such cases, the amount of the estimate related to the work performed by the Contractor or subcontractor, in default of the loan agreement, will be offset, in whole or in part, and vouchered by the Department to the Working Capital Revolving Fund or designated escrow account. Payment for the work shall be considered as issued and received by the Contractor or subcontractor on the date of the offset voucher. Further, the amount of the offset voucher shall be a credit against the Department's obligation to pay the Contractor, the Contractor's obligation to pay the subcontractor, and the Contractor's or subcontractor's total loan indebtedness to the Department. The offset shall continue until such time as the entire loan indebtedness is satisfied. The Department will notify the Contractor and Fund Control Agent in a timely manner of such offset. The Contractor or subcontractor shall not be entitled to additional payment in consideration of the offset.

The failure to perform any requirement, obligation, or term of the contract by the Contractor shall be reason for withholding any progress payments until the Department determines that compliance has been achieved."

REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES (BDE)
Effective: January 1, 2019

Revise Section 669 of the Standard Specifications to read:

"**SECTION 669. REMOVAL AND DISPOSAL OF REGULATED SUBSTANCES**

669.01 Description. This work shall consist of the transportation and proper disposal of contaminated soil and groundwater. This work shall also consist of the removal, transportation, and proper disposal of underground storage tanks (UST), their content and associated underground piping to the point where the piping is above the ground, including determining the content types and estimated quantities.

669.02 Equipment. The Contractor shall notify the Engineer of the delivery of all excavation, storage, and transportation equipment to a work area location. The equipment shall comply with OSHA and American Petroleum Institute (API) guidelines and shall be furnished in a clean condition. Clean condition means the equipment does not contain any residual material classified as a non-special waste, non-hazardous special waste, or hazardous waste. Residual materials include, but are not limited to, petroleum products, chemical products, sludges, or any other material present in or on equipment.

Before beginning any associated soil or groundwater management activity, the Contractor shall provide the Engineer with the opportunity to visually inspect and approve the equipment. If the equipment contains any contaminated residual material, decontamination shall be performed on the equipment as appropriate to the regulated substance and degree of contamination present according to OSHA and API guidelines. All cleaning fluids used shall be treated as the contaminant unless laboratory testing proves otherwise.

669.03 Pre-construction Submittals. Prior to beginning this work, or working in areas with regulated substances, the Contractor shall submit a Regulated Substance Pre-Construction Plan (RSPCP) to the Engineer for review and approval using form BDE 2730. The form shall be signed by an Illinois licensed Professional Engineer or Professional Geologist.

As part of the RSPCP, the qualifications of Contractor(s) or firm(s) performing the following work shall be listed.

(a) On-Site Monitoring. Qualification for on-site monitoring of regulated substance work and on-site monitoring of UST removal requires either pre-qualification in Hazardous Waste by the Department or demonstration of acceptable project experience in remediation and special waste operations for contaminated sites in accordance with applicable Federal, State, or local regulatory requirements.

Qualification for each individual performing on-site monitoring requires a minimum of one-year of experience in similar activities as those required for the project.

(b) Underground Storage Tank. Qualification for underground storage tank (UST) work requires licensing and certification with the Office of the State Fire Marshall (OSFM) and possession of all permits required to perform the work. A copy of the permit shall be provided to the Engineer prior to tank removal.

The qualified Contractor(s) or firm(s) shall also document it does not have any current or former ties with any of the properties contained within, adjoining, or potentially affecting the work.

The Engineer will require up to 30 calendar days for review of the RSPCP. The review may involve rejection or revision and resubmittal; in which case, an additional 30 days will be required for each subsequent review. Work shall not commence until the RSPCP has been approved by the Engineer. After approval, the RSPCP shall be revised as necessary to reflect changed conditions in the field.

CONSTRUCTION REQUIREMENTS

669.04 Contaminated Soil and/or Groundwater Monitoring. Prior to beginning excavation, the Contractor shall mark the limits of removal for approval by the Engineer. Once excavation begins, the work and work area involving regulated substances shall be monitored by qualified personnel. The qualified personnel shall be on-site continuously during excavation and loading of material containing regulated substances. The qualified personnel shall be equipped with either a photoionization detector (PID) (minimum 10.6eV lamp), or a flame ionization detector (FID), and other equipment, as appropriate, to monitor for potential contaminants associated with volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs). The PID or FID meter shall be calibrated on-site and background level readings taken and recorded daily, and as field and weather conditions change. Any field screen reading on the PID or FID in excess of background levels indicates the potential presence of contaminated material requiring handling as a non-special waste, special waste, or hazardous waste. PID or FID readings may be used as the basis of increasing the limits of removal with the approval of the Engineer but shall in no case be used to decrease the limits.

The qualified personnel shall document field activities using form BDE 2732 (Regulated Substances Monitoring Daily Record) including the name(s) of personnel conducting the monitoring, weather conditions, PID or FID calibration records, a list of equipment used on-site, a narrative of activities completed, photo log sheets, manifests and landfill tickets, monitoring results, how regulated substances were managed and other pertinent information.

Samples will be collected in accordance with the RSPCP. Samples shall be analyzed for the contaminants of concern (COCs), including pH, based on the property's land use history, the encountered abnormality and/or the parameters listed in the maximum allowable concentration (MAC) for chemical constituents in uncontaminated soil established pursuant to Subpart F of 35 Ill. Adm. Code 1100.605. The analytical results shall serve to document the level of contamination.

Samples shall be grab samples (not combined with other locations). The samples shall be taken with decontaminated or disposable instruments. The samples shall be placed in sealed containers and transported in an insulated container to the laboratory. The container shall maintain a temperature of 39 °F (4 °C). All samples shall be clearly labeled. The labels shall indicate the sample number, date sampled, collection location and depth, and any other relevant observations.

The laboratory shall use analytical methods which are able to meet the lowest appropriate practical quantitation limits (PQL) or estimated quantitation limit (EQL) specified in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods", EPA Publication No. SW-846; "Methods for the Determination of Organic Compounds in Drinking Water", EPA, EMSL, EPA-600/4-88/039; and “Methods for the Determination of Organic Compounds in Drinking Water, Supplement III”, EPA 600/R-95/131, August 1995. For parameters where the specified cleanup objective is below the acceptable detection limit (ADL), the ADL shall serve as the cleanup objective. For other parameters the ADL shall be equal to or below the specified cleanup objective.

669.05 Contaminated Soil and/or Groundwater Management and Disposal. The management and disposal of contaminated soil and/or groundwater shall be according to the following:

(a) Soil Analytical Results Exceed Most Stringent MAC. When the soil analytical results indicate that detected levels exceed the most stringent maximum allowable concentration (MAC) for chemical constituents in uncontaminated soil established pursuant to Subpart F of 35 Illinois Administrative Code 1100.605, the soil shall be managed as follows:

(1) When analytical results indicate inorganic chemical constituents exceed the most stringent MAC but they are still considered within area background levels by the Engineer, the excavated soil can be utilized within the construction limits as fill, when suitable. If the soils cannot be utilized within the construction limits, they shall be managed and disposed of off-site as a non-special waste, special waste, or hazardous waste as applicable.

(2) When analytical results indicate chemical constituents exceed the most stringent MAC but do not exceed the MAC for a Metropolitan Statistical Area (MSA) County, the excavated soil can be utilized within the construction limits as fill, when suitable, or managed and disposed of off-site as “uncontaminated soil” at a clean construction and demolition debris (CCDD) facility or an uncontaminated soil fill operation (USFO) within an MSA County provided the pH of the soil is within the range of 6.25 - 9.0, inclusive.

(3) When analytical results indicate chemical constituents exceed the most stringent MAC but do not exceed the MAC for an MSA County excluding Chicago, or the MAC within the Chicago corporate limits, the excavated soil can be utilized within the construction limits as fill, when suitable, or managed and disposed of off-site as “uncontaminated soil” at a CCDD facility or an USFO within an MSA County excluding Chicago or within the Chicago corporate limits provided the pH of the soil is within the range of 6.25 - 9.0, inclusive.

(4) When analytical results indicate chemical constituents exceed the most stringent MAC but do not exceed the MAC for an MSA County excluding Chicago, the excavated soil can be utilized within the construction limits as fill, when suitable, or managed and disposed of off-site as “uncontaminated soil” at a CCDD facility or an USFO within an MSA County excluding Chicago provided the pH of the soil is within the range of 6.25 - 9.0, inclusive.

(5) When the Engineer determines soil cannot be managed according to Articles 669.05(a)(1) through (a)(4) above, the soil shall be managed and disposed of off-site as a non-special waste, special waste, or hazardous waste as applicable.

(b) Soil Analytical Results Do Not Exceed Most Stringent MAC. When the soil analytical results indicate that detected levels do not exceed the most stringent MAC, the excavated soil can be utilized within the construction limits or managed and disposed off-site as "uncontaminated soil" according to Article 202.03. However, the excavated soil cannot be taken to a CCDD facility or an USFO for any of the following reasons.

(1) The pH of the soil is less than 6.25 or greater than 9.0.

(2) The soil exhibited PID or FID readings in excess of background levels.

(c) Soil Analytical Results Exceed Most Stringent MAC but Do Not Exceed Tiered Approach to Corrective Action Objectives (TACO) Residential. When the soil analytical results indicate that detected levels exceed the most stringent MAC but do not exceed TACO Tier 1 Soil Remediation Objectives for Residential Properties pursuant to 35 IAC 742 Appendix B Table A, the excavated soil can be utilized within the right-of-way or managed and disposed off-site as "uncontaminated soil" according to Article 202.03. However, the excavated soil cannot be taken to a CCDD facility or an USFO.

(d) Groundwater. When groundwater analytical results indicate the detected levels are above Appendix B, Table E of 35 Illinois Administrative Code 742, the most stringent Tier 1 Groundwater Remediation Objectives for Groundwater Component of the Groundwater Ingestion Route for Class 1 groundwater, the groundwater shall be managed off-site as a special waste. The groundwater shall be containerized and trucked to an off-site treatment facility or may be discharged to a sanitary sewer or combined sewer when permitted by the local sewer authority. Groundwater discharged to a sewer shall be pre-treated to remove particulates and measured with a calibrated flow meter to comply with applicable discharge limits. A copy of the permit shall be provided to the Engineer prior to discharging groundwater to the sewer.

All groundwater encountered within trenches may be managed within the trench and allowed to infiltrate back into the ground. If the groundwater cannot be managed within the trench it must be removed as a special or hazardous waste. The Contractor is prohibited from managing groundwater within the trench by discharging it through any existing or new storm sewer. The Contractor shall install backfill plugs within the area of groundwater contamination.

One backfill plug shall be placed down gradient to the area of groundwater contamination. Backfill plugs shall be installed at intervals not to exceed 50 ft (15 m). Backfill plugs are to be 4 ft (1.2 m) long, measured parallel to the trench, full trench width and depth. Backfill plugs shall not have any fine aggregate bedding or backfill, but shall be entirely cohesive soil or any class of concrete. The Contractor shall provide test data that the material has a permeability of less than 10^{-7} cm/sec according to ASTM D 5084, Method A or per another test method approved by the Engineer.

The Contractor shall use due care when transferring contaminated material from the area of origin to the transporter. Should releases of contaminated material to the environment occur (i.e., spillage onto the ground, etc.), the Contractor shall clean-up spilled material and place in the appropriate storage containers as previously specified. Clean-up shall include, but not be limited to, sampling beneath the material staging area to determine complete removal of the spilled material.

The Contractor shall be responsible for transporting and disposing all material classified as a non-special waste, special waste, or hazardous waste from the job site to an appropriately permitted landfill facility. The transporter and the vehicles used for transportation shall comply with all federal, state, and local rules and regulations governing the transportation of non-special waste, special waste, or hazardous waste.

All equipment used by the Contractor to haul contaminated material to the landfill facility shall be lined with a 6 mil (150 micron) polyethylene liner and securely covered during transportation. The Contractor shall obtain all documentation including any permits and/or licenses required to transport the contaminated material to the disposal facility.

The Contractor shall provide engineered barriers, when required, and shall include materials sufficient to completely line excavation surfaces, including sloped surfaces, bottoms, and sidewall faces, within the areas designated for protection.

The Engineer shall coordinate with the Contractor on the completion of all documentation. The Contractor shall make all arrangements for collection and analysis of landfill acceptance testing. The Contractor shall coordinate for waste disposal approval with the disposal facility. After the Contractor completes these activities and upon receipt of authorization from the Engineer, the Contractor shall initiate the disposal process.

The Contractor shall provide the Engineer with all transport-related documentation within two days of transport or receipt of said document(s). The Engineer shall maintain the file for all such documentation. For management of special or hazardous waste, the Contractor shall provide the Engineer with documentation the Contractor (or subcontractor, if a subcontractor is used for transportation) is operating with a valid Illinois special waste transporter permit at least two weeks before transporting the first load of contaminated material.

The Contractor shall schedule and arrange the transport and disposal of each load of contaminated material produced. The Contractor shall make all transport and disposal arrangements so no contaminated material remains within the project area at the close of business each day. Exceptions to this specification require prior approval from the Engineer within 24 hours of close of business. The Contractor shall be responsible for all other pre-disposal/transport preparations necessary daily to accomplish management activities.

Any waste generated as a special or hazardous waste from a non-fixed facility shall be manifested off-site using the Department's county generator number. An authorized representative of the Department shall sign all manifests for the disposal of the contaminated material and confirm the Contractor's transported volume. Any waste generated as a non-special waste may be managed off-site without a manifest, a special waste transporter, or a generator number.

The Contractor shall select a landfill mandated by definition of the contaminant within the State of Illinois. The Department will review and approve or reject the facility proposed by the Contractor to use as a landfill. The Contractor shall verify whether the selected disposal facility is compliant with those applicable standards as mandated by definition of the contaminant and whether the disposal facility is presently, has previously been, or has never been, on the United States Environmental Protection Agency (U.S. EPA) National Priorities List or the Resource Conservation and Recovery Act (RCRA) List of Violating Facilities. The Contractor shall be responsible for coordinating permits with the IEPA. The use of a Contractor selected landfill shall in no manner delay the construction schedule or alter the Contractor's responsibilities as set forth.

669.06 Non-Special Waste Certification. An authorized representative of the Department shall sign and date all non-special waste certifications. The Contractor shall be responsible for providing the Engineer with the required information that will allow the Engineer to certify the waste is not a special waste.

(a) Definition. A waste is considered a non-special waste as long as it is not:

(1) a potentially infectious medical waste;

(2) a hazardous waste as defined in 35 IAC 721;

(3) an industrial process waste or pollution control waste that contains liquids, as determined using the paint filter test set forth in subdivision (3)(A) of subsection (m) of 35 IAC 811.107;

(4) a regulated asbestos-containing waste material, as defined under the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61.141;

(5) a material containing polychlorinated biphenyls (PCB's) regulated pursuant to 40 CFR Part 761;

(6) a material subject to the waste analysis and recordkeeping requirements of 35 IAC 728.107 under land disposal restrictions of 35 IAC 728;

(7) a waste material generated by processing recyclable metals by shredding and required to be managed as a special waste under Section 22.29 of the Environmental Protection Act; or

(8) an empty portable device or container in which a special or hazardous waste has been stored, transported, treated, disposed of, or otherwise handled.

(b) Certification Information. All information used to determine the waste is not a special waste shall be attached to the certification. The information shall include but not be limited to:

(1) the means by which the generator has determined the waste is not a hazardous waste;

(2) the means by which the generator has determined the waste is not a liquid;

(3) if the waste undergoes testing, the analytic results obtained from testing, signed and dated by the person responsible for completing the analysis;

(4) if the waste does not undergo testing, an explanation as to why no testing is needed;

(5) a description of the process generating the waste; and

(6) relevant material safety data sheets.

669.07 Temporary Staging. The Contractor shall excavate and dispose of all waste material as mandated by the contaminants without temporary staging. If circumstances require temporary staging, he/she shall request in writing, approval from the Engineer.

When approved, the Contractor shall prepare a secure location within the project area capable of housing containerized waste materials. The Contractor shall contain all waste material in leak-proof storage containers such as lined roll-off boxes or 55 gal (208 L) drums, or stored in bulk fashion on storage pads. The design and construction of such storage pad(s) for bulk materials shall be subject to approval by the Engineer. The Contractor shall place the staged storage containers on an all-weather gravel-packed, asphalt, or concrete surface. The Contractor shall maintain a clearance both above and beside the storage units to provide maneuverability during loading and unloading. The Contractor shall provide any assistance or equipment requested by the Engineer for authorized personnel to inspect and/or sample contents of each storage container. All containers and their contents shall remain intact and undisturbed by unauthorized persons until the manner of disposal is determined. The Contractor shall keep the storage containers covered, except when access is requested by authorized personnel of the Department. The Engineer shall authorize any additional material added to the contents of any storage container before being filled.

The Contractor shall ensure the staging area is enclosed (by a fence or other structure) to ensure direct access to the area is restricted, and he/she shall procure and place all required regulatory identification signs applicable to an area containing the waste material. The Contractor shall be responsible for all activities associated with the storage containers including, but not limited to, the procurement, transport, and labeling of the containers. The Contractor shall clearly mark all containers in permanent marker or paint with the date of waste generation, location and/or area of waste generation, and type of waste (e.g., decontamination water, contaminated clothing, etc.). The Contractor shall place these identifying markings on an exterior side surface of the container. The Contractor shall separately containerize each contaminated medium, i.e. contaminated clothing is placed in a separate container from decontamination water. Containers used to store liquids shall not be filled in excess of 80 percent of the rated capacity. The Contractor shall not use a storage container if visual inspection of the container reveals the presence of free liquids or other substances that could classify the material as a hazardous waste in the container.

The Department will not be responsible for any additional costs incurred, if mismanagement of the staging area, storage containers, or their contents by the Contractor results in excess cost expenditure for disposal or other material management requirements.

669.08 Underground Storage Tank Removal. For the purposes of this section, an underground storage tank (UST) includes the underground storage tank, piping, electrical controls, pump island, vent pipes and appurtenances.

Prior to removing an UST, the Engineer shall determine whether the Department is considered an "owner" or "operator" of the UST as defined by the UST regulations (41 Ill. Adm. Code Part 176). Ownership of the UST refers to the Department's owning title to the UST during storage, use or dispensing of regulated substances. The Department may be considered an "operator" of the UST if it has control of, or has responsibility for, the daily operation of the UST. The Department may however voluntarily undertake actions to remove an UST from the ground without being deemed an "operator" of the UST.

In the event the Department is deemed not to be the "owner" or "operator" of the UST, the OSFM removal permit shall reflect who was the past "owner" or "operator" of the UST. If the "owner" or "operator" cannot be determined from past UST registration documents from OSFM, then the OSFM removal permit will state the "owner" or "operator" of the UST is the Department. The Department’s Office of Chief Counsel (OCC) will review all UST removal permits prior to submitting any removal permit to the OSFM. If the Department is not the “owner” or “operator” of the UST then it will not register the UST or pay any registration fee.

The Contractor shall be responsible for obtaining all permits required for removing the UST, notification to the OSFM, using an OSFM certified tank contractor, removal and disposal of the UST and its contents, and preparation and submittal of the OSFM Site Assessment Report in accordance with 41 Ill. Adm. Code Part 176.330.

The Contractor shall contact the Engineer and the OSFM's office at least 72 hours prior to removal to confirm the OSFM inspector's presence during the UST removal. Removal, transport, and disposal of the UST shall be according to the applicable portions of the latest revision of the "American Petroleum Institute (API) Recommended Practice 1604".

The Contractor shall collect and analyze tank content (sludge) for disposal purposes. The Contractor shall remove as much of the regulated substance from the UST system as necessary to prevent further release into the environment. All contents within the tank shall be removed, transported and disposed of, or recycled. The tank shall be removed and rendered empty according to IEPA definition.

The Contractor shall collect soil samples from the bottom and sidewalls of the excavated area in accordance with 35 Ill. Adm. Code Part 734.210(h) after the required backfill has been removed during the initial response action, to determine the level of contamination remaining in the ground, regardless if a release is confirmed or not by the OSFM on-site inspector.

In the event the UST is designated a leaking underground storage tank (LUST) by the OSFM's inspector, or confirmation by analytical results, the Contractor shall notify the Engineer and the DESU. Upon confirmation of a release of contaminants from the UST and notifications to the Engineer and DESU, the Contractor shall report the release to the Illinois Emergency Management Agency (IEMA) (e.g., by telephone or electronic mail) and provide them with whatever information is available ("owner" or "operator" shall be stated as the past registered "owner" or "operator", or the IDOT District in which the UST is located and the DESU Manager);

The Contractor shall perform the following initial response actions if a release is indicated by the OSFM inspector:

(a) Take immediate action to prevent any further release of the regulated substance to the environment, which may include removing, at the Engineer's discretion, and disposing of up to 4 ft (1.2 m) of the contaminated material, as measured from the outside dimension of the tank

(b) Identify and mitigate fire, explosion and vapor hazards;

(c) Visually inspect any above ground releases or exposed below ground releases and prevent further migration of the released substance into surrounding soils and groundwater; and

(d) Continue to monitor and mitigate any additional fire and safety hazards posed by vapors and free product that have migrated from the UST excavation zone and entered into subsurface structures (such as sewers or basements).

The UST excavation shall be backfilled according to applicable portions of Sections 205, 208, and 550 with a material that will compact and develop stability. The material shall be approved prior to placement. All uncontaminated concrete and soil removed during tank extraction may be used to backfill the excavation, at the discretion of the Engineer.

After backfilling the excavation, the site shall be graded and cleaned.

669.09 Regulated Substance Final Construction Report. Not later than 90 days after completing this work, the Contractor shall submit a Regulated Substance Final Construction Report (RSFCR) to the Engineer using form BDE 2733 and required attachments. The form shall be signed by an Illinois licensed Professional Engineer or Professional Geologist.

669.10 Method of Measurement. Non-special waste, special waste, and hazardous waste soil will be measured for payment according to Article 202.07(b) when performing earth excavation, Article 502.12(b) when excavating for structures, or by computing the volume of the trench using the maximum trench width permitted and the actual depth of the trench.

Groundwater containerized and transported off-site for management, storage, and disposal will be measured for payment in gallons (liters).

Backfill plugs will be measured in cubic yards (cubic meters) in place, except the quantity for which payment will be made shall not exceed the volume of the trench, as computed by using the maximum width of trench permitted by the Specifications and the actual depth of the trench, with a deduction for the volume of the pipe.

Engineered Barriers will be measured for payment in square yards (square meters).

669.11 Basis of Payment. The work of preparing, submitting and administering a Regulated Substances Pre-Construction Plan will be paid for at the contract lump sum price for REGULATED SUBSTANCES PRE-CONSTRUCTION PLAN.

On-site monitoring of regulated substances, including completion of form BDE 2732 for each day of work, will be paid for at the contract unit price per calendar day, or faction thereof, for ON-SITE MONITORING OF REGULATED SUBSTANCES.

The installation of engineered barriers will be paid for at the contract unit price per square yard (square meter) for ENGINEERED BARRIER.

The work of removing a UST, soil excavation, soil and content sampling, and the excavated soil, UST content, and UST disposal will be paid for at the contract unit price per each for UNDERGROUND STORAGE TANK REMOVAL.

The transportation and disposal of soil and other materials from an excavation determined to be contaminated will be paid for at the contract unit price per cubic yard (cubic meter) for NON-SPECIAL WASTE DISPOSAL, SPECIAL WASTE DISPOSAL, or HAZARDOUS WASTE DISPOSAL.

The transportation and disposal of groundwater from an excavation determined to be contaminated will be paid for at the contract unit price per gallon (liter) for SPECIAL WASTE GROUNDWATER DISPOSAL or HAZARDOUS WASTE GROUNDWATER DISPOSAL. When groundwater is discharged to a sanitary or combined sewer by permit, the cost will be paid for according to Article 109.05.

Backfill plugs will be paid for at the contract unit price per cubic yard (cubic meter) for BACKFILL PLUGS.

Payment for temporary staging, if required, will be paid for according to Article 109.04.

Payment for accumulated stormwater removal and disposal will be according to Article 109.04. Payment will only be allowed if appropriate stormwater and erosion control methods were used.

Payment for decontamination, labor, material, and equipment for monitoring areas beyond the specified areas, with the Engineer's prior written approval, will be according to Article 109.04.

The sampling and testing associated with this work will be paid for as follows.

(a) BETX Soil/Groundwater Analysis. When the contaminants of concern are gasoline only, soil or groundwater samples shall be analyzed for benzene, ethylbenzene, toluene, and xylenes (BETX). The analysis will be paid for at the contract unit price per each for BETX SOIL ANALYSIS and/or BETX GROUNDWATER ANALYSIS using EPA Method 8021B.

(b) BETX-PNAS Soil/Groundwater Analysis. When the contaminants of concern are middle distillate and heavy ends, soil or groundwater samples shall be analyzed for BETX and polynuclear aromatics (PNAS). The analysis will be paid for at the contract unit price per each for BETX-PNAS SOIL ANALYSIS and/or BETX-PNAS GROUNDWATER ANALYSIS using EPA Method 8021B for BETX and EPA Method 8310 for PNAs.

(c) Priority Pollutants Soil Analysis. When the contaminants of concern are used oils, soil samples shall be analyzed for priority pollutant VOCs, priority pollutants SVOCs, and priority pollutants metals. The analysis will be paid for at the contract unit price per each for PRIORITY POLLUTANTS SOIL ANALYSIS using EPA Method 8260B for VOCs, EPA Method 8270C for SVOCs, and using an ICP instrument and EPA Methods 6010B and 7471A for metals.

(d) Priority Pollutant Groundwater Analysis. When the contaminants of concern are used oils, non-petroleum material, or unknowns, groundwater samples shall be analyzed for priority pollutant VOCs, priority pollutants SVOCs, and priority pollutants metals. The analysis will be paid for at the contract unit price per each for PRIORITY POLLUTANTS GROUNDWATER ANALYSIS using EPA Method 8260B for VOCs, EPA Method 8270C for SVOCs, and EPA Methods 6010B and 7470A for metals.

(e) Target Compound List (TCL) Soil Analysis. When the contaminants of concern are unknowns or non-petroleum material, soil samples shall be analyzed for priority pollutant VOCs, priority pollutants SVOCS, priority pollutants metals, pesticides, and Resource Conservation and Recovery Act (RCRA) metals by the toxicity characteristic leaching procedure (TCLP). The analysis will be paid for at the contract unit price per each for TCL SOIL ANALYSIS using EPA Method 8260B for VOCs, EPA Method 8270C for SVOCs, EPA Method 8081 for pesticides, and ICP instrument and EPA Methods 6010B, 7471A, 1311 (extraction), 6010B, and 7470A for metals.

(f) Soil Disposal Analysis. When the waste material for disposal requires sampling for disposal acceptance, the samples shall be analyzed for TCLP VOCs, SVOCs, RCRA metals, pH, ignitability, and paint filter test. The analysis will be paid for at the contract unit price per each for SOIL DISPOSAL ANALYSIS using EPA Methods 1311 (extraction), 8260B for VOCs, 8270C for SVOCs, 6010B and 7470A for RCRA metals, 9045C for pH, 1030 for ignitability, and 9095A for paint filter.

The work of preparing, submitting and administering a Regulated Substances Final Construction Report will be paid for at the contract lump sum price REGULATED SUBSTANCES FINAL CONSTRUCTION REPORT."

STEEL COST ADJUSTMENT (BDE)
Effective: April 2, 2004 Revised: August 1, 2017

Description. Steel cost adjustments will be made to provide additional compensation to the Contractor, or a credit to the Department, for fluctuations in steel prices when optioned by the Contractor. The bidder shall indicate with their bid whether or not this special provision will be part of the contract. Failure to indicate "Yes" for any item of work will make that item of steel exempt from steel cost adjustment.

Types of Steel Products. An adjustment will be made for fluctuations in the cost of steel used in the manufacture of the following items:

Metal Piling (excluding temporary sheet piling)
Structural Steel
Reinforcing Steel

Other steel materials such as dowel bars, tie bars, mesh reinforcement, guardrail, steel traffic signal and light poles, towers and mast arms, metal railings (excluding wire fence), and frames and grates will be subject to a steel cost adjustment when the pay items they are used in have a contract value of $10,000 or greater.

The adjustments shall apply to the above items when they are part of the original proposed construction, or added as extra work and paid for by agreed unit prices. The adjustments shall not apply when the item is added as extra work and paid for at a lump sum price or by force account.

Documentation. Sufficient documentation shall be furnished to the Engineer to verify the following:

(a) The dates and quantity of steel, in lb (kg), shipped from the mill to the fabricator.

(b) The quantity of steel, in lb (kg), incorporated into the various items of work covered by this special provision. The Department reserves the right to verify submitted quantities.

Method of Adjustment. Steel cost adjustments will be computed as follows:

SCA = Q X D

Where: SCA = steel cost adjustment, in dollars
Q = quantity of steel incorporated into the work, in lb (kg)
D = price factor, in dollars per lb (kg)

$D = MPI_M - MPI_L$

Where: MPI_M = The Materials Cost Index for steel as published by the Engineering News-Record for the month the steel is shipped from the mill. The indices will be converted from dollars per 100 lb to dollars per lb (kg).

MPI_L = The Materials Cost Index for steel as published by the Engineering News-Record for the month prior to the letting for work paid for at the contract price; or for the month the agreed unit price letter is submitted by the Contractor for extra work paid for by agreed unit price,. The indices will be converted from dollars per 100 lb to dollars per lb (kg).

The unit weights (masses) of steel that will be used to calculate the steel cost adjustment for the various items are shown in the attached table.

No steel cost adjustment will be made for any products manufactured from steel having a mill shipping date prior to the letting date.

If the Contractor fails to provide the required documentation, the method of adjustment will be calculated as described above; however, the MPI_M will be based on the date the steel arrives at the job site. In this case, an adjustment will only be made when there is a decrease in steel costs.

Basis of Payment. Steel cost adjustments may be positive or negative but will only be made when there is a difference between the MPI_L and MPI_M in excess of five percent, as calculated by:

Percent Difference = $\{(MPI_L - MPI_M) \div MPI_L\} \times 100$

Steel cost adjustments will be calculated by the Engineer and will be paid or deducted when all other contract requirements for the items of work are satisfied. Adjustments will only be made for fluctuations in the cost of the steel as described herein. No adjustment will be made for changes in the cost of manufacturing, fabrication, shipping, storage, etc.

The adjustments shall not apply during contract time subject to liquidated damages for completion of the entire contract.

Attachment

Item	Unit Mass (Weight)
Metal Piling (excluding temporary sheet piling)	
Furnishing Metal Pile Shells 12 in. (305 mm), 0.179 in. (3.80 mm) wall thickness)	23 lb/ft (34 kg/m)
Furnishing Metal Pile Shells 12 in. (305 mm), 0.250 in. (6.35 mm) wall thickness)	32 lb/ft (48 kg/m)
Furnishing Metal Pile Shells 14 in. (356 mm), 0.250 in. (6.35 mm) wall thickness)	37 lb/ft (55 kg/m)
Other piling	See plans
Structural Steel	See plans for weights (masses)
Reinforcing Steel	See plans for weights (masses)
Dowel Bars and Tie Bars	6 lb (3 kg) each
Mesh Reinforcement	63 lb/100 sq ft (310 kg/sq m)
Guardrail	
Steel Plate Beam Guardrail, Type A w/steel posts	20 lb/ft (30 kg/m)
Steel Plate Beam Guardrail, Type B w/steel posts	30 lb/ft (45 kg/m)
Steel Plate Beam Guardrail, Types A and B w/wood posts	8 lb/ft (12 kg/m)
Steel Plate Beam Guardrail, Type 2	305 lb (140 kg) each
Steel Plate Beam Guardrail, Type 6	1260 lb (570 kg) each
Traffic Barrier Terminal, Type 1 Special (Tangent)	730 lb (330 kg) each
Traffic Barrier Terminal, Type 1 Special (Flared)	410 lb (185 kg) each
Steel Traffic Signal and Light Poles, Towers and Mast Arms	
Traffic Signal Post	11 lb/ft (16 kg/m)
Light Pole, Tenon Mount and Twin Mount, 30 - 40 ft (9 – 12 m)	14 lb/ft (21 kg/m)
Light Pole, Tenon Mount and Twin Mount, 45 - 55 ft (13.5 – 16.5 m)	21 lb/ft (31 kg/m)
Light Pole w/Mast Arm, 30 - 50 ft (9 – 15.2 m)	13 lb/ft (19 kg/m)
Light Pole w/Mast Arm, 55 - 60 ft (16.5 – 18 m)	19 lb/ft (28 kg/m)
Light Tower w/Luminaire Mount, 80 - 110 ft (24 – 33.5 m)	31 lb/ft (46 kg/m)
Light Tower w/Luminaire Mount, 120 - 140 ft (36.5 – 42.5 m)	65 lb/ft (97 kg/m)
Light Tower w/Luminaire Mount, 150 - 160 ft (45.5 – 48.5 m)	80 lb/ft (119 kg/m)
Metal Railings (excluding wire fence)	
Steel Railing, Type SM	64 lb/ft (95 kg/m)
Steel Railing, Type S-1	39 lb/ft (58 kg/m)
Steel Railing, Type T-1	53 lb/ft (79 kg/m)
Steel Bridge Rail	52 lb/ft (77 kg/m)
Frames and Grates	
Frame	250 lb (115 kg)
Lids and Grates	150 lb (70 kg)

STEEL PLATE BEAM GUARDRAIL MANUFACTURING (BDE)
Effective: January 1, 2019

Revise the first three paragraphs of Article 1006.25 of the Standard Specifications to read:

"**1006.25 Steel Plate Beam Guardrail.** Steel plate beam guardrail, including bolts, nuts, and washers, shall be according to AASHTO M 180. The guardrail shall be Class A, with a Type II galvanized coating.

Steel plates for mounting guardrail on existing culverts shall be according to AASHTO M 270 Grade 36 (M 270M Grade 250) and zinc coated according to AASHTO M 111.

The Department will accept guardrail based on the "Brand Registration and Guarantee" requirements of AASHTO M 180 and the manufacturer shall be listed as compliant through the NTPEP Program. The Department will maintain a qualified product list."

SUBCONTRACTOR AND DBE PAYMENT REPORTING (BDE)
Effective: April 2, 2018

Add the following to Section 109 of the Standard Specifications.

"**109.14 Subcontractor and Disadvantaged Business Enterprise Payment Reporting.** The Contractor shall report all payments made to the following parties:

(a) first tier subcontractors;

(b) lower tier subcontractors affecting disadvantaged business enterprise (DBE) goal credit;

(c) material suppliers or trucking firms that are part of the Contractor's submitted DBE utilization plan.

The report shall be made through the Department's on-line subcontractor payment reporting system within 21 days of making the payment."

SUBCONTRACTOR MOBILIZATION PAYMENTS (BDE)
Effective: November 2, 2017 Revised: April 1, 2019

Replace the second paragraph of Article 109.12 of the Standard Specifications with the following:

"This mobilization payment shall be made at least seven days prior to the subcontractor starting work. The amount paid shall be at the following percentage of the amount of the subcontract reported on form BC 260A submitted for the approval of the subcontractor's work.

Value of Subcontract Reported on Form BC 260A	Mobilization Percentage
Less than $10,000	25%
$10,000 to less than $20,000	20%
$20,000 to less than $40,000	18%
$40,000 to less than $60,000	16%
$60,000 to less than $80,000	14%
$80,000 to less than $100,000	12%
$100,000 to less than $250,000	10%
$250,000 to less than $500,000	9%
$500,000 to $750,000	8%
Over $750,000	7%"

TEMPORARY PAVEMENT MARKING (BDE)
Effective: April 1, 2012 Revised: April 1, 2017

Revise Article 703.02 of the Standard Specifications to read:

"**703.02 Materials.** Materials shall be according to the following.

(a) Pavement Marking Tape, Type I and Type III 1095.06
(b) Paint Pavement Markings 1095.02
(c) Pavement Marking Tape, Type IV ..... 1095.11"

Revise the second paragraph of Article 703.05 of the Standard Specifications to read:

"Type I marking tape or paint shall be used at the option of the Contractor, except paint shall not be applied to the final wearing surface unless authorized by the Engineer for late season applications where tape adhesion would be a problem. Type III or Type IV marking tape shall be used on the final wearing surface when the temporary pavement marking will conflict with the permanent pavement marking such as on tapers, crossovers and lane shifts."

Revise Article 703.07 of the Standard Specifications to read:

"**703.07 Basis of Payment.** This work will be paid for as follows.

a) Short Term Pavement Marking. Short term pavement marking will be paid for at the contract unit price per foot (meter) for SHORT TERM PAVEMENT MARKING. Removal of short term pavement markings will be paid for at the contract unit price per square foot (square meter) for SHORT TERM PAVEMENT MARKING REMOVAL.

b) Temporary Pavement Marking. Where the Contractor has the option of material type, temporary pavement marking will be paid for at the contract unit price per foot (meter) for TEMPORARY PAVEMENT MARKING of the line width specified, and at the contract unit price per square foot (square meter) for TEMPORARY PAVEMENT MARKING LETTERS AND SYMBOLS.

Where the Department specifies the use of pavement marking tape, the Type III or Type IV temporary pavement marking will be paid for at the contract unit price per foot (meter) for PAVEMENT MARKING TAPE, TYPE III or PAVEMENT MARKING TAPE, TYPE IV of the line width specified and at the contract unit price per square feet (square meter) for PAVEMENT MARKING TAPE, TYPE III - LETTERS AND SYMBOLS or PAVEMENT MARKING TAPE, TYPE IV – LETTERS AND SYMBOLS.

Removal of temporary pavement markings will be paid for at the contract unit price per square foot (square meter) for TEMPORARY PAVEMENT MARKING REMOVAL.

When temporary pavement marking is shown on the Standard, the cost of the temporary pavement marking and its removal will be included in the cost of the Standard."

Add the following to Section 1095 of the Standard Specifications:

"**1095.11 Pavement Marking Tape, Type IV.** The temporary, preformed, patterned markings shall consist of a white or yellow tape with wet retroreflective media incorporated to provide immediate and continuing retroreflection during both wet and dry conditions. The tape shall be manufactured without the use of heavy metals including lead chromate pigments or other similar, lead-containing chemicals.

The white and yellow Type IV marking tape shall meet the Type III requirements of Article 1095.06 and the following.

(a) Composition. The retroreflective pliant polymer pavement markings shall consist of a mixture of high-quality polymeric materials, pigments and glass beads distributed throughout its base cross-sectional area, with a layer of wet retroreflective media bonded to a durable polyurethane topcoat surface. The patterned surface shall have approximately 40% ± 10% of the surface area raised and presenting a near vertical face to traffic from any direction. The channels between the raised areas shall be substantially free of exposed beads or particles.

(b) Retroreflectance. The white and yellow markings shall meet the following for initial dry and wet retroreflectance.

(1) Dry Retroreflectance. Dry retroreflectance shall be measured under dry conditions according to ASTM D 4061 and meet the values described in Article 1095.06 for Type III tape.

(2) Wet Retroreflectance. Wet retroreflectance shall be measured under wet conditions according to ASTM E 2177 and meet the values shown in the following table.

Wet Retroreflectance, Initial R_L

Color	**R_L 1.05/88.76**
White	300
Yellow	200

(c) Color. The material shall meet the following requirements for daylight reflectance and color, when tested, using a color spectrophotometer with 45 degrees circumferential/zero degree geometry, illuminant D65, and a two degree observer angle. The color instrument shall measure the visible spectrum from 380 to 720 nm with a wavelength measurement interval and spectral bandpass of 10 nm.

Color	**Daylight Reflectance %Y**
White	65 minimum
*Yellow	36-59

*Shall match Federal 595 Color No. 33538 and the chromaticity limits as follows.

x	0.490	0.475	0.485	0.530
y	0.470	0.438	0.425	0.456

(d) Skid Resistance. The surface of the markings shall provide an average minimum skid resistance of 50 BPN when tested according to ASTM E 303.

(e) Sampling, Testing, Acceptance, and Certification. Prior to approval and use of the wet reflective, temporary, removable pavement marking tape, the manufacturer shall submit a notarized certification from an independent laboratory, together with the results of all tests, stating that the material meets the requirements as set forth herein. The certification test report shall state the lot tested, manufacturer's name, and date of manufacture.

After approval by the Department, samples and certification by the manufacturer shall be submitted for each batch used. The manufacturer shall submit a certification stating that the material meets the requirements as set forth herein and is essentially identical to the material sent for qualification. The certification shall state the lot tested, manufacturer's name, and date of manufacture.

All costs of testing (other than tests conducted by the Department) shall be borne by the manufacturer."

TRAINING SPECIAL PROVISIONS (BDE)
Effective: October 15, 1975

This Training Special Provision supersedes Section 7b of the Special Provision entitled "Specific Equal Employment Opportunity Responsibilities," and is in implementation of 23 U.S.C. 140(a).

As part of the Contractor's equal employment opportunity affirmative action program, training shall be provided as follows:

The Contractor shall provide on-the-job training aimed at developing full journeyman in the type of trade or job classification involved. The number of trainees to be trained under this contract will be **10**. In the event the Contractor subcontracts a portion of the contract work, he shall determine how many, if any, of the trainees are to be trained by the subcontractor, provided however, that the Contractor shall retain the primary responsibility for meeting the training requirements imposed by this special provision. The Contractor shall also insure that this Training Special Provision is made applicable to such subcontract. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

The number of trainees shall be distributed among the work classifications on the basis of the Contractor's needs and the availability of journeymen in the various classifications within the reasonable area of recruitment. Prior to commencing construction, the Contractor shall submit to the Illinois Department of Transportation for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed by him on the contract work who is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided hereinafter.

Training and upgrading of minorities and women toward journeyman status is a primary objective of this Training Special Provision. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g. by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent such persons are available within a reasonable area of recruitment. The Contractor will be responsible for demonstrating the steps that he has taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with this Training Special Provision. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

No employee shall be employed as a trainee in any classification in which he has successfully completed a training course leading to journeyman status or in which he has been employed as a journeyman. The Contractor should satisfy this requirement by including appropriate questions in the employee application or by other suitable means. Regardless of the method used, the Contractor's records should document the findings in each case.

The minimum length and type of training for each classification will be as established in the training program selected by the Contractor and approved by the Illinois Department of Transportation and the Federal Highway Administration. The Illinois Department of Transportation and the Federal Highway Administration shall approve a program, if it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyman status in the classification concerned by the end of the training period. Furthermore, apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, or with a State apprenticeship agency recognized by the Bureau and training programs approved by not necessarily sponsored by the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training shall also be considered acceptable provided it is being administered in a manner consistent with the equal employment obligations of Federal-aid highway construction contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program. It is the intention of these provisions that training is to be provided in the construction crafts rather then clerk-typists or secretarial-type positions. Training is permissible in lower level management positions such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the Illinois Department of Transportation and the Federal Highway Administration. Some offsite training is permissible as long as the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

Except as otherwise noted below, the Contractor will be reimbursed 80 cents per hour of training given an employee on this contract in accordance with an approved training program. As approved by the Engineer, reimbursement will be made for training of persons in excess of the number specified herein. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other source does not specifically prohibit the Contractor from receiving other reimbursement. Reimbursement for offsite training indicated above may only be made to the Contractor where he does one or more of the following and the trainees are concurrently employed on a Federal-aid project; contributes to the cost of the training, provides the instruction to the trainee or pays the trainee's wages during the offsite training period.

No payment shall be made to the Contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyman, is caused by the Contractor and evidences a lack of good faith on the part of the Contractor in meeting the requirement of this Training Special Provision. It is normally expected that a trainee will begin his training on the project as soon as feasible after start of work utilizing the skill involved and remain on the project as long as training opportunities exist in his work classification or until he has completed his training program.

It is not required that all trainees be on board for the entire length of the contract. A Contractor will have fulfilled his responsibilities under this Training Special Provision if he has provided acceptable training to the number of trainees specified. The number trained shall be determined on the basis of the total number enrolled on the contract for a significant period.

Trainees will be paid at least 60 percent of the appropriate minimum journeyman's rate specified in the contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on this project. In that case, the appropriate rates approved by the Departments of Labor or Transportation in connection with the existing program shall apply to all trainees being trained for the same classification who are covered by this Training Special Provision.

The Contractor shall furnish the trainee a copy of the program he will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily complete.

The Contractor shall provide for the maintenance of records and furnish periodic reports documenting his performance under this Training Special Provision.

Method of Measurement. The unit of measurement is in hours.

Basis of Payment. This work will be paid for at the contract unit price of 80 cents per hour for TRAINEES. The estimated total number of hours, unit price, and total price have been included in the schedule of prices.

IDOT TRAINING PROGRAM GRADUATE ON-THE-JOB TRAINING SPECIAL PROVISION
Effective: August 1, 2012 Revised: February 2, 2017

In addition to the Contractor's equal employment opportunity (EEO) affirmative action efforts undertaken as required by this Contract, the Contractor is encouraged to participate in the incentive program described below to provide additional on-the-job training to certified graduates of the IDOT pre-apprenticeship training program, as outlined in this Special Provision.

IDOT funds, and various Illinois community colleges operate, pre-apprenticeship training programs throughout the State to provide training and skill-improvement opportunities to promote the increased employment of minority groups, disadvantaged persons and women in all aspects of the highway construction industry. The intent of this IDOT Pre-Apprenticeship Training Program Graduate (TPG) special provision (Special Provision) is to place these certified program graduates on the project site for this Contract in order to provide the graduates with meaningful on-the-job training. Pursuant to this Special Provision, the Contractor must make every reasonable effort to recruit and employ certified TPG trainees to the extent such individuals are available within a practicable distance of the project site.

Specifically, participation of the Contractor or its subcontractor in the Program entitles the participant to reimbursement for graduates' hourly wages at $15.00 per hour per utilized TPG trainee, subject to the terms of this Special Provision. Reimbursement payment will be made even though the Contractor or subcontractor may also receive additional training program funds from other non-IDOT sources for other non-TPG trainees on the Contract, provided such other source does not specifically prohibit the Contractor or subcontractor from receiving reimbursement from another entity through another program, such as IDOT through the TPG program. With regard to any IDOT funded construction training program other than TPG, however, additional reimbursement for other IDOT programs will not be made beyond the TPG Program described in this Special Provision when the TPG Program is utilized.

No payment will be made to the Contractor if the Contractor or subcontractor fails to provide the required on-site training to TPG trainees, as solely determined by IDOT. A TPG trainee must begin training on the project as soon as the start of work that utilizes the relevant trade skill and the TPG trainee must remain on the project site through completion of the Contract, so long as training opportunities continue to exist in the relevant work classification. Should a TPG trainee's employment end in advance of the completion of the Contract, the Contractor must promptly notify the IDOT District EEO Officer for the Contract that the TPG's involvement in the Contract has ended. The Contractor must supply a written report for the reason the TPG trainee involvement terminated, the hours completed by the TPG trainee on the Contract, and the number of hours for which the incentive payment provided under this Special Provision will be, or has been claimed for the separated TPG trainee.

Finally, the Contractor must maintain all records it creates as a result of participation in the Program on the Contract, and furnish periodic written reports to the IDOT District EEO Officer that document its contractual performance under and compliance with this Special Provision. Finally, through participation in the Program and reimbursement of wages, the Contractor is not relieved of, and IDOT has not waived, the requirements of any federal or state labor or employment law applicable to TPG workers, including compliance with the Illinois Prevailing Wage Act.

Method of Measurement: The unit of measurement is in hours.

Basis of Payment: This work will be paid for at the contract unit price of $15.00 per hour for each utilized certified TPG Program trainee (TRAINEES TRAINING PROGRAM GRADUATE). The estimated total number of hours, unit price, and total price must be included in the schedule of prices for the Contract submitted by Contractor prior to beginning work. The initial number of TPG trainees for which the incentive is available for this contract is **10**.

The Department has contracted with several educational institutions to provide screening, tutoring and pre-training to individuals interested in working as a TPG trainee in various areas of common construction trade work. Only individuals who have successfully completed a Pre-Apprenticeship Training Program at these IDOT approved institutions are eligible to be TPG trainees. To obtain a list of institutions that can connect the Contractor with eligible TPG trainees, the Contractor may contact: HCCTP TPG Program Coordinator, Office of Business and Workforce Diversity (IDOT OBWD), Room 319, Illinois Department of Transportation, 2300 S. Dirksen Parkway, Springfield, Illinois 62764. Prior to commencing construction with the utilization of a TPG trainee, the Contractor must submit documentation to the IDOT District EEO Officer for the Contract that provides the names and contact information of the TPG trainee(s) to be trained in each selected work classification, proof that that the TPG trainee(s) has successfully completed a Pre-Apprenticeship Training Program, proof that the TPG is in an Apprenticeship Training Program approved by the U.S. Department of Labor Bureau of Apprenticeship Training, and the start date for training in each of the applicable work classifications.

To receive payment, the Contractor must provide training opportunities aimed at developing a full journeyworker in the type of trade or job classification involved. During the course of performance of the Contract, the Contractor may seek approval from the IDOT District EEO Officer to employ additional eligible TPG trainees. In the event the Contractor subcontracts a portion of the contracted work, it must determine how many, if any, of the TPGs will be trained by the subcontractor. Though a subcontractor may conduct training, the Contractor retains the responsibility for meeting all requirements imposed by this Special Provision. The Contractor must also include this Special Provision in any subcontract where payment for contracted work performed by a TPG trainee will be passed on to a subcontractor.

Training through the Program is intended to move TPGs toward journeyman status, which is the primary objective of this Special Provision. Accordingly, the Contractor must make every effort to enroll TPG trainees by recruitment through the Program participant educational institutions to the extent eligible TPGs are available within a reasonable geographic area of the project. The Contractor is responsible for demonstrating, through documentation, the recruitment efforts it has undertaken prior to the determination by IDOT whether the Contractor is in compliance with this Special Provision, and therefore, entitled to the Training Program Graduate reimbursement of $15.00 per hour.

Notwithstanding the on-the-job training requirement of this TPG Special Provision, some minimal off-site training is permissible as long as the offsite training is an integral part of the work of the contract, and does not compromise or conflict with the required on-site training that is central to the purpose of the Program. No individual may be employed as a TPG trainee in any work classification in which he/she has previously successfully completed a training program leading to journeyman status in any trade, or in which he/she has worked at a journeyman level or higher.

TRAFFIC CONTROL DEVICES - CONES (BDE)
Effective: January 1, 2019

Revise Article 701.15(a) of the Standard Specifications to read:

"(a) Cones. Cones are used to channelize traffic. Cones used to channelize traffic at night shall be reflectorized; however, cones shall not be used in nighttime lane closure tapers or nighttime lane shifts."

Revise Article 1106.02(b) of the Standard Specifications to read:

"(b) Cones. Cones shall be predominantly orange. Cones used at night that are 28 to 36 in. (700 to 900 mm) in height shall have two white circumferential stripes. If non-reflective spaces are left between the stripes, the spaces shall be no more than 2 in. (50mm) in width. Cones used at night that are taller than 36 in. (900 mm) shall have a minimum of two white and two fluorescent orange alternating, circumferential stripes with the top stripe being fluorescent orange. If non-reflective spaces are left between the stripes, the spaces shall be no more than 3 in. (75 mm) in width.

The minimum weights for the various cone heights shall be 4 lb for 18 in. (2 kg for 450 mm), 7 lb for 28 in. (3 kg for 700 mm), and 10 lb for 36 in. (5 kg for 900 mm) with a minimum of 60 percent of the total weight in the base. Cones taller than 36 in. shall be weighted per the manufacturer's specifications such that they are not moved by wind or passing traffic."

TRAFFIC SPOTTERS (BDE)
Effective: January 1, 2019

Revise Article 701.13 of the Standard Specifications to read:

"**701.13 Flaggers and Spotters.** Flaggers shall be certified by an agency approved by the Department. While on the job site, each flagger shall have in his/her possession a current driver's license and a current flagger certification I.D. card. For non-drivers, the Illinois Identification Card issued by the Secretary of State will meet the requirement for a current driver's license. This certification requirement may be waived by the Engineer for emergency situations that arise due to actions beyond the Contractor's control where flagging is needed to maintain safe traffic control on a temporary basis. Spotters are defined as certified flaggers that provide support to workers by monitoring traffic.

Flaggers and spotters shall be stationed to the satisfaction of the Engineer and be equipped with a fluorescent orange, fluorescent yellow/green, or a combination of fluorescent orange and fluorescent yellow/green vest meeting the requirements of ANSI/ISEA 107-2004 or ANSI/ISEA 107-2010 for Conspicuity Class 2 garments. Flaggers shall be equipped with a stop/slow traffic control sign. Spotters shall be equipped with a loud warning device. The warning sound shall be identifiable by workers so they can take evasive action when necessary. Other types of garments may be substituted for the vest as long as the garments have a manufacturer's tag identifying them as meeting the ANSI Class 2 requirement. The longitudinal placement of the flagger may be increased up to 100 ft (30 m) from that shown on the plans to improve the visibility of the flagger. Flaggers shall not encroach on the open lane of traffic unless traffic has been stopped. Spotters shall not encroach on the open lane of traffic, nor interact with or control the flow of traffic.

For nighttime flagging, flaggers shall be illuminated by an overhead light source providing a minimum vertical illuminance of 10 fc (108 lux) measured 1 ft (300 mm) out from the flagger's chest. The bottom of any luminaire shall be a minimum of 10 ft (3 m) above the pavement. Luminaire(s) shall be shielded to minimize glare to approaching traffic and trespass light to adjoining properties. Nighttime flaggers shall be equipped with fluorescent orange or fluorescent orange and fluorescent yellow/green apparel meeting the requirements of ANSI/ISEA 107-2004 or ANSI/ISEA 107-2010 for Conspicuity Class 3 garments.

Flaggers and spotters shall be provided per the traffic control plan and as follows.

(a) Two-Lane Highways. Two flaggers will be required for each separate operation where two-way traffic is maintained over one lane of pavement. Work operations controlled by flaggers shall be no more than 1 mile (1600 m) in length. Flaggers shall be in sight of each other or in direct communication at all times. Direct communication shall be obtained by using portable two-way radios or walkie-talkies.

The Engineer will determine when a side road or entrance shall be closed to traffic. A flagger will be required at each side road or entrance remaining open to traffic within the operation where two-way traffic is maintained on one lane of pavement. The flagger shall be positioned as shown on the plans or as directed by the Engineer.

(b) Multi-Lane Highways. At all times where traffic is restricted to less than the normal number of lanes on a multilane pavement with a posted speed limit greater than 40 mph and the workers are present, but not separated from the traffic by physical barriers, a flagger or spotter shall be furnished as shown on the plans. Flaggers shall warn and direct traffic. Spotters shall monitor traffic conditions and warn workers of errant approaching vehicles or other hazardous conditions as they occur. One flagger will be required for each separate activity of an operation that requires frequent encroachment in a lane open to traffic. One spotter will be required for each separate activity with workers near the edge of the open lane or with their backs facing traffic.

Flaggers will not be required when no work is being performed, unless there is a lane closure on two-lane, two-way pavement."

WARM MIX ASPHALT (BDE)
Effective: January 1, 2012 Revised: April 1, 2016

Description. This work shall consist of designing, producing and constructing Warm Mix Asphalt (WMA) in lieu of Hot Mix Asphalt (HMA) at the Contractor's option. Work shall be according to Sections 406, 407, 408, 1030, and 1102 of the Standard Specifications, except as modified herein. In addition, any references to HMA in the Standard Specifications, or the special provisions shall be construed to include WMA.

WMA is an asphalt mixture which can be produced at temperatures lower than allowed for HMA utilizing approved WMA technologies. WMA technologies are defined as the use of additives or processes which allow a reduction in the temperatures at which HMA mixes are produced and placed. WMA is produced by the use of additives, a water foaming process, or combination of both. Additives include minerals, chemicals or organics incorporated into the asphalt binder stream in a dedicated delivery system. The process of foaming injects water into the asphalt binder stream, just prior to incorporation of the asphalt binder with the aggregate.

Approved WMA technologies may also be used in HMA provided all the requirements specified herein, with the exception of temperature, are met. However, asphalt mixtures produced at temperatures in excess of 275 °F (135 °C) will not be considered WMA when determining the grade reduction of the virgin asphalt binder grade.

Equipment.

Revise the first paragraph of Article 1102.01 of the Standard Specifications to read:

"**1102.01 Hot-Mix Asphalt Plant.** The hot-mix asphalt (HMA) plant shall be the batch-type, continuous-type, or dryer drum plant. The plants shall be evaluated for prequalification rating and approval to produce HMA according to the current Bureau of Materials and Physical Research Policy Memorandum, "Approval of Hot-Mix Asphalt Plants and Equipment". Once approved, the Contractor shall notify the Bureau of Materials and Physical Research to obtain approval of all plant modifications. The plants shall not be used to produce mixtures concurrently for more than one project or for private work unless permission is granted in writing by the Engineer. The plant units shall be so designed, coordinated and operated that they will function properly and produce HMA having uniform temperatures and compositions within the tolerances specified. The plant units shall meet the following requirements."

Add the following to Article 1102.01(a) of the Standard Specifications.

"(11) Equipment for Warm Mix Technologies.

a. Foaming. Metering equipment for foamed asphalt shall have an accuracy of ± 2 percent of the actual water metered. The foaming control system shall be electronically interfaced with the asphalt binder meter.

b. Additives. Additives shall be introduced into the plant according to the supplier's recommendations and shall be approved by the Engineer. The system for introducing the WMA additive shall be interlocked with the aggregate feed or weigh system to maintain correct proportions for all rates of production and batch sizes."

Mix Design Verification.

Add the following to Article 1030.04 of the Standard Specifications.

"(e) Warm Mix Technologies.

(1) Foaming. WMA mix design verification will not be required when foaming technology is used alone (without WMA additives). However, the foaming technology shall only be used on HMA designs previously approved by the Department.

(2) Additives. WMA mix designs utilizing additives shall be submitted to the Engineer for mix design verification."

Construction Requirements.

Revise the second paragraph of Article 406.06(b)(1) of the Standard Specifications to read:

"The HMA shall be delivered at a temperature of 250 to 350 °F (120 to 175 °C). WMA shall be delivered at a minimum temperature of 215 °F (102 °C)."

Basis of Payment.

This work will be paid at the contract unit price bid for the HMA pay items involved. Anti-strip will not be paid for separately, but shall be considered as included in the cost of the work.

WEEKLY DBE TRUCKING REPORTS (BDE)
Effective: June 2, 2012 Revised: April 2, 2015

The Contractor shall submit a weekly report of Disadvantaged Business Enterprise (DBE) trucks hired by the Contractor or subcontractors (i.e. not owned by the Contractor or subcontractors) that are used for DBE goal credit.

The report shall be submitted to the Engineer on Department form “SBE 723” within ten business days following the reporting period. The reporting period shall be Monday through Sunday for each week reportable trucking activities occur.

Any costs associated with providing weekly DBE trucking reports shall be considered as included in the contract unit prices bid for the various items of work involved and no additional compensation will be allowed.

STORM WATER POLLUTION PREVENTION PLAN

Illinois Department of Transportation

Storm Water Pollution Prevention Plan

Route	Marked Route	Section
I-290 Eastbound	FAI 290	3434-2321-R
Project Number	**County**	**Contract Number**
C-91-137-16	Cook	62B78

This plan has been prepared to comply with the provisions of the National Pollutant Discharge Elimination System (NPDES) Permit No. ILR10 (Permit ILR10), issues by the Illinois Environmental Protection Agency (IEPA) for storm water discharges from construction site activities.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Print Name	Title	Agency
Anthony Quigley, P.E.	Regional Engineer	Illinois Dept. of Transportation

Signature	Date
Anthony Quigley	10-13-17

I. Site Description

A. Provide a description of the project location (include latitude and longitude):

The project is located on the south side of Interstate 290 on the west bank of the Des Plaines River within the Village of Forest Park, Cook County, Illinois. The latitude is 41 52'17.8 and the longitude is 87 49'35.8. Section 14, Township 39N, Range 12E. The design, installation, and maintenance of BMPs at these locations are within District one, an area where annual errosivity (R value) is less than or equal to 160. Erosivity is less than 5 in all two-week periods between October 12 and April 15, which would qualify for a construction rainfall erosivity waiver under the US Construction General Permit requirements. At these locations, erosivity is highest in spring, summer, autumn, April 16 - October 11.

B. Provide a description of the construction activity which is subject of this plan:

Construction of a proposed pump station building, including excavation to depths up to 70 feet for construction of a temporary excavation retention system; Demolition and repurposing of an existing pump station building into a grit collection chamber; Site work including parking lot asphalt paving, installation of storm sewer, excavation for a compensatory storage basin, installation of a water main, erection of two retaining walls, landscaping and erosion control work.

C. Provide the estimated duration of this project:

30 Months

D. The total area of the construction site is estimated to be 1.83 acres.

The total area of the site estimated to be disturbed by excavation, grading or other activities is 1.83 acres.

E. The following is a weighted average of the runoff coefficient for this project after construction activities are completed:

C=0.29 (Existing); C=0.57 (Proposed)

F. List all soils found within project boundaries. Include map unit name, slope information and erosivity:

Varna silt loam, 2 to 4 percent slopes, Map Unit Symbol 223B, with a erosivity of 0.37. Urban land, Map Unit Symbol 553 with no erosivity value. Orthents, loamy, undulating, Map Unit Symbol 802B with a erosivity rating of 0.37.

G. Provide an aerial extent of wetland acreage at the site:

There are no wetlands within the project limits. There is one Water of the US (WOUS) which is 0.25 acres located within the project limits. Impact to WOUS within the project site is 0.001 acres temporary impact and 0.017 acres permanent impact.

H. Provide a description of potentially erosive areas associated with this project:

On the west side of the site, there is a hill that will be cut down to complete sitework. This will create a slope of 3H:1V to meet the top of the proposed retaining wall; Grading for the compensatory storage basin required 2H:1V side slopes; disturbed area around the riverside retaining wall will be restored at 3:1 slopes; Large flows will discharge from the pump station into the compensatory storage basin through a pair of 10'x6' culverts. Special measures will be taken to prevent erosion in these areas, including installation of rip-rap; installation of erosion control blanket with temporary seeding; permanent seeding.

I. The following is a description of soil disturbing activities by stages, their locations, and their erosive factors (e.g. steepness of slopes, length of scopes, etc.):

The scope of work for this project requires a deep excavation (70 feet) to install a Temporary Excavation Retention System (TERS). There will also be excavation as deep as 24 feet to build a compensatory storage basin and to meet the final grade for the site.
All temporary runoff control measures required to keep offsite runoff from flowing over the construction area shall be installed before clearing and stripping of the site can begin. Prior to proceeding with the general earthwork on this project, the Contractor shall obtain approval of his proposed earthwork and stabilization schedule.
The following is a description of the suggested sequence of major activities which will disturb soils such as grubbing, excavation, and grading:
-Relocate existing 24" water main to the north side of the existing pump station
-Clear and temporarily grade the existing site
-Excavation and construction of the TERS
-Construction of pump station slab and perimeter walls
-Backfill area between pump station and TERS
-Install pump station outfall culverts
-Construct retaining walls
-Grading of compensatory storage basin
-Underground sitework (storm sewer, electrical ductbanks)
-Finish grade the site and seed areas as indicated
-Plant trees, shrubs and grasses as indicated
-Lay subgrade materials down and pave the access and parking areas

J. See the erosion control plans and/or drainage plans for this contract for information regarding drainage patterns, approximate slopes anticipated before and after major grading activities, locations where vehicles enter or exit the site and controls to prevent off site sediment tracking (to be added after contractor identifies locations), areas of soil disturbance, the location of major structural and non-structural controls identified in the plan, the location of areas where stabilization practices are expected to occur, surface waters (including wetlands) and locations where storm water is discharged to surface water including wetlands.

K. Identify who owns the drainage system (municipality or agency) this project will drain into:

IDOT owns the pump station. The pump station discharges to the Des Plaines River.

L. The following is a list of General NPDES ILR40 permittees within whose reporting jurisdiction this project is located.

IDOT/Village of Forest Park

M. The following is a list of receiving water(s) and the ultimate receiving water(s) for this site. The location of the receiving waters can be found on the erosion and sediment control plans:

The direct receiving water for the project is the Des Plaines River. The reach of the Des Plaines River the project discharges into is not identified by the IDNR as "biologically significant streams".

N. Describe areas of the site that are to be protected or remain undisturbed. These areas may include steep slopes, highly erodible soils, streams, stream buffers, specimen trees, natural vegetation, nature preserves, etc.

The WOUS within the ROW and adjacent to the ROW should be protected or remain undisturbed during construction.

O. The following sensitive environmental resources are associated with this project, and may have the potential to be impacted by the proposed development:

- ☒ Floodplain
- ☐ Wetland Riparian
- ☐ Threatened and Endangered Species
- ☐ Historic Preservation
- ☒ 303(d) Listed receiving waters for suspended solids, turbidity, or siltation
- ☐ Receiving waters with Total Maximum Daily Load (TMDL) for sediment, total suspended solids, turbidity, or siltation
- ☐ Applicable Federal, Tribal, State or Local Programs
- ☐ Other

1. 303(d) Listed receiving waters (fill out this section if checked above):

Des Plaines River

a. The name(s) of the listed water body, and identification of all pollutants causing impairment:

The Des Plaines River (segment IL_G-32) is listed on the 2016 IEPA 303(d) list as impaired. The 2016 303(d) List identifies the aquatic life use of the Des Plaines River as being impaired by chloride and total phosphorus and fish consumption use is impaired by mercury and polychlorinated biphenyls and primary contact recreation use is impaired by fecal coliform.

b. Provide a description of how erosion and sediment control practices will prevent a discharge of sediment resulting from a storm event equal to or greater than a twenty-five (25) year, twenty-four (24) hour rainfall event:

During construction, several temporary erosion and sediment control practices will be installed to filter waterborne sediment prior to discharge in a 25-yea, 24-hour rainfall event. These temporary measures (detailed below in Section II.B) will be required to be in place before any construction activities can begin, including clearing and stripping.
Permanent measures for erosion and sediment control will be installed as soon as possible during construction. After completion of the proposed improvements, the site will be permanently stabilized with seeding and erosion control blanket. Surface runoff from pavement surfaces will be captured by catch basins, allowing for removal of suspended solids and debris. Rip rap will be placed at outfalls and in the compensatory storage basin.

c. Provide a description of the location(s) of direct discharge from the project site to the 303(d) water body:

The location of direct discharge is on the southeast corner of the site, where the compensatory storage basin and the pump station discharge culverts discharge to the Des Plaines River.

d. Provide a description of the location(s) of any dewatering discharges to the MS4 and/or water body:

N/A

2. TMDL (fill out this section if checked above)

a. The name(s) of the listed water body:

N/A

b. Provide a description of the erosion and sediment control strategy that will be incorporated into the site design that is consistent with the assumptions and requirements of the TMDL:

N/A

c. If a specific numeric waste load allocation has been established that would apply to the project's discharges, provide a description of the necessary steps to meet the allocation:

N/A

P. The following pollutants of concern will be associated with this construction project:

☒ Soil Sediment	☒ Petroleum (gas, diesel, oil, kerosene, hydraulic oil / fluids)
☒ Concrete	☒ Antifreeze / Coolants
☒ Concrete Truck waste	☒ Waste water from cleaning construction equipment
☒ Concrete Curing Compounds	☐ Other (specify)
☒ Solid waste Debris	☐ Other (specify)
☒ Paints	☐ Other (specify)
☒ Solvents	☐ Other (specify)
☒ Fertilizers / Pesticides	☐ Other (specify)

II. Controls

This section of the plan addresses the controls that will be implemented for each of the major construction activities described in I.C. above and for all use areas, borrow sites, and waste sites. For each measure discussed, the Contractor will be responsible for its implementation as indicated. The Contractor shall provide to the Resident Engineer a plan for the implementation of the measures indicated. The Contractor and subcontractors, will notify the Resident Engineer of any proposed changes, maintenance, or modifications to keep construction activities compliant with the Permit ILR10. Each such Contractor has signed the required certification on forms which are attached to, and are a part of, this plan:

A. **Erosion and Sediment Controls:** At a minimum, controls must be coordinated, installed, and maintained to:
1. Minimize the amount of soil exposed during construction activity;
2. Minimize the disturbance of steep slopes;
3. Maintain natural buffers around surface waters, direct storm water to vegetated areas to increase sediment removal and maximize storm water infiltration, unless infeasible;
4. Minimize soil compaction and, unless infeasible, preserve topsoil.

B. **Stabilization Practices:** Provided below is a description of interim and permanent stabilization practices, including site- specific scheduling of the implementation of the practices. Site plans will ensure that existing vegetation is preserved where attainable and disturbed portions of the site will be stabilized. Stabilization practices may include but are not limited to: temporary seeding, permanent seeding, mulching, geotextiles, sodding, vegetative buffer strips, protection of trees, preservation of mature vegetation, and other appropriate measures. Except as provided below in II(B)(1) and II(B)(2), stabilization measures shall be initiated **immediately** where construction activities have temporarily or permanently ceased, but in no case more than **one (1) day** after the construction activity in that portion of the site has temporarily or permanently ceases on all disturbed portions of the site where construction will not occur for a period of fourteen (14) or more calendar days.

1. Where the initiation of stabilization measures is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.
2. On areas where construction activity has temporarily ceased and will resume after fourteen (14) days, a temporary stabilization method can be used.

The following stabilization practices will be used for this project:

☐ Preservation of Mature Vegetation	☒ Erosion Control Blanket / Mulching
☐ Vegetated Buffer Strips	☐ Sodding
☒ Protection of Trees	☐ Geotextiles
☒ Temporary Erosion Control Seeding	☒ Other (specify) Mulch Method 2
☐ Temporary Turf (Seeding, Class 7)	☐ Other (specify)
☐ Temporary Mulching	☐ Other (specify)
☒ Permanent Seeding	☐ Other (specify)

Describe how the stabilization practices listed above will be utilized during construction:

Temporary Erosion Control Seeding- Temporary seeding shall be applied in accordance with IDOT's Standard Specifications and the notes on the plans. The seed mixture shall be in accordance with Class 7 seeding, modified with the addition of winter wheat from August 1st to December 1. The quantity of winter wheat shall be the same as the quantity of spring oats in the Standard Specifications.

Permanent Seeding- Seeding, Class 4 and Class 1A shall be installed in accordance with the Standard Specifications.

Erosion Control Blankets/Mulching- Erosion control blankets shall be installed over fill slopes and in high velocity areas that have been brought to final grade and seeded to protect slopes from rill and gully erosion and allow seeds to germinate properly.

Mulch Method 2- Mulch Method 2 should be applied to slopes for temporary stabilization prior to seasons when Temporary Seed will not germinate, for example mid-July and winter.

Where possible, stabilization of the initial Stage should be completed before work is moved to the subsequent stages.

Stabilization controls runoff volume and velocity, peak runoff rates and volumes of discharge to minimize exposed soil, disturbed slopes, sediment discharges from construction, and provides for natural buffers and minimization of soil compaction. Existing vegetated areas where disturbance can be avoided will not require stabilization.

Describe how the stabilization practices listed above will be utilized after construction activities have been completed:

All areas disturbed by construction will be stabilized as soon as permitted with Sodding or Seeding of the classes specified in the plans immediately following the finished grading at locations shown on the plans or as directed by the Engineer.

C. **Structural Practices:** Provided below is a description of structural practices that will be implemented, to the degree attainable, to divert flows from exposed soils, store flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Such practices may include but are not limited to: perimeter erosion barrier, earth dikes, drainage swales, sediment traps, ditch checks, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and temporary or permanent sediment basins. The installation of these devices may be subject to Section 404 of the Clean Water Act.

The following stabilization practices will be used for this project:

☒ Perimeter Erosion Barrier	☒ Rock Outlet Protection
☒ Temporary Ditch Check	☒ Riprap
☒ Storm Drain Inlet Protection	☐ Gabions
☐ Sediment Trap	☐ Slope Mattress
☐ Temporary Pipe Slope Drain	☒ Retaining Walls
☐ Temporary Sediment Basin	☐ Slope Walls
☐ Temporary Stream Crossing	☐ Concrete Revetment Mats
☒ Stabilized Construction Exits	☐ Level Spreaders
☐ Turf Reinforcement Mats	☒ Other (specify) IN-STREAM WORK PLAN (ISWP)
☐ Permanent Check Dams	☒ Other (specify) STABILIZED FLOW LINE
☐ Permanent Sediment Basin	☐ Other (specify)
☐ Aggregate Ditch	☐ Other (specify)
☐ Paved Ditch	☐ Other (specify)

Describe how the structural practices listed above will be utilized during construction:

---Perimeter Erosion Barrier- Prior to commencement of any grading activities, a continuous silt filter fence shall be placed adjacent to construction areas to intercept sheet flow of waterborne silt and sediment and prevent it from leaving the construction site. The locations requiring silt fence are designated on the Erosion Control Plans. A fully enclosed silt filter fence shall be placed around any soil stockpiles on site in accordance with the Standard Specifications. Locations of stockpiles are to be determined by the Contractor and approved by the Engineer.
---Silt fence should only be used as PEB in areas where the work area is higher than the perimeter. The use of silt fence at the top of the slope/elevations higher than the work area should always be avoided. If necessary, temporary fence should be utilized in these locations (where the top of slope/elevation is higher than the work area) in lieu of silt fence.
---Temporary Ditch Check - Rolled excelsior ditch checks shall be placed in disturbed or newly graded swales at the spacing such that the low point in the center of the ditch check is at the same elevation as the base of the ditch check immediately upstream, or as directed by the Engineer. The ditch checks will prevent siltation, scour, and downstream erosion of newly graded swales and drainage ways. Temporary ditch check locations are marked on the Erosion Control Plans.
---Storm Drain Inlet Protection - Inlet filters and inlet filter cleaning shall be provided for all storm sewers. These filters will be placed in every inlet, catch basin or manhole with an open or closed lid, which will drain water during at least a 10-year storm event, and shall be cleaned in accordance with the Special Provisions. The Erosion Control Plans will identify the structures requiring inlet filters.
---Avoid using the INLET AND PIPE PROTECTION shown on the Highway Standard Sheets 280001. Straw bales and silt fence should not be used as inlet and pipe protection. Inlet and pipe protection should be comprised of ditch checks, temporary seeding and temporary erosion control blanket and will be installed at all storm sewer and culverts. Inlet filters, as specified in Article 1081.15(h) of the Standard Specifications (current edition) will be installed at all inlets, catch basins, and manholes for the duration of construction. Inlet filters will be cleaned on a regular basis. Ensure proper quantities of inlet filters. ditch checks, temporary seeding and temporary erosion control blanket are included in the contract.
---Stabilized Construction Exits - Coarse aggregate overlaying a geotextile fabric shall be placed in locations as may be necessary for Contractor access. The aggregate surface of the access points will capture soil debris, reducing the amount of soil deposits placed onto the roadway by vehicles leaving the work zones. Stabilized construction exits will be located by the Contractor in the field, if necessary, and must be approved by the Engineer prior to installation. The exits shall be installed in accordance with the Illinois Urban Manual, latest edition.
---Retaining Walls - A cast in place retaining wall will be placed along the river side of the project. A sheet pile retaining wall will be placed at the west side of the lot.
---All work associated with installation and maintenance of Stabilized Construction Entrances, Concrete Washouts, and In-Stream Work are incidental to the contract and should not be paid for separately. The only exception is Cofferdams (Type 2) since it needs to be signed by a Structural Engineer.
---Stabilized Flow Line- The Contractor should provide to the RE a plan to ensure that a stabilized flow line will be provided during storm sewer construction. The use of a stabilized flow line between installed storm sewer and open disturbance will reduce the potential for the offsite discharge of sediment bearing waters, particularly when rain is forecasted so that flow will not erode. Lack of an approved plan or failure to comply will result in an ESC Deficiency Deduction.
---THIS PROJECT REQUIRES A US ARMY CORPS OF ENGINEERS (usace) 404 PERMIT THAT WILL BE SECURED BY THE DEPARTMENT. ALL CONDITIONS OF THE 404 PERMIT, FOUND IN THE SPECIAL PROVISIONS, MUST BE FOLLOWED. AS A CONDITION OF THIS PERMIT, THE CONTRACTOR WILL NEED TO SUBMIT AN IN-STREAM WORK PLAN (INCLUDING WORK WITHIN WETLANDS) TO THE DEPARTMENT FOR APPROVAL. GUIDELINES ON ACCEPTABLE IN-STREAM WORK TECHNIQUES (INCLUDING WORK WITHIN WETLANDS) CAN BE FOUND ON THE USACE WEBSITE. THE USACE DEFINES AND DETERMINES IN-STREAM WORK. THE COST OF ALL MATERIALS AND LABOR NECESSAY TO COMPLY WITH THE ABOVE PROVISIONS TO PREPARE AND IMPLEMENT AN IN-STREAM WORK PLAN (INCLUDING WORK WITHIN WETLANDS) WILL NOT BE PAID FOR SEPARATELY, BUT SHALL BE CONSIDERED AS INCLUDED IN THE UNIT BID PRICES OF THE CONTRACT AND NO ADDITIONAL COMPENSATION WILL BE ALLOWED.

Describe how the structural practices listed above will be utilized after construction activities have been completed:

Rock Outlet Protection and Riprap- All major storm sewer outlets shall be protected with riprap to dissipate flow velocity and disperse the point of discharge.

D. **Treatment Chemicals**

Will polymer flocculents or treatment chemicals be utilized on this project: ☐ Yes ☒ No

If yes above, identify where and how polymer flocculents or treatment chemicals will be utilized on this project.

E. **Permanent Storm Water Management Controls:** Provided below is a description of measures that will be installed during the construction process to control volume and pollutants in storm water discharges that will occur after construction operations have been completed. The installation of these devices may be subject to Section 404 of the Clean Water act.

1. Such practices may include but are not limited to: storm water detention structures (including wet ponds), storm water retention structures, flow attenuation by use of open vegetated swales and natural depressions, infiltration of runoff on site, and sequential systems (which combine several practices).

   The practices selected for implementation were determined on the basis of the technical guidance in Chapter 41 (Construction Site Storm Water Pollution Control) of the IDOT Bureau of Design & Environment Manual. If practices other than those discussed in Chapter 41 are selected for implementation or if practices are applied to situations different from those covered in Chapter 41, the technical basis for such decisions will be explained below.

2. Velocity dissipation devices will be placed at discharge locations and along the length of any outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g. maintenance of hydrologic conditions such as the hydroperiod and hydrodynamics present prior to the initiation of construction activities).

Description of permanent storm water management controls:

Permanent measures for storm water management controls will be placed as soon as possible during construction. The proposed drainage system will consist of a mainline conveyance storm sewer. Catch basins will collect runoff from the parking lot and access drive. This runoff will then be discharged into the compensatory storage basin. The compensatory storage basin will discharge via a channel to the Des Plaines River.

F. **Approved State or Local Laws:** The management practices, controls, and provisions contained in this plan will be in accordance with IDOT specifications, which are at least as protective as the requirements contained in the Illinois Environmental Protection Agency's Illinois Urban Manual. Procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by local officials shall be described or incorporated by reference in the space provided below. Requirements specified in sediment and erosion site plans, site permits, storm water management site plans or site permits approved by local officials that are applicable to protecting surface water resources are, upon submittal of an NOI, to be authorized to discharge under the Permit ILR10 incorporated by reference and are enforceable under this permit even if they are not specifically included in the plan.

Description of procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by local officials:

All management practices, controls, and other provisions provided in this plan are in accordance with the IDOT Standard Specifications for Road and Bridge Construction and the Illinois Urban Manual.

G. **Contractor Required Submittals:** Prior to conducting any professional services at the site covered by this plan, the Contractor and each subcontractor responsible for compliance with the permit shall submit to the Resident Engineer a Contractor Certification Statement, BDE 2342a.

1. The Contractor shall provide a construction schedule containing an adequate level of detail to show major activities with implementation of pollution prevention BMPs, including the following items:

- Approximate duration of the project, including each stage of the project
- Rainy season, dry season, and winter shutdown dates
- Temporary stabilization measures to be employed by contract phases
- Mobilization time frame
- Mass clearing and grubbing/roadside clearing dates
- Deployment of Erosion Control Practices
- Deployment of Sediment Control Practices (including stabilized construction entrances/exits)
- Deployment of Construction Site Management Practices (including concrete washout facilities, chemical storage, refueling locations, etc.)
- Paving, saw-cutting, and any other pavement related operations
- Major planned stockpiling operations
- Time frame for other significant long-term operations or activities that may plan non-storm water discharges such as dewatering, grinding, etc.
- Permanent stabilization activities for each area of the project

2. The Contractor and each subcontractor shall provide, as an attachment to their signed Contractor Certification Statement, a discussion of how they will comply with the requirements of the permit in regard to the following items and provide a graphical representation showing location and type of BMPs to be used when applicable:
    - Vehicle Entrances and Exits - Identify type and location of stabilized construction entrances and exits to be used and how they will be maintained.
    - Material delivery, Storage, and Use - Discuss where and how materials including chemicals, concrete curing compounds, petroleum products, etc. will be stored for this project.
    - Stockpile Management - Identify the location of both on-site and off-site stockpiles. Discuss what BMPs will be used to prevent pollution of storm water from stockpiles.
    - Waste Disposal - Discuss methods of waste disposal that will be used for this project.
    - Spill Prevention and Control - Discuss steps that will be taken in the event of a material spill (chemicals, concrete curing compounds, petroleum, etc.).
    - Concrete Residuals and Washout Wastes - Discuss the location and type of concrete washout facilities to be used on this project and how they will be signed and maintained.
    - Litter Management - Discuss how litter will be maintained for this project (education of employees, number of dumpsters, frequency of dumpster pick-up, etc.).
    - Vehicle and Equipment Cleaning and Maintenance - Identify where equipment cleaning and maintenance locations for this project and what BMPs will be used to ensure containment and spill prevention.
    - Dewatering Activities - Identify the controls which will be used during dewatering operations to ensure sediments will not leave the construction site.
    - Polymer Flocculants and Treatment Chemicals - Identify the use and dosage of treatment chemicals and provide the Resident Engineer with Material Safety Data Sheets. Describe procedures on how the chemicals will be used and identify who will be responsible for the use and application of these chemicals. The selected individual must be trained on the established procedures.
    - Additional measures indicated in the plan.

III. Maintenance

When requested by the Contractor, the Resident Engineer will provide general maintenance guides to the Contractor for the practices associated with this project. The following additional procedures will be used to maintain, in good and effective operating conditions, the vegetation, erosion and sediment control measures and other protective measures identified in this plan. It will be Contractor's responsibility to attain maintenance guidelines for any manufactured BMPs which are to be installed and maintained per manufacture's specifications.

Construction equipment shall be stored and fueled only at designated locations. All necessary measures shall be taken to contain any fuel or pollution runoff in compliance with environmental law and EPA Water Quality Regulations. Leaking equipment or supplies shall be immediately repaired or removed from the site. On a weekly basis, the Engineer shall inspect the project to determine whether erosion control efforts are in place and effective and if additional control measures are necessary. Sediment collected during construction by the various temporary erosion control systems shall be disposed on the site on a regular basis as directed by the Engineer and stabilized accordingly.

All erosion and sediment control measures should be checked weekly and after each significant rainfall (0.5 inch or greater in a 24-hour period) or equivalent snowfall. Additionally, during winter months (if applicable), all measures should be checked after each significant snowmelt. The following items should be checked:

1. Seeding – all areas subject to erosion, including erodible bare earth areas, will be temporarily seeded and inspected on a weekly
   basis to minimize the amount of erodible surface within the contract limits;
2. Perimeter Erosion Barrier - sediment will be removed if the integrity of the fence is in jeopardy and any fencing knocked down
   will be repaired immediately;
3. Erosion Control Blanket - any areas which fail will be repaired immediately;
4. Ditch Checks - sediment will be removed if the integrity of the ditch check is in jeopardy. Any ditch check which fails will be repaired
   or replaced immediately;
5. Tree Protection;
6. Sedimentation and/or Dewatering Basins (if any);
7. Stabilized Construction Exits (if any); and
8. Areas used for materials and storage that are exposed to storm water.

Additionally, all locations where vehicles enter and exit the construction site and all other areas subject to erosion should also be inspected periodically. Inspection of these areas shall be made at least once every seven (7) days and within 24 hours of the end of each 0.5 inch or greater rainfall or equivalent snowfall.

All maintenance of the erosion and sediment control measures will be the responsibility of the Contractor. This maintenance shall be in accordance with the IDOT Erosion and Sediment Control Field Guide for Construction Inspection (dated July 1, 2010) and IDOT's Best Management Practices - Maintenance Guides.

These maintenance guides can be located at the following links:
http://www.idot.illinois.gov/transportation-system/environment/erosion-and-sediment-control

The temporary erosion control systems shall remain in place with proper maintenance until the permanent erosion controls are in place, working propely, and seeding has been established. Once the permanent erosion control systems have taken hold and are functional, the temporary items shall be removed along with any trapped sediment and any disturbed areas shall be reseeded.

IV. Inspections

Qualified personnel shall inspect disturbed areas of the construction site which have not yet been finally stabilized, structural control measures, and locations where vehicles and equipment enter and exit the site using IDOT Storm Water Pollution Prevention Plan Erosion Control Inspection Report (BC 2259). Such inspections shall be conducted at least once every seven (7) calendar days and within twenty-four (24) hours of the end of a storm or by the end of the following business or work day that is 0.5 inch or greater or equivalent snowfall.

Inspections may be reduced to once per month when construction activities have ceased due to frozen conditions. Weekly inspections will recommence when construction activities are conducted, or if there is 0.5" or greater rain event, or a discharge due to snowmelt occurs.

If any violation of the provisions of this plan is identified during the conduct of the construction work covered by this plan, the Resident Engineer shall notify the appropriate IEPA Field Operations Section office by e-mail at: epa.swnoncomp@illinois.gov, telephone or fax within twenty-four (24) hours of the incident. The Resident Engineer shall then complete and submit an "Incidence of Non-Compliance" (ION) report for the identified violation within five (5) days of the incident. The Resident Engineer shall use forms provided by IEPA and shall include specific information on the cause of noncompliance, actions which were taken to prevent any further causes of noncompliance, and a statement detailing any environmental impact which may have resulted from the noncompliance. All reports of non-compliance shall be signed by a responsible authority in accordance with Part VI. G of the Permit ILR10.

The Incidence of Non-Compliance shall be mailed to the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attn: Compliance Assurance Section
1021 North Grand East
Post Office Box 19276
Springfield, Illinois 62794-9276

Additional Inspections Required:

All Offsite Borrow, Waste, and Use areas are part of the construction site and are to be inspected according to the language in this section.

V. Failure to Comply

Failure to comply with any provisions of this Storm Water Pollution Prevention Plan will result in the implementation of a National Pollutant Discharge Elimination System/Erosion and Sediment Control Deficiency Deduction against the Contractor and/or penalties under the Permit ILR10 which could be passed on to the Contractor.

Illinois Department of Transportation

Contractor Certification Statement

Prior to conducting any professional services at the site covered by this contract, the Contractor and every subcontractor must complete and return to the Resident Engineer the following certification. A separate certification must be submitted by each firm. Attach to this certification all items required by Section II.G of the Storm Water Pollution Prevention Plan (SWPPP) which will be handled by the Contractors/subcontractor completing this form.

Route	Marked Route	Section
I-290 Eastbound	FAI-290	3434-2321-R
Project Number	**County**	**Contract Number**
C-91-137-16	Cook	62B78

This certification statement is a part of SWPPP for the project described above, in accordance with the General NPDES Permit No. ILR10 issued by the Illinois Environmental Protection Agency.

I certify under penalty of law that I understand the terms of the Permit No. ILR10 that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

In addition, I have read and understand all of the information and requirements stated in SWPPP for the above mentioned project; I have received copies of all appropriate maintenance procedures; and, I have provided all documentation required to be in compliance with the Permit ILR10 and SWPPP and will provide timely updates to these documents as necessary.

☐ Contractor

☐ Sub-Contractor

Print Name	Signature
Title	**Date**
Name of Firm	**Telephone**
Street Address	**City/State/Zip**

Items which the Contractor/subcontractor will be responsible for as required in Section II.G. of SWPPP:

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Davis-Bacon and Related Act Provisions
V. Contract Work Hours and Safety Standards Act Provisions
VI. Subletting or Assigning the Contract
VII. Safety: Accident Prevention
VIII. False Statements Concerning Highway Projects
IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
X. Compliance with Governmentwide Suspension and Debarment Requirements
XI. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection

for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 "Contract provisions and related matters" with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each

classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b. (1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b. (1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;

(2) the prime contractor remains responsible for the quality of the work of the leased employees;

(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and

(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of

Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

Contract Provision - Cargo Preference Requirements

In accordance with Title 46 CFR § 381.7 (b), the contractor agrees—

"(1) To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.

(2) To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, 'on-board' commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b) (1) of this section to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.

(3) To insert the substance of the provisions of this clause in all subcontracts issued pursuant to this contract."

Provisions (1) and (2) apply to materials or equipment that are acquired solely for the project. The two provisions do not apply to goods or materials that come into inventories independent of the project, such as shipments of Portland cement, asphalt cement, or aggregates, when industry suppliers and contractors use these materials to replenish existing inventories.

MINIMUM WAGES FOR FEDERAL AND FEDERALLY ASSISTED CONSTRUCTION CONTRACTS

This project is funded, in part, with Federal-aid funds and, as such, is subject to the provisions of the Davis-Bacon Act of March 3, 1931, as amended (46 Sta. 1494, as amended, 40 U.S.C. 276a) and of other Federal statutes referred to in a 29 CFR Part 1, Appendix A, as well as such additional statutes as may from time to time be enacted containing provisions for the payment of wages determined to be prevailing by the Secretary of Labor in accordance with the Davis-Bacon Act and pursuant to the provisions of 29 CFR Part 1. The prevailing rates and fringe benefits shown in the General Wage Determination Decisions issued by the U.S. Department of Labor shall, in accordance with the provisions of the foregoing statutes, constitute the minimum wages payable on Federal and federally assisted construction projects to laborers and mechanics of the specified classes engaged on contract work of the character and in the localities described therein.

General Wage Determination Decisions, modifications and supersedes decisions thereto are to be used in accordance with the provisions of 29 CFR Parts 1 and 5. Accordingly, the applicable decision, together with any modifications issued, must be made a part of every contract for performance of the described work within the geographic area indicated as required by an applicable DBRA Federal prevailing wage law and 29 CFR Part 5. The wage rates and fringe benefits contained in the General Wage Determination Decision shall be the minimum paid by contractors and subcontractors to laborers and mechanics.