

TECHNICAL SPECIFICATIONS FOR
THE CONSTRUCTION OF
SURVEYOR PUMP STATION ELECTRICAL
IMPROVEMENTS
Town Project # 2022-2C

TOWN OF ADDISON, TEXAS
PUBLIC WORKS AND ENGINEERING SERVICES

BID NUMBER 23-01

VOLUME 2 of 2

JANUARY 2023

PREPARED BY



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PUBLIC WORKS & ENGINEERING SERVICES

TOWN OF ADDISON, TEXAS

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Lori Ward

COUNCIL MEMBERS

Tom Braun

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CAPITAL/DEVELOPMENT PROJECTS MANAGER

Wilson Kakembo, P.E.

SURVEYOR PUMP STATION ELECTRICAL IMPROVEMENTS

KLEINFELDER PROJECT NO. 20224986.001A

I hereby certify that the applicable portions of this project plans and specifications were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Texas.


SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
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Chanakya Sah
11-18-2022

Kleinfelder, Inc.
TBPE Reg No. F-16438

- Division 01 General Requirements
- Division 02 Site Construction
- Division 09 Finishes
- Division 11 Equipment
- Division 15 Mechanical



George B. Luke
16 November 2022

Gupta & Associates, Inc.
TBPE Reg. No. F-2593

- Division 16 Electrical

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SECTION 01010 SUMMARY OF WORK

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.2 LOCATION OF WORK

- A. The work of this Contract is located in the Town of Addison, at the Surveyor Ground Storage Tank (GST) at 15150 Surveyor Blvd, Dallas, Texas.

1.3 SUMMARY

- A. Furnish all labor, materials, equipment, and incidentals and make modifications to the electrical improvements for Motor Control center (MCC) and Instrumentation and controls (I&C) and ready for operation as indicated on the Drawings and specified herein.
- B. The work for the Surveyor Storage Tank Electrical Improvements includes, but is not necessarily limited to, the following major items:
 - 1. Remove & Replace Existing Motor Control Center (MCC).
 - 2. Remove & Replace Instrumentation & Control (I&C).
 - 3. Remove and dispose of existing Pump #2 and associated motor, and baseplate and replace with new pump and motor per spec 15900 & 15900.1.
- C. The work shall also conform to such additional Drawings and addenda to these Specifications and Drawings as may be published or exhibited prior to the opening of bid proposals and to such drawings in explanation of details, or as may be furnished by the Engineer from time to time during the construction.
- D. Work and materials which are necessary in the construction but which are not specifically referred to in the Specification, or shown on the Drawings, but implied by the Contract shall be furnished by the Contractor at his own cost and expense and shall be such as will correspond with the general character of the work as may be determined by the Engineer, whose decisions as to the necessity for and character of such work and materials shall be final and conclusive. It is the intent of these Specifications to produce a complete, operational, and finished project whether shown in every detail or not.

1.4 WORK BY OTHERS: (NOT USED)

1.5 WORK SEQUENCE:

- A. The Contractor is required to determine his/her own method of construction and detailed work sequence within the general terms of the Contract, as long as the restraints are observed, and the overall project completion time is observed.

1.6 CONTRACTOR'S USE OF PREMISES:

- A. Contractor shall limit the use of the premises for the performance of the Work and storage of materials and equipment to allow for the Owner's use.
- B. Contractor shall coordinate with Owner for site access as needed.
- C. Contractor shall assume full responsibility for security of all his and his subcontractors' materials and equipment stored on the site for staging area.
- D. If directed by the Owner, Contractor shall move stored items which interfere with operations of Owner.
- E. Obtain and pay for use of additional storage or work areas if needed to perform the Work.
- F. Any damage to the existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.
- G. Any fence that is damaged or removed by the Contractor shall be replaced at the Contractor's expense in like kind, and to the satisfaction of the Owner.
- H. The contractor shall keep the tank site secure with perimeter fencing from possible intruders for the entire duration of the project.

1.7 UTILITIES

- A. The utilities indicated on the drawings have been located primarily from information furnished by others and are considered approximate both as to size and location. There are additional utilities to be encountered that are not shown on the drawings, and it shall be the Contractor's responsibility to locate all existing utilities and to protect same from damage or harm. All utilities interfered with or damaged shall be properly restored, at the expense of the Contractor, to the satisfaction of its Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01011 SITE CONDITIONS

PART 1 – GENERAL

1.1 SITE INVESTIGATION AND REPRESENTATION

- A. The Contractor acknowledges that he/she has satisfied himself/herself to the nature and location of the work. The general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river/stream stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this contract.
- B. The Contractor further acknowledges that he/she has satisfied himself/herself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site.
- C. The Contractor shall be responsible for performing his/her own geotechnical investigation as needed.

1.2 RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Known utilities and structures adjacent to or expected to be encountered in the work are shown on the drawings. The locations shown are taken from existing records and the best information available from existing plans, however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the owner or the Engineer for their accuracy or completeness.
- B. Neither the Owner nor his offices or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the work.
- C. The contractor shall be responsible for acquiring permits required for the work to be completed.
- D. The Contractor shall at all times provide unobstructed access to entrance gate, exit gate, fire hydrants, underground conduit, manholes, and water or gas valve boxes.
- E. Where the Contractor's operations could cause damage which might result in considerable expense, loss, and inconvenience when his operations are adjacent to or near railway, telegraph, telephone, television, power, oil, gas, water, sewer, irrigation, or other systems, no operations shall be commenced until the

Contractor has made all arrangements necessary for the protection of these utilities and services.

- F. The Contractor shall notify all utility offices that are affected by the construction operation at least 15 days in advance of commencing construction operations. The Contractor shall not expose any utility without first obtaining permission from the affected agency. Once permission has been granted, locate and if necessary, expose and provide temporary support for all existing underground utilities in advance of operations.
- G. The Contractor shall be solely and directly responsible to the Owners and operators of such utility properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage that may result from the construction operations under this Contract.
- H. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, the Contractor shall promptly notify the proper authority and cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair. In no event shall interruption of any water or utility service be allowed unless prior approval is granted by the owner of the utility.
- I. The Contractor shall replace, at his own expense, any and all other existing utilities of structures removed or damaged during construction, unless otherwise provided for in these Contract Documents.
- J. The Contractor shall give immediate notice to the Engineer, the Owner and the utility when a physical conflict is determined to exist.
- K. When notified by the Contractor that an interference or conflict has been determined to exist, the Engineer will determine whether such interference shall be considered as required by construction or as incidental to construction.

1.3 INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage and to protect existing structures whether on the surface, above ground or underground. An attempt has been made to show major structures on the plans, while the information has been compiled from the best available sources, its completeness and accuracy cannot be guaranteed, and it is presented as a guide to avoid known possible difficulties. Where existing structures are damaged during work, they shall be restored at the Contractor's expense to at least their original condition and to the satisfaction of the Engineer.

1.4 PAYMENTS

- A. The work specified in this section shall be considered as part of the Agreement between the Owner and the Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01025 MEASUREMENT AND PAYMENT

PART 1: GENERAL

1.1 GENERAL

- A. The Total Amount Bid in the Bid Form shall cover all Work required by the Contract Documents. The lump sum and unit prices bid shall include all costs in connection with the proper and successful completion of the Work, including but not limited to: furnishing all materials, equipment, supplies, and appurtenances; providing all construction equipment and tools; and performing all necessary labor and supervision to fully complete the Work. All Work not specifically set forth as to the pay item or items in the Bid Form shall be considered subsidiary obligations of Contractor and all costs in connection therewith shall be included in the prices bid.

1.2 BID FORM

- A. The Bid Form is a part of these Contract Documents and lists each item of work for which payment will be made. No payment will be made for items other than those listed in the Bid Form.
- B. Required items of work and incidentals necessary for the satisfactory completion of the Project which are not specifically listed in the Bid Form, and which are not specified in this Section to be measured or to be included in one of the items listed in the Bid Form shall be considered as incidental to the work required under this contract, and all costs thereof, including Contractor's overhead costs and profit, shall be considered as included in the prices bid for the various Bid Items. The Contractor shall prepare his bid accordingly.
- C. Work includes furnishing all labor, equipment, tools, and materials, and performing all operations required to complete the work satisfactorily, in place, as specified and as indicated on the Drawings.

1.3 MEASUREMENT AND PAYMENT

- A. Measurement of an item of work will be by the unit indicated in the Bid Form.
- B. Measurement will include all necessary and incidental related work not specified to be included in any other item of work listed in the Bid Form.
- C. Unless otherwise stated in individual sections of the specifications or in the Bid Form no separate payment will be made for any item of work, materials, parts, equipment, supplies, or related items required to perform and complete the requirements of any section. The costs for all such items required shall be included in the Contract price bid for item of which it is a part.
- D. Payment will be made at the Contract price per unit indicated in the Bid Form with total price of the Contract being equal to the Total Bid, as specified and as modified, by extending unit prices multiplied by quantities, as appropriate to reflect actual work included in the Project. Such price and payment shall constitute full compensation

to the Contractor for furnishing all plant, labor, equipment, tools, and materials, and for performing all operations required to furnish to the Owner the entire Project, complete in place, as specified and as indicated on the Drawings.

- E. Measurement for payment does not signify acceptance of Work.
- F. Quantities shown in the Bid Form are approximate quantities only. Payment will be made only for measured quantities actually installed, inspected by the construction inspector and accepted by Owner.
- G. Measurements, such as linear feet, will be to the nearest whole unit.
- H. Some individual technical specification sections may contain measurement and/or payment provisions that may or may not be consistent with this Section 01025 and the Proposal. In all cases, Section 01025 and the Proposal will take precedence over the technical specifications with regard to measurement and payment.
- I. Where estimated quantities are shown for lump sum payment items, such quantities are provided for the Contractor's information only. The Engineer is not responsible for the accuracy of such information and the Contractor shall perform his own calculations to verify such quantities. No adjustment will be made in the price due to real or alleged errors in the estimated quantities.
- J. If the Owner elects to delete any lump sum item, the dollar amount to be deleted from the Contract shall be the total amount shown in the Proposal/Bid Form/Schedule of Values for that item, including overhead and profit.
- K. Contractor shall pay subcontractors in accord with the subcontract agreement within five (5) business days after receipt by Contractor of the payment by Town. Contractor's failure to make the required payments to subcontractors will authorize the Town to withhold future payments from the Contractor until compliance with this paragraph is accomplished.

It is understood that the partial pay estimates will be approximate only, and all partial pay estimates and payment of same will be subject to correction in the estimate rendered following the discovery of the mistake in any previous estimate. Partial payment by Owner for the amount of work done or of its quality or sufficiency or acceptance of the work done; shall not release the Contractor of any of its responsibilities under the Contract Documents.

The Town reserves the right to withhold the payment of any partial estimate if the Contractor fails to perform the work in strict accordance with the specifications or other provisions of this contract.

1.4 BID ITEMS – BASE BID

See Proposal From PF

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

**SECTION 01110
ENVIRONMENTAL PROTECTION PROCEDURES**

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

1.2 SCOPE OF WORK:

- A. The work covered by this section consists of furnishing all labor materials and equipment and performing all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environmental for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water, and land, and involves management of noise and solid waste, as well as other pollutants.
- C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, staked hay bales, seeding, mulching, or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area.
- D. Specific requirements for erosion and sedimentation controls are in the Contract documents.
- E. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- F. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (EPA) and local Conservation Commission.

- G. Schedule and conduct all work in a manner that will minimize the level of noise escaping the site, especially at night and on weekends.

1.3 APPLICABLE REGULATIONS:

- A. Comply with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement.

1.4 NOTIFICATIONS:

- A. The Engineer will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectional acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. The Contractor shall, after receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

1.5 IMPLEMENTATION:

- A. Prior to commencement of the work, meet with the Engineer to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program.
- B. Remove temporary environmental control features, when approved by the Engineer, and incorporate permanent control features into the project at the earliest practicable time.

1.6 PROTECTION OF WATERWAYS

- A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.
- B. Contractors are specifically cautioned that disposal of materials into any waters of the State must conform with the requirements of the TCEQ, and an applicable permit from the U.S. Army Corps of Engineers.
- C. The Contractor shall be responsible for providing holding ponds or an approved method which will handle, carry through, or divert around his work all flows, including storm flows and flows created by construction activity, so

as to prevent silting of waterways or flooding damage to the property or adjacent properties.

- D. The Contractor is responsible for researching the need for a U.S. EPA NPDES permit for the construction site. If one is required, the Contractor is responsible for obtaining the permit and for monitoring the site per the permit requirements until final completion.

1.7 DISPOSAL OF EXCESS EXCAVATION AND OTHER WASTE MATERIALS

- A. Excess excavated material not required or suitable for backfill and other waste material must be disposed of at sites approved by the Owner and Engineer.
- B. Unacceptable disposal sites include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.
- C. The Contractor may make his own arrangements for disposal subject to submission of proof to the Engineer that the Owner(s) of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency and submission of a haul route plan including a map of the proposed route(s).
- D. The Contractor shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

1.8 USE OF CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture or any other applicable regulatory agency. Use of all such chemicals and disposal of residues shall be in conformance with the manufacturer's instructions.
- B. Any oil or other hydrocarbon spilled or dumped on the Owner's site during construction must be excavated and completely removed from the site prior to final acceptance. Soil contaminated by the Contractor's operations shall become the property of the Contractor, who will bear all costs of testing and disposal.
- C. Before a Contractor commences work, the following steps shall be completed.
 - 1. The Owner will inform Contractor of his rights under the Texas Hazards Communication Act.

2. The Owner will provide a copy of the Chemical List giving the hazardous chemicals to which the Contractor, his employees and agents may be exposed to on the project site.
3. The Owner will provide copies of all MSDSs to the Contractor for the hazardous chemicals which he may be exposed to on the project site.
4. The Owner will inform the Contractor of his obligation to inform his employees and agents of each of the above requirements.
5. The Contractor shall provide MSDSs for all hazardous chemicals he may bring onto the project site that Owner's employees may be exposed to.
6. The Contractor shall sign a Contractor Acknowledgement certifying that he has received the information provided by the Owner on hazardous chemicals and maintain the Acknowledgement with the original Contract.

1.9 PAYMENT

- A. The work specified in this Section shall be considered as part of the Agreement between the Owner and the Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EROSION CONTROL:

- A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures such as siltation basins, hay check dams, mulching, jute netting, and other equivalent techniques shall be used as appropriate. Offsite surface water shall be diverted around the site to a downstream channel ahead of siltation barriers. Flow of surface water into excavated areas shall be prevented. Ditches around construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled, and the ground surface restored to original condition.

3.2 PROTECTION OF STREAMS WETLANDS, AND SURFACE WATER:

- A. Care shall be taken to prevent or reduce to a minimum any damage to any stream, drainage ditch, storm drain or sewer from pollution by debris, sediment, or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such water will be diverted through a settling basin or filter before being directed into the streams.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water, or any storm sewer. Water from dewatering operations shall be treated by filtration, settling

basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.

- C. Water being flushed from structures or pipelines after disinfection, with a chlorine residual of 2 mg/l or greater, shall be treated with a dechlorination solution, in a method as specified by American Water Works Association Standard C-655 and as approved by the Engineer, prior to discharge.

3.3 PROTECTION OF LAND RESOURCES:

- A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction that will appear to be natural and not detract from the appearance of the project. Confine all construction activities to areas shown on the Drawings.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly before beginning operations near them.
- D. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition. The Engineer will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.
- E. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1-inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
- F. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed or replaced.
- G. The locations of the Contractor's storage, and other construction building, required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Drawings and shall require written approval of the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the

selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.

- H. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess of waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling, and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded per Town of Addison requirements, or approved by the Engineer.
- I. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.4 PROTECTION OF AIR QUALITY:

- A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control. The Contractor will be required to maintain all excavations, embankments, stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.
- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of chlorides may be permitted with approval from the Engineer.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

3.5 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

- A. During the life of this Contract, maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

3.6 NOISE CONTROL:

- A. The Contractor shall make every effort to minimize noises caused by his operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with State and Federal (OSHA) regulations.

END OF SECTION

SECTION 01300 PROJECT MEETINGS

PART 1: GENERAL

1.1 SCOPE OF WORK

- A. Schedule, attend, and administer as specified, preconstruction conference, periodic progress meetings, and specially called meetings throughout progress of the Work.
- B. Representatives of Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
- C. Meetings administered by Owner and Engineer may be tape recorded. If recorded, tapes will be used to prepare minutes and retained by Owner for future reference.
- D. Meetings, in addition to those specified in this Section, may be held when requested by the Owner, Engineer or Contractor.

1.2 PRECONSTRUCTION CONFERENCE

- A. A preconstruction conference will be held within ten days after execution of agreement and before Work is started. The conference will be scheduled and administered by the Owner.
- B. The Engineer will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the conference.
- C. Attendance:
 - 1. Contractor's project manager.
 - 2. Contractor's superintendent.
 - 3. Subcontractor or supplier representatives per Owner's request.
 - 4. Engineer's representatives per Owner's request.
 - 5. Owner's representatives.
 - 6. Others as appropriate.
- D. Preliminary Agenda:
 - 1. Introductions
 - 2. Schedule completion dates and Liquidated Damages.

3. Construction Scheduling, including critical path.
4. Authority of Contractor.
5. Authority of Construction Manager and Engineer.
6. Submittals.
7. Procedures for Change Orders, CMRs, PCMs, Field Orders, RFIs, etc.
8. Record Drawings
9. Quality control.
10. Safety Procedures.
11. Temporary construction facilities.
12. Use of Town of Addison Facilities.
13. Security and Work after Normal Hours.
14. Measurement and payment.
15. Town of Addison Administrative Procedures
16. Project Work Summary
17. Correspondence Routing
18. Pay Request Procedures

1.2 PROGRESS MEETINGS

- A. Formal project coordination meetings will be held monthly. Meetings will be scheduled and administered by the Engineer. Additional progress meetings to discuss specific topics will be conducted on an as-needed basis. Such additional meetings shall include, but not be limited to:
 1. Coordinating facility/equipment shutdowns.
 2. Installation of equipment.
 3. Start-up of equipment.
 4. Problem Area Resolutions
 5. Equipment approval.
- B. The Contractor will preside at progress meetings.
- C. Attendance: Same as preconstruction conference.

D. Preliminary Agenda:

1. Review, approval of minutes of previous meeting.
2. Review of work progress since previous meeting.
3. Field observations, problems, and conflicts.
4. Problems which impede construction schedule.
5. Review of off-site fabrication, delivery schedules.
6. Review of construction interfacing and sequencing requirements with other construction contracts.
7. Corrective measures and procedures to regain projected schedule.
8. Revisions to construction schedule.
9. Progress, schedule, during succeeding work period.
10. Coordination of schedules.
11. Review submittal schedules.
12. Maintenance of quality standards.
13. Pending changes and substitutions.
14. Review proposed changes for:
 - a. Effect on construction schedule and on completion date.
 - b. Effect on other contracts of the Project.
15. Review Record Documents.
16. Review monthly pay request.
17. Review status of RFIs.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01310 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of:
 - 1. Submittals Related to Project Management and Coordination.
 - 2. Utility Notification and Coordination.
 - 3. Work Sequencing /Constraints.
 - 4. Facility Operations.
 - 5. Adjacent Facilities and Properties.
 - 6. Owner's Occupancy.
 - 7. Partial Utilization by the Owner.
 - 8. Physical Conditions.
 - 9. Construction Photographs.
 - 10. Audio-Video Recordings.
 - 11. Cutting, Fitting and Patching.
- B. Refer to Section 1300 for Project Meetings

1.2 SUBMITTALS

- A. Informational:
 - 1. Photographs and other records of examination.
 - 2. Video Recordings: Submit one copy, including updated copy of project video log, within 5 days of being taken.

1.3 UTILITY NOTIFICATION AND COORDINATION

- A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work.
 - 1. Electric Company: ONCOR Electric, LLC, ph. 972-569-1205
 - 2. Public Works Department, Jason Sutton, ph. 214-263-0033
- B. Before excavation, contact Texas One Call System, Inc., ph 811 to arrange for field location of known utilities.

1.4 WORK SEQUENCING/CONSTRAINTS

- A. Include the following work sequences in the Progress Schedule.
- B. This Section identifies several construction constraints that must be reflected in the Contractor project coordination. An overall outline is presented in this Section for the Construction coordination, demolition, and seasonal/process constraints that shall be considered during construction. The sequence of Work for this Project must reflect the constraints identified herein.

- C. Definitions:
 - 1. Minor Shutdown: Any shutdown requiring less than 8 hours.
 - 2. Major Shutdown: Any shutdown other than a minor shutdown.

- D. Shutdown of Operations:
 - 1. Provide 14 days advance notice to Engineer and Owner of need for a minor shutdown.
 - 2. Provide 30 days advance notice to Engineer and Owner of need for a major shutdown.
 - 3. Contractor shall schedule a shutdown coordination meeting with Owner and Engineer one week prior to each shutdown.
 - 4. Do not proceed with work affecting a facility's operation without obtaining Owner and Engineer advance approval of the need for, and duration of, such work. The Owner will endeavor to grant Contractor requests where possible. However, because Owner's primary responsibility is to deliver potable water, the requested timing may not be possible.
 - 5. Any shutdowns shall require a shutdown plan, including detailed schedule, backup tools and equipment, personnel involved, contingency plan, and any procedures involved in restarting the process or facility. Owner's approval of the Shutdown Plan is required prior to any shutdowns.
 - 6. Shutdowns will be allowed, but may be limited to low demand periods.
 - 7. No minor or major shutdowns allowed within 7 days of a previous shutdown.

1.5 FACILITY OPERATIONS

- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified, and to minimize the number of shutdowns of the plant and existing unit processes.
- B. Perform Work continuously during critical connections and changeovers, as required, to prevent interruption of Owner's operations.
- C. Conduct Work outside regular working hours on prior written consent of Owner to meet Project schedule and avoid undesirable conditions.
- D. Be responsible for planning, designing, and providing various temporary services, utilities, connections, temporary piping, bypass facilities and temporary connections, and similar items to maintain continuous operations of Owner's facility. Sequences other than those specified will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of operations.
- E. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer.

Such authorization will be considered within 48 hours after receipt of Contractor's written request.

- F. Any tanks or pipelines requiring drainage prior to construction will be drained by the Owner's staff to the maximum extent possible utilizing existing piping and drains where they exist. Contractor shall provide temporary pumping and effort to complete drainage of tank or pipeline as required. Provide minimum 7 days' notice to Engineer and Owner of need to drain a facility, unless otherwise specified.
- G. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage in the written request. Provide temporary provisions for continuous power supply to critical existing facility components, is requested by Owner.
- H. Coordinate proposed work with Engineer and Owner before implementing unit shutdowns. Under no circumstances shall Work end if such actions may inadvertently cause a cessation of any facility operation. In such cases, remain onsite until necessary repairs are complete and facility is brought back online.

1.6 ADJACENT FACILITIES AND PROPERTIES

- A. Examination:
 - 1. After Effective Date of the Agreement and before Work at Site is started Contractor, Engineer, and affected property owners and utility owners shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
 - 2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
- B. Documentation:
 - 1. Record and submit documentation of observations made on examination inspections for signature of Engineer and Contractor and in accordance with paragraph Construction Photographs and Audio-Video Recordings.
 - 2. Upon receipt, Engineer will review, sign, and return one record copy of documentation to Contractor to be kept on file in field office. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of adjacent property owners, Contractor, and Owner.

1.7 OWNER'S OCCUPANCY

- A. Owner will occupy the premises during the period of construction for the

conduct of its normal operations. Cooperate with Owner in all construction operations to minimize conflict and to facilitate Owner usage.

1.8 PARTIAL UTILIZATION BY THE OWNER

- A. Schedule operations for completion of portions of the Work, as designated under Work Sequence/Constraints, herein, for Owner's occupancy or separate operation prior to Substantial Completion of the entire Work.
- B. Unless agreed in writing prior to Owner's use, the following conditions shall apply:
 - 1. Contractor's Responsibilities:
 - a. Allow access for Owner's personnel.
 - b. Allow operation of ventilation and electrical systems.
 - c. All other responsibilities as specified in the General Conditions.
 - 2. Owner's Responsibilities:
 - a. Operate ventilating systems and pay cost of same.
 - b. Assume responsibility of power requirements.
 - c. Assume responsibility for security and fire protection in utilized areas, but not extending to Contractor's materials and equipment in utilized areas.
 - d. Assume responsibility for property insurance of utilized areas.
 - 3. Other Conditions of Owner's Use: The correction period for the occupied or separately operated portion of Work shall commence at the date of Substantial Completion for that separate part.

1.9 PHYSICAL CONDITIONS

- A. Exercise reasonable care to verify locations of existing subsurface facilities and utilities.
- B. Areas immediate and adjacent to planned excavations shall be thoroughly checked by means of visual examination and with electronic metal and pipe detection equipment for indications of underground utilities and facilities.
- C. Make exploratory excavation where existing underground facilities or utilities may potentially conflict with proposed excavations and facilities or where there is reasonable cause to verify the presence or absence of, or to obtain physical information regarding underground facilities or utilities. Conduct exploratory excavations as acceptable to and in the presence of Engineer prior to proceeding with major excavation in the area and sufficiently in advance of construction to avoid possible delays to Contractor's Work. Promptly take measurements, photographs, and obtain survey data.

1.10 CONSTRUCTION PHOTOGRAPHS

- A. Photographically document all phases of the project including preconstruction, construction progress, and post-construction.

- B. Engineer shall have the right to select the subject matter and vantage point from which photographs are to be taken.
- C. Preconstruction and Post-Construction:
 - 1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take photographs of all areas of the Construction Site and property adjacent to perimeter of Construction Site.
 - 2. Particular emphasis shall be directed to structures both inside and outside the Site.
- D. Construction Progress Photos:
 - 1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
 - 2. Take photos as frequent as required to document all major aspects of construction. Coordinate with Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CUTTING, FITTING, AND PATCHING

- A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
- B. Obtain prior written authorization of Engineer and Owner before commencing work to cut or otherwise alter:
 - 1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
 - 2. Weather- or moisture-resistant elements.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Work of others.
- C. Refinish surfaces to provide an even finish.
 - 1. Refinish continuous surfaces to nearest intersection.
 - 2. Refinish entire assemblies.
 - 3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and Work is evident in finished surfaces.
- D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown.
- E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.

- F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
- G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

SECTION 01329 – SAFETY PLAN

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Development and maintenance of a Construction Safety Plan.

1.2 REFERENCES

- A. OSHA.

1.3 CONSTRUCTION SAFETY PLAN

- A. Detail the Methods and Procedures to comply with Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Include the following:
 - 1. Identification of the Certified or Licensed Safety Consultant, who will prepare, initiate, maintain and supervise safety programs, and procedures.
 - 2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
 - 3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, and safety equipment used in multi-level structures.
 - 4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
 - 5. Procedures for reporting safety or health hazards.
 - 6. Procedures to follow to correct a recognized safety and health hazard.
 - 7. Procedures for investigation of accidents, injuries, illnesses and unusual events that have occurred at the construction site.
 - 8. Periodic and scheduled inspections of general work areas and specific work stations.
 - 9. Training for employees and workers at the jobsite.
 - 10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
- B. Assume responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
 - 1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
 - 2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.
- C. Transmit to OWNER and ENGINEER copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01300 SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Specifications and Contract documents other Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section specifies the general methods and requirements of submissions applicable to the following work-related submittals.
 - 1. Shop Drawings.
 - 2. Product Data.
 - 3. Samples.
 - 4. Construction Photographs.
 - 5. Construction or Submittal Schedules.
 - 6. Or equal submittals.
- B. Detailed submittal requirements will be specified in the technical specifications section.

1.3 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

- A. Shop Drawings:
 - 1. Shop drawings, as defined in the General Conditions, and as specified in individual work sections include, but are not necessarily limited to: custom-prepared data such as fabrication and erection/installation (working) drawings of concrete reinforcement, structural details and piping layout, schedule information, setting diagrams, actual shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications as applicable to the work.
 - 2. All shop and working drawings shall be prepared on standard size sheets.
 - 3. All shop drawings shall be submitted using a transmittal form approved by the Engineer. Submittal form shall include identification of transmittal number and specification section number.

4. All shop drawings submitted by subcontractors for review shall be sent directly to the Contractor for approval. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
5. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy himself that they conform to the intent of the Drawings and Specifications. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
6. All details on shop drawings submitted for approval shall show clearly the relation of the various parts of the main members and lines of the structure, and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted for approval.
7. If requested by the Engineer, submittals for equipment specified shall include a listing of all installations where identical or similar equipment has been installed and been in operation for a period of at least one year.

B. Product Data:

1. Product data as specified in individual sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and printed installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances including certificates of compliance and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications and recommended spare-parts listing, and printed product warranties, as applicable to the Work.

C. Samples:

1. Samples specified in individual sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the Work.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
1. Field measurements
 2. Field construction criteria
 3. Catalog numbers and similar data
 4. Conformance with the Specifications
- B. Each shop drawing, sample, and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: **"Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."** Shop drawings and product data sheets 11-in. X 17-in. and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Engineer a copy of each submittal transmittal form for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples to the Engineer.
1. Submittals received "WITHOUT" Certification Statement shall not be reviewed.
- C. The Contractor shall utilize an 8-character submittal cross-reference identification numbering system in the following manner:
1. The first five digits shall be the applicable Specification Section Number.
 2. The next two digits shall be the numbers 01-99 to sequentially number each initial separate item or drawing submitted under each specific Section number.
 3. The last character shall be a letter, A-Z, indicating the resubmission of the same Drawing (i.e. A=2nd submission, B=3rd submission, C=4th submission, etc.). A typical submittal number would be as follows:

03300-08-B

03300 = Specification Section for Concrete

08 = The eighth initial submittal under this specification section

B = The third submission (second resubmission) of that particular shop drawing

- D. If a shop drawing shows any deviation from the requirements of the Contract Documents, the Contractor shall make specific mention of the deviations in the Transmittal Form furnished by the Engineer and provide a description of the deviations in a letter attached to the submittal.
- E. The review and approval of shop drawings, samples or product data by the Engineer shall not relieve the Contractor from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will not have responsibility therefor.
- F. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- G. Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.
 - 1. Manufacturer's printed installation instructions; a part of product data submitted to the Engineer will not be reviewed and are for informational purposes only.

1.5 "OR EQUAL"

- A. Should the Contractor seek approval of a product other than the brand or brands named in these specifications, it shall furnish written evidence that such product conforms in all respects to the specified requirements, and that it has been used successfully elsewhere under similar conditions. Where the specified requirements involve conformance to recognized codes or standards the Contractor shall furnish evidence of such conformance in the form of test or inspection reports, prepared by a recognized agency, and bearing an authorized signature.
- B. Manufacturers' standard data and catalog cut sheets will not be considered sufficient in themselves, and the Engineer will not be responsible for seeking further data from the manufacturer, or for otherwise researching the product. Failure to provide complete data will be cause for rejection of the product.
- C. The Contractor shall be responsible for all additional costs including license fees, foundation, piping and electrical work necessary to accommodate the proposed "or equal" equipment. Items which result in a cost reduction shall be presented and a change order reflecting the cost savings will be prepared and the contract price modified.

1.6 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.
- B. All complete submittals shall be submitted sufficiently in advance of construction requirements to provide no less than fifteen (15) days, excluding Saturdays, Sundays and legal holidays for review from the time received at the Engineer's reviewing office. For submittals of major equipment, that require more than fifteen (15) days to review, due to its sheer complexity and amount of detail and also requiring review by more than one engineering discipline, a letter will be sent by the Project Manager or his/her designee to the Contractor informing him/her of the circumstances and the date it is expected the submittal will be returned to the Contractor.
- C. Number of submittals required:
 - 1. Shop Drawings: Unless otherwise stated in the respective Specifications Sections, submit six (6) copies.
 - 2. Product Data: Unless otherwise stated in the respective Specifications submit six (6) copies.
 - 3. Samples: Submit the number stated in the respective Specification Sections.
- D. Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions.
 - 2. The Project title and number.
 - 3. Contractor identification.
 - 4. The names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
 - 5. Identification of the product, with the specification section number, page and paragraph(s).
 - 6. Field dimensions, clearly identified as such.
 - 7. Relation to adjacent or critical features of the Work or materials.

8. Applicable standards, such as ASTM or Federal Specification numbers.
 9. Identification of deviations from Contract Documents.
 10. Identification of revisions on resubmittals.
 11. An 8-in. X 3-in. blank space for Contractor and Engineer stamps.
- E. Each shipment of drawings shall be accompanied by a transmittal form furnished by the Engineer giving a list of the drawing numbers and the names mentioned above.

1.7 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

- A. The Engineer's review is for general conformance with the design concept and contract drawings. Markings or comments shall not be construed as relieving the Contractor from compliance with the contract plans and specifications or from departures therefrom. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
- B. The review of shop drawings, data, and samples will be general. They shall not be construed:
1. As permitting any departure from the Contract requirements;
 2. As relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;
 3. As approving departures from details furnished by the Engineer, except as otherwise provided herein.
- C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which the Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.
- D. Two (maximum) copies of shop drawings or product data will be returned to the Contractor. Samples will not be returned.
- E. Submittals will be returned to the Contractor under one of the action codes indicated and defined on the transmittal form furnished by the Engineer.
- F. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing, on the letter of transmittal and on resubmitted shop drawings by use of revision

triangles or other similar methods, to revisions other than the corrections requested by the Engineer, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the Engineer.

- G. Partial submittals will not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor and will be considered "Rejected" until resubmitted. The Engineer may, at his option, provide a list or mark the submittal directing the Contractor to the areas that are incomplete.
- H. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least seven working days prior to release for manufacture.
- I. When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

1.8 GENERAL PROCEDURES FOR SUBMITTALS

- A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work sections, of the Specifications, so that the installation will not be delayed by processing times including disapproval resubmittal (if required), coordination with other submittals, inspection, testing (off-site and on-site), purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the Work.

1.9 CERTIFICATION FORMS

- A. If specifically specified in other sections of these Specifications, the Contractor shall submit the applicable certification form for each item required, and in the form attached to this section, completely filled in and stamped.

1.10 CERTIFICATES OF COMPLIANCE

- A. Certificates of Compliance specified in the specifications shall include and mean certificates, manufacturer's certificates, certifications, certified copies, letters of certification and certificate of materials.
- B. The Contractor shall be responsible for providing Certificates of Compliance requested and specified in the technical specifications. Certificates are required for demonstrating proof of compliance with

specification requirements and shall be executed in 6 copies unless otherwise specified. Each certificate shall be signed by an official authorized to certify on behalf of the manufacturing company and shall contain the name and address of the Supplier, the project name and location, and the quantity and date or dates of shipment or delivery to which the certificates apply. Copies of laboratory test reports submitted with certificates shall contain the name and address of the testing laboratory and the date or dates of the tests to which the report applies. Certification shall not be construed as relieving the Supplier from furnishing satisfactory material, if after tests are performed on selected samples, the material is found not to meet the specific requirements.

1.11 PROGRESS PHOTOGRAPHS

- A. The Contractor shall furnish all labor, materials and equipment necessary to furnish high resolution photographs of project site as specified herein. The Contractor shall take photographs of the project site prior to construction, monthly during construction of the project and after completion of the project. Monthly photographs shall clearly depict the construction progress during the period. Photographs shall be taken with a quality 35mm or better camera, equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to 135mm. Photographs shall be taken at locations as designated by the Engineer.
- B. Photographs shall be submitted at the monthly progress meetings in the following format:
 - 1. Photos shall be placed in 3-hole punched clear protective plastic sheets for insertion into three ring heavy duty binders. Dividers shall be provided to separate monthly photos. Dividers shall indicate month and year.
 - 2. Each print shall be marked on the reverse side to indicate project name, date and time, location, and photo number.
 - 3. A photo listing sheet shall be included in front of and facing each plastic sheet. The photo listing sheet shall list each photograph on the facing page with the project name, date and time, location, direction of exposure, and description of what is being photographed.
 - 4. Photographs shall be glossy color 3" X 5" prints and the negative shall be provided for each photograph taken.
 - 5. Prints shall be clear and sharp with proper exposure. If prints of adequate quality are not produced from exposures, additional photographs shall be taken. Computer generated and "instamatic" photographs shall not be accepted.

6. Three ring binders shall include on the covers and spine, the project name, and starting and ending date and volume number of photographs contained in the binder.

- C. Contractor shall provide two sets of photographs in binders and two flash drives with electronic files of photographs. Electronic files shall be placed in folders identified by month and year. File names shall be consistent with numbering system for photos in binders. An electronic photo listing sheet shall be included.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

PE CERTIFICATION FORM

The undersigned hereby certifies that he/she is a Professional Engineer registered in the State of _____ and that he/she has been employed by _____ to design:
(Name)

_____ in accordance with Specification
Section _____ (insert PE responsibilities) for the
_____. The undersigned further
(Name of Project)

certifies that he/she has performed the design of the _____ (Name of Project), that said design is in conformance with all applicable local, State and Federal codes, rules and regulations, and that his/her signature and PE stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to the Town of Addison or Owner's representative within seven days following written request therefore by the Owner.

PE Name

Contractor's Name

Signature

Signature

Address

Title

Address

Place PE stamp here w/ date
and signature

**SECTION 01346
AS-BUILT DRAWINGS**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following:

1. As-Built Drawings:

- a. The Contractor shall maintain and keep a record copy of as-built drawings. The drawings shall show all materials as installed. As-built drawings shall be available to the Owner and Engineer at all times during the life of the Contract. Upon request, the Owner will provide one set of reproducible of the original Contract Drawings and a sample record drawing showing required style and quality, for this purpose.

General Contractor shall be responsible for coordinating, collecting and updating as-built drawings from subcontractors.

- 1) All drawings shall be made a part of the record drawings and shall include the following:

- a) Contract Drawings: Annotate or redraft, as required, to show all revisions, substitutions, variations, omissions and discrepancies made or discovered during construction. t. Revisions shall be made and shown on all drawing views with actual dimensions established to permanent points.

- 2) Prior to preliminary inspection, furnish a reproducible of the record drawings. At the completion of the Contract and before final payment is made, furnish the Engineer one set of reproducible of the finally approved record drawings reflecting all revisions herein described.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01370 SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Provide schedule of values covering each bid item.

1.3 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTAL PROCEDURES:
 - 1. Schedule of values.
 - a. Revise and resubmit schedule until acceptable to the Engineer.
 - 2. Itemize separate line item cost for work involving each lump sum item.
 - a. Ensure that the sum of the items listed in the schedule of values for each lump sum item equals the price bid for the respective lump sum item.
 - 3. Breakdown installed costs into:
 - a. Delivered cost of product.
 - b. Total installed cost with overhead and profit.
 - (1) Do not list overhead and profit as separate items.
 - c. For water pipelines, include a breakdown for testing, chlorinating and putting into service.
 - 4. An unbalanced schedule of values providing for overpayment on items of work performed first will not be accepted.

1.4 SEQUENCING AND SCHEDULING

- A. Prepare schedule of values covering each lump sum item after review of tentative schedule at preconstruction conference, but before submission of first application for payment.
- B. Before submitting any application for payment, obtain the Engineer's approval of the Schedule of Values.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01410 – REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Regulatory requirements:
 - 1. Building code.
 - 2. Electrical code.
 - 3. Energy code.
 - 4. Fire code.
 - 5. Mechanical code.
 - 6. Plumbing code.

1.2 REFERENCES

- A. International Code Council (ICC):
 - 1. International Building Code (IBC), 2009.
 - 2. International Existing Building Code (IEBC), 2009.
 - 3. International Energy Conservation Code (IECC), 2009.
 - 4. International Fire Code (IFC), 2009.
 - 5. International Mechanical Code (IMC), 2009.
 - 6. International Plumbing Code (IPC), 2009.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70: National Electrical Code, 2011.
- C. National Electric Code Council:
 - 1. National Electric Code (NEC), NFPA 70, 2011

1.3 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Building code:
 - a. International Building Code.
 - 2. Electrical code:
 - a. NFPA 70: National Electric Code.
 - 3. Energy conservation code:
 - a. International Energy Conservation Code.
 - 4. Fire code:
 - a. International Fire Prevention Code.
 - 5. Mechanical codes:
 - a. International Mechanical Code.
 - 6. Plumbing code:
 - a. International Plumbing Code.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01420 - REFERENCES

PART 1 - GENERAL

1.1 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

- A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in the General Conditions, and as may otherwise be required herein and in the individual Specification sections.
- B. Work specified by reference to published standard or specification of government agency, technical association or trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.
- C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.
- D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.
- E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.
- F. Copies of Standards and Specifications of Technical Societies:
 - 1. Copies of applicable referenced standards have not been bound in these Contract Documents.
 - 2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor's personnel, Subcontractors, Owner, and Engineer.

1.2 ABBREVIATIONS

- A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.
 - 1. AA Aluminum Association
 - 2. AABC Associated Air Balance Council
 - 3. AAMA American Architectural Manufacturers Association
 - 4. AASHTO American Association of State Highway and Transportation Officials
 - 5. ABMA American Bearing Manufacturers' Association
 - 6. ACI American Concrete Institute
 - 7. AEIC Association of Edison Illuminating Companies
 - 8. AGA American Gas Association
 - 9. AGMA American Gear Manufacturers' Association
 - 10. AI Asphalt Institute
 - 11. AISC American Institute of Steel Construction
 - 12. AISI American Iron and Steel Institute
 - 13. AITC American Institute of Timber Construction
 - 14. ALS American Lumber Standards
 - 15. AMCA Air Movement and Control Association
 - 16. ANSI American National Standards Institute
 - 17. APA The Engineered Wood Association

18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	ARI	Air-Conditioning and Refrigeration Institute
21.	ASAE	American Society of Agricultural Engineers
22.	ASCE	American Society of Civil Engineers
23.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers,
24.	ASME	American Society of Mechanical Engineers
25.	ASNT	American Society for Nondestructive Testing
26.	ASTM	ASTM International
27.	AWI	Architectural Woodwork Institute
28.	AWPA	American Wood Preservers' Association
29.	AWPI	American Wood Preservers' Institute
30.	AWS	American Welding Society
31.	AWWA	American Water Works Association
32.	BHMA	Builders Hardware Manufacturers' Association
33.	CBM	Certified Ballast Manufacturer
34.	CDA	Copper Development Association
35.	CGA	Compressed Gas Association
36.	CIS PI	Cast Iron Soil Pipe Institute
37.	CMAA	Crane Manufacturers' Association of America
38.	CRSI	Concrete Reinforcing Steel Institute
39.	CS	Commercial Standard
40.	CSA	Canadian Standards Association
41.	CSI	Construction Specifications Institute
42.	DIN	Deutsches Institute für Normung e.V.
43.	DIPRA	Ductile Iron Pipe Research Association
44.	EIA	Electronic Industries Alliance
45.	EJCDC	Engineers Joint Contract Documents' Committee
46.	ETL	Electrical Test Laboratories
47.	FAA	Federal Aviation Administration
48.	FCC	Federal Communications Commission
49.	FDA	Food and Drug Administration
50.	FEMA	Federal Emergency Management Agency
51.	FIPS	Federal Information Processing Standards
52.	PM	Factory Mutual
53.	Fed. Spec.	Federal Specifications (FAA Specifications)
54.	FS	Federal Specifications and Standards (Technical Specifications)
55.	GA	Gypsum Association
56.	GANA	Glass Association of North America
57.	ID	Hydraulic Institute
58.	HMI	Hoist Manufacturers' Institute
59.	IBC	International Building Code
60.	ICBO	International Conference of Building Officials
61.	ICC	International Code Council
62.	ICEA	Insulated Cable Engineers' Association
63.	IFC	International Fire Code
64.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
65.	IESNA	Illuminating Engineering Society of North America
66.	IFI	Industrial Fasteners Institute
67.	IGMA	Insulating Glass Manufacturer's Alliance
68.	IMC	International Mechanical Code
69.	INDA	Association of the Non-woven Fabrics Industry
70.	IPC	International Plumbing Code
71.	ISA	Instrumentation, Systems, and Automation
72.	ISO	International Organization for Standardization

73.	ITL	Independent Testing Laboratory
74.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
75.	MIA	Marble Institute of America
76.	Mil.	Military Specifications
77.	MMA	Monorail Manufacturers' Association
78.	NAAMM	National Association of Architectural Metal Manufacturers
79.	NACE	NACE International
80.	NEBB	National Environmental Balancing Bureau
81.	NEC	National Electrical Code
82.	NECA	National Electrical Contractors Association
83.	NEMA	National Electrical Manufacturers' Association
84.	NESC	National Electrical Safety Code
85.	NETA	International Electrical Testing Association
86.	NFPA	National Fire Protection Association
87.	NHLA	National Hardwood Lumber Association
88.	NICET	National Institute for Certification in Engineering Technologies
89.	NIST	National Institute of Standards and Technology
90.	NRCA	National Roofing Contractors Association
91.	NRTL	Nationally Recognized Testing Laboratories
92.	NSF	NSF International
93.	NSPE	National Society of Professional Engineers
94.	NTMA	National Terrazzo and Mosaic Association
95.	NWWDA	National Wood Window and Door Association
96.	OSHA	Occupational Safety and Health Act (both Federal and State)
97.	PCI	Pre-cast/Pre-stressed Concrete Institute
98.	PEI	Porcelain Enamel Institute
99.	PPI	Plastic Pipe Institute
100.	PS	Product Standards Section-U.S. Department of Commerce
101.	RMA	Rubber Manufacturers' Association
102.	RUS	Rural Utilities Service
103.	SAE	Society of Automotive Engineers
104.	SDI	Steel Deck Institute
105.	SDI	Steel Door Institute
106.	SJI	Steel Joist Institute
107.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
108.	SPI	Society of the Plastics Industry
109.	SSPC	The Society for Protective Coatings
110.	SWI	Steel Window Institute
111.	TEMA	Tubular Exchanger Manufacturers' Association
112.	TCA	Tile Council of North America
113.	TIA	Telecommunications Industry Association
114.	UBC	Uniform Building Code
115.	UFC	Uniform Fire Code
116.	UL	Underwriters Laboratories Inc.
117.	UMC	Uniform Mechanical Code
118.	USBR	U.S. Bureau of Reclamation
119.	WCLIB	West Coast Lumber Inspection Bureau
120.	WWPA	Western Wood Products Association

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01450 – QUALITY CONTROL

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Quality control and control of installation.
 - 2. Tolerances.
 - 3. References.
 - 4. Mock-up requirements.
 - 5. Authority and duties of Owner's representative or inspector.
 - 6. Sampling and testing.
 - 7. Testing and inspection services.
 - 8. Contractor's responsibilities.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. When specified, products will be tested and inspected either at point of origin or at Work site:
 - 1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
 - 2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.
- I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.3 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM): E 329 - Standard for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- B. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- C. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.
- D. Obtain copies of standards where required by product specification sections.
- E. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.5 MOCK-UP REQUIREMENTS

- A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be comparison standard for remaining Work.
- D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.6 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

- A. Owner's Project Representative employed or retained by Owner is authorized to inspect the Work.
- B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.
- C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.

- D. Inspector will not:
1. Alter or waive provisions of Contract Documents.
 2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
 3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor.
 4. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.
- E. Inspector will:
1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
 2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.7 SAMPLING AND TESTING

- A. General:
1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
 2. When specified in sections where products are specified:
 - a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
 - b. Test materials in accordance with standards of national technical organizations.
- B. Sampling:
1. Furnish specimens of materials when requested.
 2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
 3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
 4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.
- C. Testing:
1. Owner will employ and pay for services of independent testing laboratory to perform routine tests of materials to confirm compliance with requirements of Contract Documents:
 - a. Mill tests, soil compaction test, and other specified tests shall be paid for by Contractor.
 2. When protesting failed tests of material in place or to be used, take additional specimens and have specimens tested:

- a. When original test proves to have been in error, file claim for reimbursement of direct costs for sampling and testing.
- D. Test standards:
1. Perform sampling, specimen preparation, and testing of materials in accordance with specified standards, and when no standard is specified, in accordance with standard of nationally recognized technical organization.
 2. Physical characteristics of materials not particularly specified shall conform to standards published by ASTM, where applicable.
 3. Standards and publication references in Contract Documents shall be edition or revision in effect on date stipulated in the Contract Documents.

1.8 TESTING AND INSPECTION SERVICES

- A. Contractor will employ and pay for specified services of an independent firm; known as Contractor's independent testing firm, to perform Contractor quality control testing as required in the technical specifications for various work and materials.
- B. Owner will employ and pay for specified services of an "Owner's independent testing firm" to perform testing and inspection as required in the technical specifications for various work and materials to confirm Contractor's compliance with Contract Documents. If Engineer or Owner's independent testing firm is not properly certified to perform specialty inspections required by the building department, Owner will employ and pay for a quality specialty inspection firm to perform required testing and inspection.
- C. The Contractor's independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.
- D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
1. Has authorization to operate in the state where the project is located.
 2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
 3. Meets requirements of ASTM E 329.
 4. Laboratory Staff: Maintain full time specialist on staff to review services.
 5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
 6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
- E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

- F. Reports will be submitted by Contractor's independent testing firm and by Owner's independent testing firm to Engineer, Contractor, and Owner in triplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents. Each report shall include:
1. Date issued.
 2. Project title and number.
 3. Testing laboratory name, address, and telephone number.
 4. Name and signature of laboratory inspector.
 5. Date and time of sampling or inspection.
 6. Record of temperature and weather conditions.
 7. Date of test.
 8. Identification of product and specification section.
 9. Location of sample or test in Project.
 10. Type of inspection or test.
 11. Results of tests and compliance with Contract Documents.
 12. Interpretation of test results, when requested by Engineer.
- G. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
 2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.
- H. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency or laboratory may not approve or accept any portion of the Work.
 3. Agency or laboratory may not assume duties of Contractor.
 4. Agency or laboratory has no authority to stop the Work.
- I. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.
- J. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.
- K. The Owner's independent testing firm responsibilities will include:
1. Test samples of mixes submitted by Contractor.
 2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.

5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
 6. Perform additional tests required by Engineer.
 7. Attend preconstruction meetings and progress meetings.
- L. Owner's independent testing firm individual test reports: After each test, Owner's independent testing firm will promptly submit electronically and three hard copies of report to Engineer and to Contractor. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results. Include the following:
1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Certified test results stamped and signed by a registered Engineer in the state that the project is located.
 10. Summary of conformance with Contract Documents.
- M. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
1. Results of testing.
 2. Testing logs.
 3. Outstanding deficiencies.
 4. Various statistical data.
 5. Testing curves (up to 4 types) as required by the Engineer.

1.9 CONTRACTOR'S RESPONSIBILITIES

- A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.
- B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.
- C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.
- D. Furnish electronically and 5 hard copies of product test reports.
- E. Furnish incidental labor and facilities:
 1. To provide access to construction to be tested.
 2. To obtain and handle samples at Work site or at source of product to be tested.
 3. To facilitate inspections and tests.

4. For storage and curing of test samples.
- F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 - PRODUCTS (NOT USED) PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01500 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.
- B. Related sections:
 - 1. Section 01330 – Submittal Procedures

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Association of Nurserymen: American Standards for Nursery Stock.
 - 2. Federal Emergency Management Agency.
 - 3. NFPA, National Fire Prevention Standard for Safeguarding Building Construction Operations.
 - 4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
 - 5. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds.
 - 6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

1.3 SUBMITTALS

- A. Informational Submittals:
 - 1. General: For products specified to be furnished under this Section, submit product data in accordance with Section 01 33 00.
 - 2. Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.
 - 3. Temporary Utility Submittals:
 - a. Electric power supply and distribution plans.
 - b. Sanitary sewer.
 - 4. Temporary Construction Submittals:
 - a. Access Roads: Routes, cross-sections, and drainage facilities.
 - b. Parking area plans.
 - c. Contractor's field office, storage yard, and storage building plans, including gravel surfaced area.
 - d. Fencing and protective barrier locations and details.
 - 5. Temporary Control Submittals:
 - a. Noise control plan.
 - b. Plan for disposal of waste materials and intended haul routes.

1.4 MOBILIZATION

- A. Mobilization shall Include, but Not be Limited to, these Principal Items:
 - 1. Obtaining required permits.
 - 2. Moving Contractor's field office and equipment required for first month operations onto Site.
 - 3. Installing temporary construction power, wiring, and lighting facilities.
 - 4. Providing onsite communication facilities, including telephones.

5. Posting OSHA required notices and establishing safety programs and procedures.
6. Have Contractor's superintendent at Site full time.

B. Use area designated for Contractor's temporary facilities as shown on Drawings.

1.5 PROTECTION OF WORK AND PROPERTY

- A. Comply with Owner's safety rules while on Owner's property.
- B. Keep Owner informed of serious onsite accidents and related claims.
- C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

1.6 TEMPORARY UTILITIES

- A. Temporary Electrical Power:
 1. Arrange with local utility to provide adequate temporary electrical service.
 2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
 3. Provide, maintain, and pay for electric power for performance of the Work except for power required for the final 7-day operational test:
 - a. When using permanent facilities, provide separate meter and reimburse OWNER for power used in connection with performance of the Work.
- B. Temporary Electrical Lighting:
 1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by Occupational Safety and Health Administration (OSHA) and state agency which administers OSHA regulations where Project is located.
 2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
 - a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by CONTRACTOR for lighting.
- C. Temporary Heating, Cooling, and Ventilating:
 1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
 2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.
- D. Temporary Water:
 1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
 2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
 3. Pay for water used for construction prior to Substantial Completion. OWNER will provide water for 7-day final test.
- E. Temporary Sanitary Facilities:
 1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
 2. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.
- F. Temporary Fire Protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

G. First Aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in Existing Facilities.

1.7 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to assure adequate load bearing capability:

1. When requested, submit design calculations by professional registered engineer prior to application of loads.
2. Submitted design calculations are for information and record purposes only.

D. Accident Prevention:

1. Exercise precautions throughout construction for protection of persons and property.
2. Observe safety provisions of applicable Laws and Regulations.
3. Guard machinery and equipment, and eliminate other hazards.
4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:

1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
2. Provide barriers with flashing lights after dark.
3. Keep barriers in place until excavations are entirely backfilled and compacted.
4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning Devices and Barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:

1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in Public Right-of-Way:

1. Mark at reasonable intervals, trenches and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
 - a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
 - a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in Protected Areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

- I. Above Grade Protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.
- K. Fences:
 - 1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence and vandalism.
 - 2. Enclose temporary offices and storage areas with fence adequate to protect temporary facilities against acts of theft, violence and vandalism.
 - 3. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to Substantial Completion.
 - 4. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
 - 5. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
 - 6. Fence temporary openings when openings are no longer necessary.

1.8 SECURITY

- A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.9 ACCESS ROADS

- A. On-Site Access Roads:
 - 1. Maintain access roads to storage areas and other areas to which frequent access is required.
 - 2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
 - 3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
 - 4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.10 TEMPORARY CONTROLS

- A. Noise Control:
 - 1. In inhabited areas, particularly residential, perform operations in manner to minimize noise.
 - 2. In residential areas, take special measures to suppress noise during night hours.

1.11 REMOVAL

- A. Clean and repair damage caused by installation or use of temporary facilities.
- B. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.
- C. Restore existing facilities used during construction to specified or original condition.

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 PROTECTION OF WORK AND PROPERTY

A. General:

1. Perform Work within right-of-way and easements in a systematic manner that minimizes inconvenience to property owners and the public.
2. Schedule the Work so construction will not interfere with irrigation of cultivated lands or pasturelands. Construction may proceed during irrigation season, provided Contractor constructs temporary irrigation ditches, turnouts, and miscellaneous structures acceptable to property owners.
3. Provide continuous access for livestock through farm areas. Do not cut off ready access to portions of farmlands in which livestock are pastured. Maintain existing fences required to restrain livestock. Keep gates closed and secure.
4. Maintain in continuous service all existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and all other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.
5. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate all activities with owner of said utility and perform all work to their satisfaction.
6. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
7. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
8. Notify property owners and utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of a utility become interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.
9. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
10. Maintain original Site drainage wherever possible.

B. Site Security:

1. Erect a temporary security fence for protection of existing facilities. Maintain fence throughout construction period. Obtain Engineer's written permission before removal of temporary security fencing.
2. Provide and maintain additional temporary security fences as necessary to protect the Work and Contractor-furnished products not yet installed.

C. Trees and Plantings:

1. Protect from damage and preserve trees, shrubs, and other plants outside limits of the Work and within limits of the Work, which are designated on the Drawings to remain undisturbed.

D. Existing Structures:

1. Where Contractor contemplates removal of small structures such as mailboxes, signposts, and culverts that interfere with Contractor's operations, obtain approval of property owner and Engineer.

2. Move mailboxes to temporary locations accessible to postal service.
3. Replace items removed in their original location and a condition equal to or better than original.

E. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

F. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

3.2 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning: Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.
3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. Noise Control:

1. Noise Control Plan: Propose plan to mitigate construction noise and to comply with noise control ordinances, including method of construction, equipment to be used, and acoustical treatments.

C. Water Pollution Control:

1. Divert sanitary sewage and non-storm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Engineer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and storm water flow, including dewatering pump discharges.
3. Comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, "Guidelines for Erosion and Sedimentation Control Planning," "Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," and "Erosion and Sediment Control- Surface Mining in Eastern United States."
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.3 PARKING AREAS

- A. Control vehicular parking to preclude interference with public traffic or parking, access by emergency vehicles, Owner's operations, or construction operations.
- B. Provide parking facilities for personnel working on the Project. No employee or equipment parking will be permitted on Owner's existing parking areas, except as specifically designated for Contractor's use.

3.4 VEHICULAR TRAFFIC

- A. Comply with Laws and Regulations regarding closing or restricting use of public streets or highways. No public or private road shall be closed, except by written permission of proper authority. Assure the least possible obstruction to traffic and normal commercial pursuits.
- B. Conduct the Work to interfere as little as possible with public travel, whether vehicular or pedestrian.
- C. Whenever it is necessary to cross, close, or obstruct roads, driveways, and walks, whether public or private, provide and maintain suitable and safe bridges, detours, or other temporary expedients for accommodation of public and private travel.
- D. Coordinate traffic routing with that of others working in same or adjacent areas.

3.5 CLEANING DURING CONSTRUCTION

- A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.
- B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, dispose of such waste materials, debris, and rubbish offsite.
- D. At least weekly, brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

SECTION 01600 DELIVERY, STORAGE AND HANDLING

PART 1: GENERAL

1.1 SCOPE OF WORK

- A. This Section specifies the general requirements for the delivery, handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.
- B. Contractor shall schedule deliveries within the guidelines set forth by the Town of Addison to meet security requirements.

1.2 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.
- C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.
- D. Deliver products to the site in manufacturer's original sealed containers or other packing systems complete with instructions for handling, storing, unpacking, protecting and installing.
- E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- F. Provide necessary equipment and personnel to unload all items delivered to the site.
- G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e., Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.

1.3 STORAGE AND PROTECTION

- A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him/her. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.

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

- C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

SECTION 01601 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 DEFINITIONS

A. Products:

1. New items for incorporation in the Work whether purchased by Contractor or Owner for the Project or taken from previously purchased stock and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by Manufacturer's product name, including make or model designation, indicated in Manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.2 DESIGN REQUIREMENTS

- A. Where Contractor design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of latest edition of International Building Code (IBC) by International Code Council.

1.3 ENVIRONMENTAL REQUIREMENTS

- A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at elevations shown on Drawings.
- B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 °F to 104 °F.

1.4 PREPARATION FOR SHIPMENT

- A. When practical, have the factory assemble products, mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
- B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.
- C. Extra Materials, Special Tools, Test Equipment, and Expendables:
1. Furnish as Required by Individual Specifications.
 2. Schedule:
 - a. Ensure that shipment and delivery occur concurrently with shipment of associated equipment.
 - b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.
 3. Packaging and Shipment:
 - a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
 - b. Prominently Displayed on Each Package, the Following:

- 1). Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
- 2). Applicable equipment description.
- 3). Quantity of parts in package.
- 4). Equipment manufacturer.
4. Deliver materials to the site.
5. Notify Engineer upon arrival for transfer of materials.
6. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.

D. Request a minimum 7-day advance notice of shipment from manufacturer. Upon receipt of Manufacturer's advance notice of shipment, promptly notify Engineer of anticipated date of equipment arrival.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.5 DELIVERY AND INSPECTION

A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in Manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with Manufacturer's instructions for unloading or as specified, and record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site, and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.6 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with Manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS. Provide Manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

C. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 °F. Protect electrical, instrumentation, and control products, and insulation against moisture, water, and dust damage. Connect and operate continuously all space heaters furnished in electrical equipment.

- D. Store fabricated products above ground on blocking or skids, prevent soiling or staining, and store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.
- E. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.
- F. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.
- G. Hazardous Materials: Prevent contamination of personnel, storage building, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide the Manufacturers standard materials suitable for service conditions unless otherwise specified in the individual Specifications.
- B. Where product specifications include a named Manufacturer, with or without model number, and also include performance requirements, named Manufacturer's products must meet the performance specifications.
- C. Like items of products furnished and installed in the Work shall be end products of one Manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, Manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.
- D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- E. Provide interchangeable components of the same Manufacturer, for similar components, unless otherwise specified.
- F. Equipment, components, systems, sub-systems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, State, and local health and safety regulations.
- G. Regulatory Requirement: Coating materials shall meet Federal, State, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
- H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16- gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated ½" mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.
- I. Authority Having Jurisdiction (AHJ):
 - 1. Provide the Work in accordance with the Texas Fire Code that incorporates 2015 International Building Code [with Texas Amendments]. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing

laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide Manufacturer's standard finish and color, except where specific color is indicated.
2. If Manufacturer has no standard color, provide equipment with gray finish as approved by Engineer.

- K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, hand wheels, chain operators, special tools, and other spare parts as required for maintenance.

- L. Lubricant: Provide initial lubricant recommended by equipment Manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

2.2 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same Manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4" minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible. Oil drains with bronze or stainless-steel valves and fill-plugs easily accessible from the normal operating area or platform.
3. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
4. Provide constant-level oilers or oil level indicators for oil lubrication systems.
5. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.3 SOURCE QUALITY CONTROL

- A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 21 days prior to scheduled test date, unless otherwise specified.
- B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).
- C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.2 INSTALLATION

- A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
- B. No shimming between machined surfaces is allowed.
- C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Repaint painted surfaces that are damaged prior to equipment acceptance.
- E. Do not cut or notch any structural member or building surface without specific approval of Engineer.
- F. Handle, install, connect, clean, condition, and adjust products in accordance with Manufacturer's instructions, and as may be specified. Retain a copy of Manufacturers' instruction at Site, available for review at all times.
- G. For material and equipment specifically indicated or specified to be reused in the Work:
 - 1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
 - 2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.3 FIELD FINISHING

- A. In accordance with Section 09900, PAINTING AND PROTECTIVE COATINGS and individual Specification sections.

3.4 ADJUSTMENT AND CLEANING

- A. Perform required adjustments, tests, operation checks, and other startup activities.

3.5 LUBRICANTS

- A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

END OF SECTION

SECTION 01710 CLEANING UP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. During its progress, the work and the adjacent areas affected thereby shall be cleaned up and all rubbish, surplus materials, and unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.
- B. Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.
- C. On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.
- D. The Contractor shall thoroughly clean all materials and equipment installed by him and his sub-contractors, and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.
- E. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, walk, and landscaping work. Suitable materials, equipment, and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the contract period.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01732 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Cutting and patching existing and new construction.
- B. Related sections:
 - 1. Section 01330 – Submittal Procedures.
 - 2. Section 01601 – Product Requirements.

1.2 SUBMITTALS

- A. Submit in accordance with Section 01330.
- B. Cutting and Patching Plan:
 - 1. Submit details of proposed construction before cutting and patching construction commences affecting:
 - a. Work of OWNER or of others.
 - b. Structural integrity of element of Project.
 - 2. Cutting and Patching Plan shall include the following:
 - a. Identification of Work.
 - b. Description of affected construction.
 - c. Necessity for cutting, patching, alteration, or excavation.
 - d. Description of proposed construction.
 - e. Scope of cutting, patching, alteration, or excavation. Verify locations of utilities and facilities which may exist by consulting with the OWNER, utility companies, and the Arkansas One Call System or other service available in area of Project (see dig/call information on the Drawings):

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with specifications and standards for products involved.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Provide adequate temporary support as necessary to ensure structural integrity of affected portion of Work.
- B. Provide devices and methods to protect other portions of Project from damage and persons from injury.
- C. Provide protection from elements for that portion of Project which may be exposed by cutting and patching, and maintain excavations free from water.

3.2 CUTTING AND PATCHING

- A. Cut, Fit, and Patch when Required to:
 - 1. Make its several parts fit together properly.
 - 2. Remove and replace construction not conforming to Contract Documents.

3. Remove samples of installed construction as specified for testing.
 4. Provide routine penetrations of nonstructural surfaces for installation of piping and electrical conduit.
- B. Execute cutting and demolition by methods which will prevent damage and will provide proper surfaces to receive installation of repairs.
- C. Openings in Existing Concrete and Masonry:
1. Create Openings by:
 - a. Saw cutting completely through concrete or masonry, or
 - b. Scoring edges of opening with saw to at least 1 inch depth on both surfaces (when accessible) and removing concrete or masonry by chipping.
 2. Do not allow saw cuts to extend beyond limits of opening.
 3. Make corners square and true by combination of core drilling and grinding or chipping.
 4. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.
- D. Sizing of Openings in Existing Concrete or Masonry:
1. Make openings sufficiently large to permit final alignment of pipe and fittings without deflections.
 2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
- E. Grouting Pipes in Place:
1. Sandblast concrete surfaces and thoroughly clean sand and other foreign material from surfaces prior to placing grout.
 2. Grout pipes, sleeves, castings, and conduits in place by pouring grout under a head of at least 4 inches. Vibrate grout into place. Completely fill the spaces occupied by pipes, sleeves, castings, and conduits.
 3. Water cure the grout.
- F. Connections to Existing Pipes:
1. Cut existing pipe square.
 2. Properly prepare the ends for the connection indicated on the Drawings.
 3. Repair any damage to existing lining and coating.
- G. Rehabilitate all areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit and fasteners with non-shrink grout and finish smooth.
 2. Remove Concrete Bases for Equipment and Supports by:
 - a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface. Do not cut existing reinforcement on floors.
 - b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
 - c. Patch with non-shrink grout to match adjacent grade and finish.
 3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.
- H. Treat Existing Concrete Reinforcement as Follows:
1. Where existing reinforcement is to remain, protect, clean, and extend into new concrete.
 2. Where Existing Reinforcement is not to be Retained, Cut Off as Follows:
 - a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.

- b. Where concrete surface at the removal line is the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

END OF SECTION

SECTION 01770 – CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of the required closeout procedures for the project:
 - 1. Providing and delivering informational submittals.
 - 2. Preparing, maintaining, providing and delivering Record Documents.
 - 3. Furnishing Releases from Agreements.
 - 4. Furnishing Evidence of Compliance with Requirements of Governing Authorities.
 - 5. Providing Warranties and Bonds.
 - 6. Providing Certificate of Final Completion.

- B. Related sections:
 - 1. 01025 – Measurement and Payment.
 - 2. 01780 – Operation and Maintenance Data.
 - 3. 01790 – Demonstration and Training.

1.2 SUBMITTALS

- A. Informational Submittals:
 - 1. Submit Prior to Application for Final Payment.
 - a. Record Documents: As required in General Conditions.
 - b. Approved Shop Drawings and Samples: As required in the General Conditions.
 - c. Operations and Maintenance Manuals: In accordance with Section 01780, and as required in individual Specification sections.
 - d. Certificates of Testing and Inspection: As required in the General Conditions, these General Requirements sections, and the individual Specifications sections.
 - e. Training Sessions: In accordance with Section 01790, and individual Specifications sections.
 - f. Certificate of Substantial Completion.
 - g. Special bonds, Special Guarantees, and Service Agreements.
 - 2. Form of Submittal:
 - a. Bind in commercial quality 8-1/2" by 11" three ring, side binders with hardback, cleanable, plastic covers.
 - 1). Label cover of each binder with typed or printed title Warranties and Bonds, with title of Project; name; address, and telephone number of Contractor and equipment Supplier, and name of responsible principal.
 - 2). Table of Contents: Neatly typed, in the sequence of the of the Project Manual, with each item identified with the number and title of the Specification section in which specified, and the name of the product or Work item.
 - 3). Separate each warranty or Bond with index tab sheets keyed to the Table of Contents. Provide full information, using separate typed sheets as necessary. List Subcontractor, Supplier, and Manufacturer, with name, address, and telephone number of responsible contact for service and warranty issues.
 - 3. Preparation of Submittal:
 - a. Obtain notarized warranties and Bonds, executed in duplicate by responsible Subcontractor, Supplier, and Manufacturer, within 10 days after completion of the applicable item or Work, except for items put into use with Owner's permission, leave date of beginning of time warranty until date of Substantial Completion is determined.
 - 4. Time of Submission: Submit within 10 days after the date of Date of Substantial Completion and prior to submission of Final Application of Payment.
 - a. Spare parts and special tools as required by individual Specification sections.
 - b. Consent of Surety to Final Payment: As required in General Conditions.

- c. Releases or Waivers of Liens and Claims: As required in General Conditions.
- d. Releases from Agreements.
- e. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01025.
- f. Extra Materials: As required by individual Specification sections.

1.3 RECORD DOCUMENTS

- A. Quality Assurance:
 1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
 2. Accuracy of Records:
 3. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
 4. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
 5. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
 6. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.
 7. Maintain at Project site, available to OWNER and ENGINEER, 1 copy of the Contract Documents, shop drawings and other submittals, in good order.

1.4 RELEASES FROM AGREEMENTS

- A. Furnish Owner written releases from property owners or public agencies where side agreements or special easements have been made, or where Contractor's operations have not been kept within the Owner's construction right-of-way.
- B. In the Event Contractor is Unable to Secure Written Releases:
 1. Inform Owner of the reasons.
 2. Owner or its representatives will examine the Site, and Owner will direct Contractor to complete the Work that may be necessary to satisfy terms of the side agreement or special easement.
 3. Should Contractor refuse to perform this Work, Owner reserves right to have it done by separate contract and deduct cost of same from Contract Price, or require Contractor to furnish a satisfactory bond in a sum to cover legal Claims for damages.
 4. When Owner is satisfied that the Work has been completed in agreement with Contract Documents and terms of side agreement or special easement, right is reserved to waive requirement for written release if:
 5. Contractor's failure to obtain such statement is due to grantor's refusal to sign, and this refusal is not based upon any legitimate Claims that Contractor has failed to fulfill terms of side agreement or special easement, or
 6. Contractor is unable to contact or has had undue hardship in contacting grantor.

1.5 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

- A. Submit the Following:
 1. Certificate of Occupancy.
 2. Certificates of Inspection:
 - a. Mechanical.
 - b. Electrical.

1.6 WARRANTIES AND BONDS

- A. Provide executed Warranty or Guaranty Form if required by Contract Documents.
- B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

1.7 CERTIFICATE OF FINAL COMPLETION

- A. When 7-day operational test has been successfully completed, ENGINEER will certify that new facilities are operationally complete. ENGINEER will submit a list of known items (punch list) still to be completed or corrected prior to contract completion.
- B. List of items to be completed or corrected will be amended as items are resolved by CONTRACTOR.
- C. When all items have been completed or corrected, submit written certification that the entire work is complete in accordance with the Contract Documents and request final inspection.
- D. Upon completion of final inspection, ENGINEER will either prepare a written acceptance of the entire work or advise CONTRACTOR of work not complete. If necessary, inspection procedures will be repeated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS

- A. General:
 - 1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents. Drawings will be full size.
 - 2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
 - 3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

- B. Preservation:
 - 1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
 - 2. Make documents and Samples available at all times for observation by Engineer.

- C. Making Entries on Drawings:
 - 1. Use an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
 - a. Make annotations with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

- 2. Date entries.

3. Call attention to entry by "cloud" drawn around area or areas affected.
 4. Legibly mark to record actual changes made during construction, including, but not limited to:
 5. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
 6. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work, and Reference to at least two measurements to permanent surface improvements.
 7. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
 8. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
 9. Changes made by Addenda and Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
 10. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items that are described in previous subparagraph above.
 11. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
 12. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
 13. Make identification so descriptive that it may be related reliably to Specifications.
 14. Mark and record field changes and detailed information contained in submittals and change orders.
 15. Record actual depths, horizontal and vertical location of underground pipes, duct banks and other buried utilities. Reference dimensions to permanent surface features.
 16. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
 17. Identify location of spare conduits including beginning, ending and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
 18. Provide schedules, lists, layout drawings, and wiring diagrams.
 - D. Maintain Documents Separate From Those Used for Construction:
 1. Label documents "RECORD DOCUMENTS."
 - E. Keep Documents Current:
 1. Record required information at the time the material and equipment is installed and before permanently concealing.
 - F. Deliver record documents with transmittal letter containing date, Project title, CONTRACTOR's name and address, list of documents, and signature of CONTRACTOR.
 - G. During progress meetings, record documents will be reviewed to ascertain that changes have been recorded.
 - H. Final Schedule Submittal.
- 3.2 FINAL CLEANING
- A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.
 1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner.

2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
 3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
 4. Clean all windows.
 5. Clean and wax wood, vinyl, or painted floors.
 6. Broom clean exterior paved driveways and parking areas.
 7. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
 8. Rake and clean all other surfaces.
 9. Leave water courses, gutters, and ditches open and clean.
 10. Perform final cleaning prior to inspections for Final Acceptance.
 11. Employ skilled workers who are experienced in cleaning operations.
 12. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.
 13. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.
 14. Clean roofs, gutters, downspouts, and drainage systems.
 15. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
 - a. Police yards and grounds to keep clean.
 16. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.
 17. Remove non-permanent protection and labels.
 18. Polish waxed woodwork and finish hardware.
 19. Wash tile.
 20. Wash and polish glass, inside and outside.
 21. Wash and shine mirrors.
 22. Polish glossy surfaces to clear shine.
 23. Vacuum carpeted and soft surfaces.
- B. Use only cleaning materials recommended by Manufacturer of surfaces to be cleaned.

3.3 WASTE DISPOSAL

- A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
 1. Prior to making disposal on private property, obtain written permission from OWNER of such property.
- B. Do not fill ditches, washes, or drainage ways which may create drainage problems.
- C. Do not create unsightly or unsanitary nuisances during disposal operations.
- D. Maintain disposal site in safe condition and good appearance.
- E. Complete leveling and cleanup prior to Final Acceptance of the Work.

3.4 TOUCH-UP AND REPAIR

- A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Final Acceptance.
- B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

3.5 CLOSEOUT DOCUMENTS

- A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:
1. Evidence of Compliance with Requirements of Governing Authorities.
 2. Project Record Documents.
 3. Operation and Maintenance Manuals.
 4. Warranties and Bonds.
 5. Evidence of Payment and Release of Stop Payment Notices as outlined in Conditions of the Contract.
 6. Release of claims as outlined in Conditions of the Contract.
 7. Certificate of Final Completion.

END OF SECTION

SECTION 01780 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Summary includes: detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.
- B. Related sections:
 - 1. Section 01770 – Closeout Procedures.

1.2 DEFINITIONS

- A. Preliminary Data: Initial and subsequent submissions for Engineer's review.
- B. Final Data: Engineer-accepted data, submitted as specified herein.
- C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.3 SEQUENCING AND SCHEDULING

- A. Equipment and System Data:
 - 1. Preliminary Data:
 - a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
 - b. Submit prior to shipment date.
 - 2. Final Data:
 - a. Submit Instructional Manual Formatted data not less than 30 days prior to equipment or system field functional testing.
- B. Materials and Finishes Data:
 - 1. Preliminary Data: Submit at least 15 days prior to request for final inspection.
 - 2. Final Data: Submit within 10 days after final inspection.

1.4 DATA FORMAT

- A. Prepare preliminary data in the form of an instructional manual. Prepare final data in the form of an instructional manual and in electronic media format.
- B. Instructional Manual Format:
 - 1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
 - 2. Size: 8-1/2" x 11" minimum.
 - 3. Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA" and list:
 - a. Project title.
 - b. Designate applicable system, equipment, material, or finish.
 - c. Identity of separate structure as applicable.
 - d. Identity of general subject matter covered in manual.
 - e. Identity of equipment number and Specification section.
 - 4. Title Page:

- a. Contractor name, address, and telephone number.
 - b. Subcontractor, Supplier, installer, or maintenance contractor's name, address, and telephone number, as appropriate.
 - 1). Identify area of responsibility of each.
 - 2). Provide name and telephone number of local source of supply for parts and replacement.
5. Table of Contents:
- a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
 - b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
6. Paper: 20-pound minimum, white for typed pages.
7. Text: Manufacturer's printed data, or neatly typewritten.
8. Three-hole punched data for binding and composition; arrange printing so that punched holes do not obliterate data.
9. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.
- C. Electronic Media Format:
1. Portable Document Format (PDF):
 - a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
 - b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
 - c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

1.5 SUBMITTALS

- A. Procedures of Submittal
1. Contractor shall:
 - a. Submit all submittals electronically to facilitate the transfer of submittals and related files.
 - b. Submit all required final hard copies and required electronic copies as specified herein.
- B. Informational:
1. Data Outline: Submit one electronic copy via email of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
 2. Preliminary Data:
 - a. Submit one electronic copy for Engineer's review.
 - b. If data meets conditions of the Contract:
 - 1). One electronic copy will be returned to Contractor.
 - 2). One electronic copy will be forwarded to Resident Project Representative.
 - 3). One electronic copy will be retained in Engineer's file
 - c. If data does not meet conditions of the Contract:
 - 1). One electronic copy will be returned to Contractor with Engineer's comments (on separate document) for revision.
 - 2). Engineer's comments will be retained in Engineer's file.
 - 3). One electronic copy will be retained in Engineer's file.
 - 4). Re-submit one electronic copy revised in accordance with Engineer's comments.
 3. Final Data: Submit two hard copies and one electronic copy in each format specified herein.

1.6 DATA FOR EQUIPMENT AND SYSTEMS

- A. Content for Each Unit (or Common Units) and System:
1. Product Data:
 - a. Include only those sheets that are pertinent to specific product.
 - b. Clearly annotate each sheet to:
 - 1). Identify specific product or part installed.
 - 2). Identify data applicable to installation.
 - 3). Delete references to inapplicable information.
 - c. Function, normal operating characteristics, and limiting conditions.
 - d. Performance curves, engineering data, nameplate data, and tests.
 - e. Complete nomenclature and commercial number of replaceable parts.
 - f. Original Manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
 - g. Spare parts ordering instructions.
 - h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, and terminals).
 2. As-installed, color-coded piping diagrams.
 3. Charts of valve tag numbers, with the location and function of each valve.
 4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
 - a. Format:
 - 1). Provide reinforced, punched, binder tab; bind in with text.
 - 2). Reduced to 8-1/2" x 11", or 11" x 17" folded to 8-1/2" x 11".
 - 3). Where reduction is impractical, fold and place in 8-1/2" x 11" envelopes bound in text.
 - 4). Identify Specification section and product on Drawings and envelopes.
 - b. Relations of component parts of equipment and systems.
 - c. Control and flow diagrams.
 - d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
 5. Instructions and Procedures: Within text, as required to supplement product data.
 - a. Format:
 - 1). Organize in consistent format under separate heading for each different procedure.
 - 2). Provide logical sequence of instructions for each procedure.
 - 3). Provide information sheet for Owner's personnel, including:
 - a). Proper procedures in event of failure.
 - b). Instances that might affect validity of guarantee or Bond.
 - b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
 - c. Operating Procedures:
 - 1). Startup, break-in, routine, and normal operating instructions.
 - 2). Test procedures and results of factory tests where required.
 - 3). Regulation, control, stopping, and emergency instructions.
 - 4). Description of operation sequence by control Manufacturer.
 - 5). Shutdown instructions for both short and extended duration.
 - 6). Summer and winter operating instructions, as applicable.
 - 7). Safety precautions.
 - 8). Special operating instructions.
 - d. Maintenance and Overhaul Procedures:
 - 1). Routine maintenance.
 - 2). Guide to troubleshooting.
 - 3). Disassembly, removal, repair, reinstallation, and re-assembly.
 6. Guarantee, Bond, and Service Agreement: In accordance with Section 01770, CLOSEOUT PROCEDURES.

- B. Content for Each Electric or Electronic Item or System:
1. Description of Unit and Component Parts:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Interconnection wiring diagrams, including control and lighting systems.
 2. Circuit Directories of Panelboards:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. List of electrical relay settings, and control and alarm contact settings.
 4. Electrical interconnection wiring diagram, including control and lighting systems.
 5. As-installed control diagrams by control Manufacturer.
 6. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Safety precautions.
 - d. Special operating instructions.
 7. Maintenance Procedures:
 - a. Routine maintenance.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
 8. Manufacturer's printed operating and maintenance instructions.
 9. List of original Manufacturer's spare parts, Manufacturer's current prices, and recommended quantities to be maintained in storage.
- C. Maintenance Summary:
1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
 2. Format: Use only 8-1/2" x 11" size paper.
 3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
 4. Recommended Spare Parts:
 - a. Data to be consistent with Manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
 - b. "Unit" is the unit of measure for ordering the part.
 - c. "Quantity" is the number of units recommended.
 - d. "Unit Cost" is the current purchase price.

1.7 DATA FOR MATERIALS AND FINISHES

- A. Content for Architectural Products, Applied Materials, and Finishes:
1. Manufacturer's data, giving full information on products:
 - a. Catalog number, size, and composition.
 - b. Color and texture designations.
 - c. Information required for reordering special-manufactured products.
 2. Instructions for Care and Maintenance:
 - a. Manufacturer's recommendation for types of cleaning agents and methods.
 - b. Cautions against cleaning agents and methods that are detrimental to product.
 - c. Recommended schedule for cleaning and maintenance.
 3. Content for Moisture Protection and Weather Exposed Products:
 4. Manufacturer's data, giving full information on products:
 - a. Applicable standards.
 - b. Chemical composition.

- c. Details of installation.
- 5. Instructions for inspection, maintenance, and repair.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01790 – DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes description and requirements of the required demonstration and training for the project:
 - 1. Providing and delivering informational submittals.
 - 2. Submitting required qualifications of Manufacturer's Representative.
 - 3. Preparing, maintaining, providing and delivering Manufacturer's Certificate of Compliance and Manufacturer's Certificate of Proper Installation.
 - 4. Furnishing required Training.
 - 5. Furnishing required Equipment Testing, Unit Process and Facility Performance Demonstration.
- B. Related Sections
 - 1. Section 01300– Project Meetings.
 - 2. Section 01780 – Operation and Maintenance Data.

1.2 DEFINITIONS

- A. Person-Day: One person for 8 hours within regular Contractor working hours.
- B. Facility: Entire Project, or an agreed-upon portion including all unit processes.
- C. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets Manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.
- D. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.
- E. Unit Process: As used in this Section, a unit process is a portion of the facility that performs a specific process function.
- F. Facility Performance Demonstration:
 - 1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
 - 2. Such demonstration is for the purposes of:
 - a. Verifying to Owner entire facility performs as a whole, and
 - b. Documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.3 SUBMITTALS

- A. Informational Submittals:
 - 1. Training Schedule: Submit not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.

2. Lesson Plan: Submit proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Training Session Tapes: Furnish Owner with two complete sets of DVDs fully indexed and cataloged with printed label stating session and date taped.
4. Facility Startup and Performance Demonstration Plan.
5. Functional and performance test results.
6. Completed Unit Process Startup Form for each unit process.
7. Completed Facility Performance Demonstration/Certification Form.

1.4 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- A. Authorized representative of the Manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment Manufacturer to issue the certifications required of the Manufacturer. Additional qualifications may be specified elsewhere.
- B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

1.5 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

- A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:
 1. Step-by-step instructions for startup of each unit process and the complete facility.
 2. Unit Process Startup Form (sample attached), to minimally include the following:
 - a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
 - b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
 - c. Startup requirements for each unit process, including water, power, chemicals, etc.
 - d. Space for evaluation comments.
 3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
 - a. Description of unit processes included in the facility startup.
 - b. Sequence of unit process startup to achieve facility startup.
 - c. Description of computerized operations, if any, included in the facility.
 - d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
 - e. Signature spaces for Contractor and Engineer.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Furnish Manufacturers' services when required by an individual specification section, to meet the requirements of this Section.
- B. Where time is necessary in excess of that stated in the Specifications for Manufacturer's services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.
- C. Schedule Manufacturer's services to avoid conflict with other onsite testing or other Manufacturer's onsite services.

- D. Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
 - E. Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.
 - F. When specified in individual specification sections, Manufacturer's onsite services shall include:
 - 1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
 - 2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by Manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 - 3. Providing, on a daily basis, copies of all Manufacturer's representatives' field notes and data to Engineer.
 - 4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
 - 5. Resolution of assembly or installation problems attributable to or associated with, respective Manufacturer's products and systems.
 - 6. Assistance during functional and performance testing, and facility startup and evaluation.
 - 7. Training of Owner's personnel in the operation and maintenance of respective product as required.
 - 8. Additional requirements may be specified elsewhere.
 - G. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01300, PROJECT MEETINGS, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.
 - H. Contractor's Testing and Startup Representative:
 - 1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
 - 2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.
 - I. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.
 - J. Provide Subcontractor and equipment Manufacturer's with adequate staff to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.
 - K. Owner will:
 - 1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
 - 2. Operate process units and facility with support of Contractor.
 - 3. Provide labor and materials as required for laboratory analyses.
- 3.2 MANUFACTURER'S CERTIFICATE OF COMPLIANCE
- A. When specified in individual Specification section, submit prior to shipment of product or material.
 - B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

- C. Signed by product Manufacturer certifying that product or material specified conforms to or exceeds specified. Attach supporting reference data, affidavits, and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.3 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this Section, shall be completed and signed by the equipment Manufacturer's representative.
- B. Such form shall certify that the signing party is a duly authorized representative of the Manufacturer, is empowered by the Manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

3.4 TRAINING

- A. General:
 - 1. Furnish Manufacturer's representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
 - 2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01780, OPERATION AND MAINTENANCE DATA.
 - 3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
 - 4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
- B. Training Schedule:
 - 1. List specified equipment and systems that require training services and show:
 - a. Respective Manufacturer.
 - b. Estimated dates for installation completion.
 - c. Estimated training dates.
 - 2. Allow for multiple sessions when several shifts are involved.
 - 3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by Manufacturer's representatives. Adjust schedule for interruptions in operability of equipment.
- C. Lesson Plan: When Manufacturer or vendor training of Owner personnel is specified, prepare for each required course, containing the following minimum information:
 - 1. Title and objectives.
 - 2. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
 - 3. Course description and outline of course content.
 - 4. Format (e.g., lecture, self-study, demonstration, hands-on).
 - 5. Instruction materials and equipment requirements.
 - 6. Resumes of instructors providing the training.
- D. Pre-startup Training:
 - 1. Coordinate training sessions with Owner's operating personnel and Manufacturer's representatives, and with submission of operation and maintenance manuals in accordance with Section 01780, OPERATIONS AND MAINTENANCE DATA.

2. Complete at least 14 days prior to beginning of facility startup.
- E. Post-startup Training: If required in Specifications furnish and coordinate training of Owner's operating personnel by respective Manufacturer's representatives.
- F. Taping of Training Sessions:
1. Furnish audio and color video taping of all instruction sessions, including Manufacturer's representatives, hands-on equipment instruction and classroom sessions.
 2. Video training DVDs shall be produced by a qualified, professional video specialist approved by Owner.
 3. Use DVD format, suitable for playback on standard equipment available commercially in the United States.

3.5 EQUIPMENT TESTING

- A. Preparation:
1. Complete installation before testing.
 2. Furnish qualified Manufacturer's representatives, when required by individual Specification sections.
 3. Obtain and submit from equipment Manufacturer's representative Manufacturer's Certificate of Proper Installation Form when required by individual Specification sections.
 4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
 - a. Owner/Project Name.
 - b. Equipment or item tested.
 - c. Date and time of test.
 - d. Type of test performed (Functional or Performance).
 - e. Test method.
 - f. Test conditions.
 - g. Test results.
 - h. Signature spaces for Contractor and Engineer as witness.
 5. Cleaning and Checking: Prior to beginning functional testing:
 - a. Calibrate testing equipment in accordance with Manufacturer's instructions.
 - b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
 - c. Lubricate equipment in accordance with Manufacturer's instructions.
 - d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f. Check power supply to electric-powered equipment for correct voltage.
 - g. Adjust clearances and torque.
 - h. Test piping for leaks.
 6. Ready-to-test determination will be by Engineer-based at least on the following:
 - a. Acceptable Operation and Maintenance Data.
 - b. Notification by Contractor of equipment readiness for testing.
 - c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
 - d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
 - e. Availability and acceptability of Manufacturer's representative, when specified, to assist in testing of respective equipment.
 - f. Satisfactory fulfillment of other specified Manufacturer's responsibilities.
 - g. Equipment and electrical tagging complete.
 - h. Delivery of all spare parts and special tools.
- B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When in Engineer's opinion, equipment meets functional requirements specified such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.6 STARTUP OF UNIT PROCESSES

- A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.
- B. Startup sequencing of unit processes shall be as chosen by Contractor to meet schedule requirements.
- C. Make adjustments, repairs, and corrections necessary to complete unit process startup.
- D. Startup shall be considered complete when, in opinion of Engineer, unit process as operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.
- E. Significant Interruption: May include any of the following events:
 1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
 2. Failure to meet specified functional operation for more than 2 consecutive hours.
 3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
 4. Failure of any non-critical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
 5. As determined by Engineer.
- F. A significant interruption will require startup then in progress to be stopped. After corrections are made; start up test period and start from beginning again.

3.7 FACILITY PERFORMANCE DEMONSTRATION

- A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.
- B. Demonstrate proper operation of required interfaces within and between individual unit processes.

- C. After facility is operating, complete performance testing of equipment and systems not previously tested.
- D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility.
- E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic operation.

3.8 SUPPLEMENTS

- A. Supplements listed below, following “End of Section”, are a part of this Specification:
 - 1. Manufacturer’s Certificate of Proper Installation Form.
 - 2. Unit Process Startup Form.
 - 3. Facility Performance Demonstration/Certification Form.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER: Town of Addison EQUIP. SERIAL NO: _____ EQUIP. TAG NO:

_____ EQUIP. SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above referenced equipment/system has been:

(Check Applicable)

<input type="checkbox"/>	Installed in accordance with Manufacturer's recommendations.
<input type="checkbox"/>	Inspected, checked, and adjusted.
<input type="checkbox"/>	Serviced with proper initial lubricants.
<input type="checkbox"/>	Electrical and mechanical connections meet quality and safety standards.
<input type="checkbox"/>	All applicable safety equipment has been properly installed.
<input type="checkbox"/>	Functional tests.
<input type="checkbox"/>	System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments:

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate its equipment, and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20__.

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

UNIT PROCESS STARTUP FORM

OWNER: _____ Town of Addison _____ PROJECT: _____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure: (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):

Evaluation Comments:

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER: _____ Town of Addison _____ PROJECT: _____

Unit Process Description: (List unit processes involved in facility startup):

Unit Processes Startup Sequence: (Describe sequence for startup, including computerized operations if any):

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ Date: _____, 20 ____

Engineer: _____ Date: _____, 20 ____

SECTION 01795 WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

1.3 RELATED WORK

- A. Refer to General Conditions of the Contract for the general requirements relating to warranties and bonds.
- B. General closeout requirements are included in Section 01770 – CLOSEOUT PROCEDURE.
- C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted are included in the individual Sections of the Specifications.
- D. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

1.4 SUBMITTALS

- A. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within fifteen days of completion of that designated portion of the Work.
- C. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Engineer for approval prior to final execution.

- D. Refer to individual Sections of the Specifications for specific content requirements, and particular requirements for submittal of special warranties.
- E. At Final Completion, compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- F. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-in. by 11-in. paper.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification Section in which specified, and the name of the product or work item.
- H. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer, supplier, and manufacturer.
- I. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name, address, and telephone numbers of the Contractor and equipment supplier.
- J. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.
- K. Schedule of Special Warranties
 - 1. The manufacturer of the coating system shall provide the Owner a minimum warranty of ten (15) years on the surface preparation and coating.

1.5 WARRANTY REQUIREMENT

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.

1.6 DEFINITION

- A. Standard Product Warranties are pre-printed written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 02410 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Portions of buildings and other areas, equipment and materials selective demolition, and partial demolition work are as shown on Drawings and specified herein.
 - 2. Equipment and materials to be removed for construction and reinstalled for reuse or continued operation are as shown on the drawings and specified herein.

1.2 SUBMITTALS

- A. Shop Drawings: Plans showing all equipment and materials to be removed and reinstalled for reuse on continued operation including interim storage plans for each item.
- B. Quality Control Submittals:
 - 1. Schedule of demolition, as part of and consistent with the progress schedule
 - 2. Methods of demolition and equipment proposed to demolish each structure.
 - 3. Copies of any authorizations and permits required to perform Work.

PART 2 - PRODUCTS

(NOT USED) PART 3 -

EXECUTION

3.1 PREPARATION

- A. Utilities:
 - 1. Notify Owner and appropriate utilities 72 hours prior to turning off affected services before starting demolition or alterations.
- B. Removal and Storage of Equipment for Reuse:
 - 1. Do not remove equipment and materials without approval of Engineer.
 - 2. Properly store and maintain equipment and materials in same condition as when removed.
 - 3. Engineer will determine condition of equipment and materials prior to removal.

3.2 DEMOLITION

- A. Drawings define minimum portion of equipment to be removed and structures to be modified. Unless otherwise shown, rough cuts or breaks may not be made exceeding limits of demolition shown.
- B. Provide all demolition, removal, temporary storage, and reinstallation of existing equipment as required for implementation of the work.
- C. Remove all materials associated with existing equipment that is to be removed or relocated.

3.3 DISPOSAL

- A. Dispose of debris and other non-salvaged materials offsite in licensed landfills.

3.4 SALVAGE

A. Equipment and materials not reused or reinstalled, including all metals and piping within the limits of demolition, unless otherwise specified, shall be delivered to the Owner for scrap. If Owner refuses the material, contractor is responsible for disposal.

END OF SECTION

SECTION 09900 - PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Exposed, buried, and submerged metal, exposed PVC and CPVC, exposed FRP, and aluminum and dissimilar metals, to be protective painted, whether specifically mentioned or not, except as specified otherwise. Prime coat structural steel surfaces. Exterior concrete surfaces will not be protective painted unless specifically indicated. Interior concrete surfaces will be protective painted as specified herein.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. ASTM International (ASTM):
 - a. D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - b. D 4541 - Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
 2. NACE International (NACE):
 - a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
 - b. SP0188-06 - Discontinuity (Holiday) Testing of Protective Coatings.
 3. National Association of Pipe Fabricators (NAPF):
 - a. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
 4. NSF International (NSF):
 - a. 61 - Drinking Water System Components - Health Effects.
 5. Society for Protective Coatings (SSPC):
 - a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors.
 - b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
 - c. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.
 - d. SP-1 - Solvent Cleaning.
 - e. SP-2 - Hand Tool Cleaning.
 - f. SP-3 - Power Tool Cleaning.
 - g. SP-5 - White Metal Blast Cleaning.
 - h. SP-6 - Commercial Blast Cleaning.
 - i. SP-7 - Brush-Off Blast Cleaning.
 - j. SP 8, Pickling.
 - k. SP-10 - Near-White Blast Cleaning.
 - l. SP 11-T, Power Tool Cleaning to Bare Metal.
 - m. SP 13, Surface Preparation of Concrete.
 - n. Guide No. 3, PA, Guide to Safety in Painting Applications.
 6. U.S. Environment Protection Agency (EPA):
 - a. Method 24 - Surface Coatings.
 7. NACE International (NACE):
 - a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
 - b. SP0188-06 - Discontinuity (Holiday) Testing of Protective Coatings.
 8. National Association of Pipe Fabricators (NAPF):
 - a. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
 9. NSF International (NSF):
 - a. 61 - Drinking Water System Components - Health Effects.

10. Society for Protective Coatings (SSPC):
 - a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors.
 - b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
 - c. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.
 - d. SP-1 - Solvent Cleaning.
 - e. SP-2 - Hand Tool Cleaning.
 - f. SP-3 - Power Tool Cleaning.
 - g. SP-5 - White Metal Blast Cleaning.
 - h. SP-6 - Commercial Blast Cleaning.
 - i. SP-7 – Brush-Off Blast Cleaning.
 - j. SP 8, Pickling.
 - k. SP-10 – Near-White Blast Cleaning.
 - l. SP 11-T, Power Tool Cleaning to Bare Metal.
 - m. SP 13, Surface Preparation of Concrete.
 - n. Guide No. 3, PA, Guide to Safety in Painting Applications.
11. U.S. Environment Protection Agency (EPA):
 - a. Method 24 - Surface Coatings.

1.3 DEFINITIONS

- A. Terms used in this section:
 1. Submerged metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.
 2. Submerged concrete and masonry surfaces: Surfaces which are or will be:
 3. Underwater.
 4. In structures which normally contain water.
 5. Below tops of walls of water containing structures.
 6. Exposed surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.
 7. Dry film thickness (DFT): Thickness of fully cured coating, measured in mils.
 8. Volatile organic compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.
 9. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
 10. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.
 11. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
 12. FRP: Fiberglass Reinforced Plastic.
 13. HCl: Hydrochloric Acid.
 14. MDFT: Minimum Dry Film Thickness.
 15. MDFTPC: Minimum Dry Film Thickness per Coat.
 16. Mil: Thousandth of an inch.
 17. Military Specification-Paint.
 18. PSDS: Paint System Data Sheet.
 19. SFPG: Square Feet per Gallon.
 20. SFPGPC: Square Feet per Gallon per Coat.
 21. SP: Surface Preparation.

1.4 PERFORMANCE REQUIREMENTS

- A. Coating materials shall be especially adapted for use in potable water applications.
- B. Coating materials used in contact with potable water supply systems shall be certified to NSF 61.

1.5 SUBMITTALS

- A. General: Submit in accordance with Section 01330 SUBMITTAL PROCEDURES.
- B. Shop Drawings:
 - 1. Schedule of proposed coating materials.
 - 2. Schedule of surfaces to be coated with each coating material.
- C. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
 - 1. Data Sheets:
 - a. For each paint system, furnish a Paint System Data Sheet (PSDS), the Manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system. The PSDS form is appended to the end of this section.
 - b. Submit required information on a system-by-system basis.
 - c. Furnish copies of paint system submittals to the coating applicator.
 - d. Indiscriminate submittal of Manufacturer's literature only is not acceptable.
 - e. Regulatory requirements: Submit data concerning the following:
 - f. Volatile organic compound limitations.
 - g. Coatings containing lead compounds and PCBs.
 - h. Abrasives and abrasive blast cleaning techniques, and disposal.
 - i. NSF certification of coatings for use in potable water supply systems.
- D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.
- E. Certificates: Submit in accordance with requirements for Product Data.
- F. Manufacturer's Instructions: Include the following:
 - 1. Special requirements for transportation and storage.
 - 2. Mixing instructions.
 - 3. Shelf life.
 - 4. Pot life of material.
 - 5. Precautions for applications free of defects.
 - 6. Surface preparation.
 - 7. Method of application.
 - 8. Recommended number of coats.
 - 9. Recommended dry film thickness (DFT) of each coat.
 - 10. Recommended total dry film thickness (DFT).
 - 11. Drying time of each coat, including prime coat.
 - 12. Required prime coat.
 - 13. Compatible and non-compatible prime coats.
 - 14. Recommended thinners, when recommended.
 - 15. Limits of ambient conditions during and after application.
 - 16. Time allowed between coats (minimum and maximum).
 - 17. Required protection from sun, wind, and other conditions.
 - 18. Touch-up requirements and limitations.
 - 19. Minimum adhesion of each system submitted in accordance with ASTM D 4541.
- G. Manufacturer's Representative's Field Reports.
- H. Operations and Maintenance Data: Submit as specified in Section 01770 CLOSEOUT PROCEDURES.

1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
2. Reports on visits to project site to observe and approve coating application procedures.
3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

1.6 QUALITY ASSURANCE

- A. Quality Assurance Submittals:
1. Quality Assurance plan.
 2. Qualifications of coating applicator including List of Similar Projects and List of References substantiating experience.
 3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
 4. If the Manufacturer of finish coating differs from that of shop primer, provide both Manufacturers' written confirmation that materials are compatible.
 5. Manufacturer's written instructions and special details for applying each type of paint.
 6. Manufacturers' Certification of Proper Installation.
- B. Certifications: All paints and coatings to be used on this project comply with current federal, state, and local VOC regulations
- C. Applicator qualifications:
1. Minimum of 5 years' experience applying specified type or types of coatings under conditions similar to those of the Work:
 2. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
 3. Manufacturer approved applicator when manufacturer has approved applicator program.
 4. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
 5. Approved and licensed by elastomeric polyurethane (100 percent solids) manufacturer to apply 100 percent solids elastomeric polyurethane system.
 6. Applicator of off-site application of coal tar epoxy shall have successfully applied coal tar epoxy on similar surfaces in material, size, and complexity as on the Project.
- D. Regulatory requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead:
1. Do not use coal tar epoxy in contact with drinking water or exposed to ultraviolet radiation.
 2. Perform surface preparation and painting in accordance with recommendations of the following:
 3. Paint Manufacturer's instructions.
 4. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
 5. Federal, state, and local agencies having jurisdiction.
- E. Samples:
1. Reference Panel:
 - a. Prior to start of surface preparation, furnish a 4" by 4" steel panel for each grade of sandblast specified herein, prepared to specified requirements.
 - b. Provide panel representative of the steel used; prevent deterioration of surface quality.
 - c. Upon approval of Engineer, panel to be reference source for inspection.
 - d. Unless otherwise specified, before painting work is started, prepare minimum 8" by 10" samples with type of paint and application specified on similar substrate to which paint is to be applied.
 - e. Furnish additional samples as required until colors, finishes, and textures are approved.

- f. Approved samples to be the quality standard for final finishes.
 - g. Field samples:
 - h. Prepare and coat a minimum 100 square foot area between corners or limits such as control or construction joints of each system.
 - i. Approved field sample may be part of Work.
 - j. Obtain approval before painting other surfaces.
- F. Pre-installation conference: Conduct as specified in Section 01300 PROJECT MEETINGS.
- G. Compatibility of coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.
- H. Services of coating manufacturer's representative: Arrange for coating manufacturer's representative to attend pre-installation conferences. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be "shop primed and coated".
- I. Contract Closeout Submittals: Special guarantee.
- 1.7 PRODUCT DELIVERY, STORAGE AND HANDLING
- A. Deliver, store, and handle products as specified in Section 01601 PRODUCT REQUIREMENTS.
- B. Remove unspecified and unapproved paints from Project site immediately.
- C. Deliver new unopened containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.
- 1. Do not deliver materials aged more than 12 months from manufacturing date.
- D. Store coatings in well-ventilated facility that provides protection from the sun, weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.
- E. Take precautions to prevent fire and spontaneous combustion.
- F. Shipping:
- 1. Where pre-coated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
 - 2. Use nonmetallic or padded slings and straps in handling.
- 1.8 PROJECT CONDITIONS
- A. Surface moisture contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
- 1. Plaster and gypsum wallboard: 12 percent.
 - 2. Masonry, concrete, and concrete block: 12 percent.
 - 3. Interior located wood: 15 percent.
 - 4. Concrete floors: 7 percent.
- B. Do not apply coatings:
- 1. Under dusty conditions or adverse environmental conditions, unless tenting, covers, or other such protection is provided for structures to be coated.

2. When light on surfaces measures less than 15 foot-candles.
 3. When ambient or surface temperature is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
 4. When relative humidity is higher than 85 percent.
 5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
 6. When surface temperature exceeds the manufacturer's recommendation.
 7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
 8. Apply clear finishes at minimum 65 degrees Fahrenheit.
- C. Provide fans, heating devices, dehumidifiers, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
- D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 55 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes.
- E. Dehumidification and heating for coating of digester interiors, wet wells, and high humidity enclosed spaces:
1. Provide dehumidification and heating of digester interior spaces in which surface preparation, coating application, or curing is in progress according to the following schedule:
 - a. October 1 to April 30: Provide continuous dehumidification and heating as required to maintain the tanks within environmental ranges as specified in this Section and as recommended by the coating material manufacturer. For the purposes of this Section, "continuous" is defined as 24 hours per day and 7 days per week.
 - b. May 1 to September 30: Provide temporary dehumidification and heating as may be required to maintain the tanks within the specified environmental ranges in the event of adverse weather or other temporary condition. At CONTRACTOR's option and at his sole expense, CONTRACTOR may suspend work until such time as acceptable environmental conditions are restored, in lieu of temporary dehumidification and heating. Repair or replace any coating or surface preparation damaged by suspension of work, at CONTRACTOR's sole expense.
 2. Equipment requirements:
 - a. Capacity: Provide dehumidification, heating, and air circulation equipment with minimum capacity to perform the following:
 - 1) Maintain the dew point of the air in the tanks at a temperature at least 5 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is underway.
 - 2) Reduce dew point temperature of the air in the tanks by at least 10 degrees Fahrenheit in 20 minutes.
 - 3) Maintain air temperature in the tanks at 60 degrees minimum.
 - b. Systems:
 - 1) Internal combustion engine generators: May be used; CONTRACTOR shall obtain all required permits and provide air pollution and noise control devices on equipment as required by permitting agencies.]
 - 2) Dehumidification: Provide desiccant or refrigeration drying. Desiccant types shall have a rotary desiccant wheel capable of continuous operation. No Liquid, granular, or loose lithium chloride drying systems will be allowed.
 - 3) Heating: Electric, indirect combustion, or steam coil methods may be used. Direct fired combustion heaters will not be allowed during abrasive blasting, coating application, or coating cure time.
 3. Design and submittals:
 - a. CONTRACTOR shall prepare dehumidification and heating plan for this project, including all equipment and operating procedures.

- b. Suppliers of services and equipment shall have not less than 3 years' experience in similar applications.
 - c. Supplier: The following or equal:
 - 1) Cargocaire Corporation (Munters) or equal.
 - d. Submit dehumidification and heating plan for ENGINEER's review.
4. Monitoring and performance:
- a. Measure and record relative humidity and temperature of air, and structure temperature twice daily (beginning and end of work shifts) to verify that proper humidity and temperature levels are achieved inside the work area after the dehumidification equipment is installed and operational. Test results shall be made available to the ENGINEER upon request.
 - b. Interior space of the working area and tank(s) shall be sealed and a slight positive pressure maintained as recommended by the supplier of the dehumidification equipment.
 - c. The filtration system used to remove dust from the air shall be designed so that it does not interfere with the dehumidification equipment's ability to control the dew point and relative humidity inside the reservoir.
 - 1) The air from the tank, working area, or dust filtration equipment shall not be recirculated through the dehumidifier during coating application or when solvent vapors are present.

1.9 SEQUENCING AND SCHEDULING

- A. Sequence and Schedule coating application as specified by the MANUFACTURER.

1.10 SPECIAL GUARANTEE

- A. Furnish Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of work specified in this Specification section found *defective* during a period of 1 year after the date of Substantial Completion.
- B. Contractor and paint Manufacturer shall jointly and severally furnish guarantee.

1.11 MAINTENANCE

- A. Extra materials: Deliver as specified in Section 01770. Include minimum 1 gallon of each type and color of coating applied:
 - 1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
 - 2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Special coatings: One of the following or equal:
 - 1. Carboline: Carboline, St. Louis, MO.
 - 2. Ceilcote: International Protective Coatings, Berea, OH.
 - 3. Dampney: The Dampney Company, Everett, MA.
 - 4. Devoe: International Protective Coatings, Louisville, KY.
 - 5. Dudick: Dudick, Inc., Streetsboro, OH.
 - 6. GET: Global Eco Technologies, Pittsburg, CA.

7. Henkel: Henkel North America, Madison Heights MI.
8. IET: Integrated Environmental Technologies, Santa Barbara, CA.
9. Induron Protective Coatings, Birmingham, AL.
10. PPG Amercoat: PPG Protective & Marine Coatings, Brea, CA.
11. Raven Lining Systems, Broken Arrow, OK.
12. Rustoluem : Rustoleum Corp., Sommerset, NJ.
13. Sanchem: Sanchem, Chicago, IL.
14. Superior: Superior Environmental Products, Inc., Addison, TX.
15. S-W: Sherwin-Williams Co., Cleveland, OH.
16. Tnemec: Tnemec Co., Kansas City, MO.
17. Wasser: Wasser High Tech Coatings, Kent, WA.
18. ZRC: ZRC Worldwide Innovative Zinc Technologies, Marshfield, MA.

2.2 PREPARATION AND PRETREATMENT MATERIALS

- A. Metal pretreatment: As manufactured by one of the following or equal:
1. Henkel: Galvaprep 5.
 2. International: AWLGrip Alumiprep 33.
- B. Surface cleaner and degreaser: As manufactured by one of the following or equal:
1. Carboline Surface Cleaner No.3.
 2. Devoe: Devprep 88.
 3. S-W: Clean and Etch.

2.3 COATING MATERIALS

- A. Alkali resistant bitumastic: As manufactured by one of the following or equal:
1. Carboline: Bitumastic No. 50.
 2. S-W: Targuard.
 3. Wasser: MC-Tar.
- B. Wax coating: As manufactured by the following or equal:
1. Sanchem: No-Ox-Id A special.
- C. High solids epoxy (self-priming) not less than 72 percent solids by volume: As manufactured by one of the following or equal:
1. Carboline: Carboguard 891.
 2. Devoe: Bar Rust 233H.
 3. Induron: PE-70
 4. PPG Amercoat: Amerlock 2.
 5. S-W: Macropoxy 646.
 6. Tnemec: HS Epoxy Series 104.
- D. Aliphatic or aliphatic-acrylic polyurethane: As manufactured by one of the following or equal:
1. Carboline: Carbothane 134 VOC.
 2. Devoe: Devthane 379.
 3. PPG Amercoat: Amershield VOC.
 4. S-W: High Solids Polyurethane [CA].
 5. Tnemec: Endura-Shield II Series 1075 (U).
- E. Epoxy Novolac: Multi-component aggregate-filled epoxy system specifically designed for exposure to municipal wastewater. As manufactured by one of the following or equal:
1. Sauereisen: Sewergard No. 210, 210S, or 210GL
 2. Carboline: Plasite 4550 S
 3. Devoe: Devmat 100

4. Raven 410

- F. High temperature coating 150 to 350 degrees Fahrenheit: As manufactured by one of the following or equal:
 1. Carboline: Thermaline 4900.
 2. Dampney: Thermalox 245 Silicone - Zinc Dust.
 3. PPG Amercoat: Amerlock 2/400 GFK.

- G. High temperature coating 400 to 1,000 degrees Fahrenheit (dry): As manufactured by one of the following or equal:
 1. Carboline: Thermaline 4700.
 2. Dampney: Thermolox 230C Series Silicone.
 3. Devoe: HT-12, High Heat Silicone.

- H. High temperature coating up to 1,400 degrees Fahrenheit: As manufactured by the following or equal:
 1. Dampney: Thermalox 240 Silicone Ceramix.

- I. Asphalt varnish: AWWA C 500.

- J. Protective coal tar: As manufactured by one of the following or equal:
 1. Carboline: Bitumastic No. 50.
 2. PPG Amercoat: 78HB

- K. Coal tar epoxy: As manufactured by one of the following or equal:
 1. Carboline: 300-M, Bitumastic.
 2. PPG Amercoat: 78HB.
 3. S-W: Tar Guard 100.
 4. Tnemec: Series 46H-413.

- L. Vinyl ester: Glass mat reinforced, total system 125 mils DFT. As manufactured by one of the following or equal:
 1. Carboline: Semstone 870.
 2. Ceilcote: 6640 Ceilcrete.
 3. Dudick: Protecto-Flex 800.
 4. Tnemec: Chembloc Series 239SC.

- M. Elastomeric polyurethane, 100 percent solids, ASTM D 16, Type V, (Urethane P): As manufactured by the following or equal:
 1. GET: Endura-Flex EF-1988.

- N. Concrete floor coatings: As manufactured by one of the following or equal:
 1. Carboline: Semstone 140SL.
 2. Devoe: Devran 124.
 3. Dudick: Polymer Alloy 1000.
 4. Tnemec: Tneme-Glaze Series 282.

- O. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
 1. S-W: DTM Acrylic B66W1.
 2. Tnemec: Tneme-Cryl Series 6.

- P. Galvanizing Zinc Compound: As manufactured by one of the following or equal:
 1. ZRC: Cold Galvanizing Compound.

2.4 MIXES

- A. Mix in accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

- A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:
- B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
 - 1. Mask off surfaces of items not to be coated or remove items from area.
- C. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.
- D. Place cotton waste, cloths, and material which may constitute fire hazard in closed metal containers and remove daily from site.
- E. Remove electrical plates, surface hardware, fittings, and fastenings, prior to application of coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.2 GENERAL PREPARATION

- A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Section.
- B. Protect following surfaces from abrasive blasting by masking, or other means:
 - 1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
 - 2. Machined surfaces for sliding contact.
 - 3. Surfaces to be assembled against gaskets.
 - 4. Surfaces of shafting on which sprockets are to fit.
 - 5. Surfaces of shafting on which bearings are to fit.
 - 6. Machined surfaces of bronze trim, including those slide gates.
 - 7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
 - 8. Galvanized items, unless scheduled to be coated.
- C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.
- D. Concrete:
 - 1. Allow new concrete to cure for minimum of 28 days before coating.
 - 2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Etch or brush off-blast clean in accordance with SSPC SP-7 to provide surface profile equal to 40 to 60-grit sandpaper, or as recommended by coating manufacturer. All concrete surfaces shall be vacuumed clean prior to coating application.
- E. Ferrous metal surfaces:
 - 1. Remove grease and oil in accordance with SSPC SP-1.

2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified.
 3. Abrasive blast surfaces prior to coating.
 - a. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
 - b. When metal surfaces are exposed because of coating damage, abrasive blast surfaces and feather in to a smooth transition before touching-up.
 - c. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC SP-10, unless blasting may damage adjacent surfaces, prohibited or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP-3.
 - d. Ferrous metal surfaces to be submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP-5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.
 4. All abrasive blast cleaned surfaces shall be blown down with clean dry air and or vacuumed.
- F. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.
- G. Sherardized, aluminum, copper, and bronze surfaces: Prepare in accordance with coating manufacturer's instructions.
- H. Galvanized surface:
1. Degrease or solvent clean (SSPC SP-1) to remove oily residue.
 2. Power tool or hand tool clean or whip abrasive blast.
 3. Test surface for contaminants using copper sulfate solution.
 4. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.
- I. Shop primed metal:
1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
 2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP-10, unless greater degree of surface preparation is required by coating manufacturer's representative.
 3. Correct abraded, scratched, or otherwise damaged areas of prime coat by sanding or abrasive blasting to bare metal in accordance with SSPC SP-2, SP 3, or SP-6, as directed by the ENGINEER.
 4. When entire shop priming fails or has weathered excessively (more than 25 percent of the item), or when recommended by coating manufacturer's representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-10.
 5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-10.
 6. When prime coat not authorized by ENGINEER is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP-10.
 7. Shop applied bituminous paint or asphalt varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.
- J. Cadmium-plated, zinc-plated, or sherardized fasteners:
1. Abrasive blast in same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.

- K. Abrasive blast components to be attached to surfaces which cannot be abrasive blasted before components are attached.
- L. Grind sharp edges to approximately 1/16-inch radius before abrasive blast cleaning.
- M. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning in accordance with NACE SP0178.
- N. PVC and FRP Surfaces:
 - 1. Prepare surfaces to be coated by light sanding (de-gloss) and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.
- O. Cleaning of previously coated surfaces:
 - 1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
 - a. Cleaning agent: Biodegradable non-flammable and containing no volatile organic compounds.
 - b. Manufacturer: The following or equal:
 - 1) Chlor-Rid International, Inc.
 - 2. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
 - 3. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
 - 4. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions.

3.3 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

- A. Remove grilles, covers, and access panels for mechanical and electrical system from location and coat separately.
- B. Prepare and finish coat-primed equipment with color selected by the ENGINEER.
- C. Prepare and prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with prefinished coating.
- D. Replace identification markings on mechanical or electrical equipment when coated over or spattered.
- E. Prepare and coat interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.
- F. Prepare and coat dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.
- G. Prepare and coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.
- H. Prepare and coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

- I. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with Contract Documents.

3.4 GENERAL APPLICATION REQUIREMENTS

- A. Apply coatings in accordance with manufacturer's instructions.
- B. Coat metal unless specified otherwise:
 - 1. Aboveground piping to be coated shall be empty of contents during application of coatings.
- C. Verify metal surface preparation immediately before applying coating in accordance with SSPC SP COM.
- D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
- E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.
- F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.
- G. Multiple coats:
 - 1. Apply minimum number of specified coats.
 - 2. Apply additional coats when necessary to achieve specified thicknesses.
 - 3. Apply coats to thicknesses specified, especially at edges and corners.
 - 4. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
 - 5. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.
 - 6. Dust coatings between coats.
- H. Coat surfaces without drops, overspray, dry spray, runs, ridges, waves, holidays, laps, or brush marks.
- I. Remove spatter and droppings after completion of coating.
- J. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.
- K. Plural component application: Drums shall be premixed each day. All gauges shall be working order prior to the start of application. Ratio checks shall be completed prior to each application. A spray sample shall be sprayed on plastic sheeting to insure set time is complete prior to each application. Hardness testing shall be performed after each application.
- L. Spray application:
 - 1. Stripe coat edges, welds, nuts, bolts, difficult to reach areas by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
 - 2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for spray application.
 - 3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
 - 4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

- M. Drying and recoating:
1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
 2. For submerged service the CONTRACTOR shall provide a letter to the ENGINEER that the lining system is fully cured and ready to be placed into service.
 3. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
 4. Do not allow excessive drying time or exposure which may impair bond between coats.
 5. Recoat epoxies within time limits recommended by coating manufacturer.
 6. When time limits are exceeded, abrasive blast clean and de-gloss clean prior to applying another coat.
 7. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
 8. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
 9. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
 10. Leave no holidays.
 11. Sand and feather in to a smooth transition and recoat and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.
- N. Concrete:
1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.5 ALKALI RESISTANT BITUMASTIC

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.
- B. Application:
1. Apply in accordance with general application requirements and as follows:
 - a. Apply at least 2 coats, 8 to 14 mils dry film thickness each.

3.6 WAX COATING

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.
- B. Application:
1. Apply in accordance with general application requirements and as follows:
 - a. Apply at least 1/32-inch thick coat with 2-inch or shorter bristle brush.
 - b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.7 HIGH SOLIDS EPOXY SYSTEM

- A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP-5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-10.

- b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP-10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 6.
- c. Abrasive blast clean ductile iron surfaces at jobsite in accordance with SSPC SP-7.

B. Application:

- 1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply minimum 2-coat system with minimum total dry film thickness (DFT) of 12 mils.
 - b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
 - c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish, and to prevent damage to other surfaces.
 - d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
 - e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.8 HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:

- 1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Prepare concrete surfaces in accordance with general preparation requirements.
 - b. Touch up shop primed steel and miscellaneous iron.
 - c. Abrasive blast ferrous metal surfaces at jobsite prior to coating. Abrasive blast clean rust and discoloration from surfaces.
 - d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
 - e. Lightly sand (de-gloss) fiberglass and poly vinyl chloride (PVC) pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer's instructions.
 - f. Abrasive blast clean ductile iron surfaces.

B. Application:

- 1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply 3 coat system consisting of:
 - 1) Primer: 4 to 5 mils dry film thickness high solids epoxy.
 - 2) Intermediate coat: 4 to 5 mils dry film thickness high solids epoxy.
 - 3) Topcoat: 2.5 to 3.5 mils dry film thickness aliphatic or aliphatic-acrylic polyurethane topcoat.
- 2. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer's instructions.

3.9 EPOXY NOVOLAC SYSTEM

A. Preparation:

- 1. Prepare surfaces in accordance with general preparation requirements and as follows:
- 2. Prepare concrete to obtain clean, open pore with exposed aggregate in accordance with manufacturer's instructions.
- 3. Prepare ferrous metal surfaces in accordance with SSPC SP-5, with coating manufacturer's recommended anchor pattern.
- 4. Complete application of prime coat within 6 hours of abrasive blast cleaning. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-5.
- 5. When handling steel, wear gloves to prevent hand printing.

6. Adjust pH of concrete to within 7 to 11 before applying prime coat.

B. Application:

1. Apply coatings in accordance with general application requirements and in accordance with manufacturer's instructions.
2. Continue to monitor dew point. Dew point shall remain 5 degrees above ambient temperature for a minimum of 8 hours after application of coating.

3.10 HIGH TEMPERATURE COATING

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements and as follows:
 - a. Abrasive blast surface in accordance with SSPC SP-10.

B. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply number of coats in accordance with manufacturer's instructions.

3.11 ASPHALT VARNISH

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements.

B. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply minimum 2 coats.

3.12 PROTECTIVE COAL TAR

A. Preparation:

1. Prepare surfaces in accordance with general preparation coal tar requirements.

B. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Apply minimum 20 mils dry film thickness coating.

3.13 COAL TAR EPOXY

A. Preparation:

1. Prepare surfaces in accordance with general preparation requirements and as follows:

B. Abrasive blast iron or steel surfaces to be coated as submerged metal in accordance with SSPC SP-5. Prepare other metal surfaces to be coated with coal tar epoxy in accordance with epoxy manufacturer's instructions.

C. Application:

1. Apply coatings in accordance with general application requirements and as follows:
 - a. Waterproofing outside surfaces of concrete structures: Apply minimum 2 coats with total dry film thickness of 40 mils.
 - b. Apply 2 coats of [8 mils] each for a total [16 mils] dry film thickness.
 - c. Apply coal tar epoxy on blasted steel on same day that steel is blasted.
 - d. Apply succeeding coats over previous coat as soon as application does not cause sagging, within the following times, or as recommended by the coating manufacturer, whichever is sooner.

Average Temperature Degrees (Fahrenheit)	Maximum Time Between Coats (Hours)
50 to 60	36
60 to 70	24
70 to 80	12
80 to 120	4

- e. Apply additional coats required to obtain specified thickness.
- f. When previous coat has cured or set or Maximum Time Between Coats has lapsed, abrasive blast previous coat until surface film is removed. Wash and clean surface with cleaning solvent. Apply succeeding coat within Maximum Time Between Coats or as recommended by coating manufacturer, whichever is sooner.
- g. When succeeding coat is applied over previous coat which has cured or set or Maximum Time Between Coats has lapsed, and surface has not been abrasive blasted, remove entire coating system to substrate, and apply new coatingsystem.
- h. Where coating system is applied to exterior concrete surfaces below grade, extend system at least 3 inches above finish grade in straight level. Step extended system down 3 inches when extended system reaches 6 inches above finish grade.

3.14 VINYL ESTER

A. Preparation:

- 1. Prepare surfaces in accordance with coating manufacturer's recommendations and as directed and approved by coating manufacturer's representative.

B. Application:

- 1. Apply prime coat, as required by coating manufacturer, base coat, glass mat, and topcoat to total dry film thickness of 125 mils minimum:
 - a. Final topcoat on floors shall include non-skid surface, applied in accordance with manufacturer's instructions.
- 2. Perform high voltage holiday detection test in accordance with SP0188-06, over 100 percent of coated surface areas to ensure pinhole free finished coating system.
- 3. All work shall be accomplished in strict accordance with coating manufacturer's instructions and under direction of coating manufacturer's representative.

3.15 ELASTOMERIC POLYURETHANE (100 PERCENT SOLIDS)

A. Preparation:

- 1. Prepare surfaces in strict accordance with coating manufacturer's instructions and as directed and approved by coating manufacturer's representative.

B. Application:

- 1. Apply epoxy primer at DFT of 1 to 2 mils, in strict accordance with manufacturer's instructions.
- 2. Apply polyurethane coating at minimum total DFT as follows:
 - a. Steel: 60 mils DFT.
 - b. Ductile iron and ductile iron pipe coating and lining: 30 mils DFT.
 - c. Concrete: 120 mils DFT.
 - d. Or as recommended by the coating manufacturer and accepted by theENGINEER.

C. For concrete application, provide saw cutting for coating terminations in strict accordance with manufacturer's instructions:

- D. Perform high voltage holiday detection test in accordance with SP0188-06, over 100 percent of coated surface areas to ensure pinhole free finished coating system.

3.16 CONCRETE FLOOR COATINGS

- A. Preparation:
 - 1. Prepare surfaces in accordance with general application requirements and in strict accordance with coating manufacturer's instructions.
- B. Application:
 - 1. Apply primer if required by coating manufacturer.
 - 2. Apply 1 or more coats as recommended by coating manufacturer to receive a minimum total dry film thickness of 25 mils, color as selected by OWNER.
- C. Final topcoat shall include non-skid surface, applied in strict accordance with coating manufacturer's instructions.

3.17 WATERBORNE ACRYLIC EMULSION

- A. Preparation:
 - 1. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning in accordance with SSPC SP-1.
 - 2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.
- B. Application:
 - 1. Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.18 FIELD QUALITY CONTROL

- A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.
- B. Control and check dry film thicknesses and integrity of coatings.
- C. Measure dry film thickness with calibrated thickness gauge.
- D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gage or Positector 6000.
- E. Verify coat integrity with low-voltage sponge or high-voltage spark holiday detector, in accordance with SP0188 06. Allow ENGINEER to use detector for additional checking.
- F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.
- G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing:
 - 1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
 - 2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

3.19 PROTECTIVE COATINGS SYSTEMS

A. System No. 2: Submerged Metal – Potable General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5)	Primer – High Solids Epoxy (Self Priming)	1 coat, 6 MDFT
	Top Coat – High Solids Epoxy	3 coats, 3 MDFTPC

B. System No. 3: Exposed Metal - Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2.5 MDFT
	Intermediate Coat – High Solids Epoxy	1 coat, 4 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

C. System No. 4: Exposed Metal – Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2.5 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

D. System No. 5: Buried Metal - General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel Blast (SP 10)	Standard Hot Coal-Tar Enamel	AWWA C203
	-OR- Coal-Tar Epoxy	AWWA C210
	-OR- Tape Coat System	AWWA C214
	For Acidic Soil, Brackish Water High Bacteria - Hot Coal-Tar, Double Felt	AWWA C203, App. A, Sec. A1.5
	For Highly Abrasive Soil, Brackish Water - Hot Coal-Tar, Fibrous Glass	AWWA C203, App. A, Sec. A1.5
	-OR- Tape Coat System	AWWA C214 with Double Outer Wrap

E. System No. 6 High Temperature (150° - 350°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Top Coat – High Temperature Coating 150° - 350°	1 coat, 2 MDFT

F. System No. 7 High Temperature (400° - 1000°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Top Coat – High Temperature Coating 400° - 1000°	1 coat, 2 MDFT 1 coat, 1.5 MDFT

G. System No. 8 High Temperature (1000° - 1400°):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP 10)	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Top Coat – High Temperature Coating up to 1400°	1 coat, 1.5 MDFT

H. System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), or Power Tool (SP 3),	Wash Primer or Coating Manufacturer's Recommendation.	1 coat, 0.4 MDFT
		Remaining coats as required by exposure

I. System No. 11 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Primer – Organic Zinc Rich	1 coat, 3 MDFT Additional coats as required by exposure.

J. System No. 12 Skid-Resistant Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
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Brush-off Blast (SP 7) or Plastic Surface Preparation	High Solids Epoxy (aggregated)	1 coat, 16 MDFT
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K. System No. 13 Sliding Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1), followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Wax Coating	1 coat, 31 MDFT

L. System No. 14 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
Plastic Surface Preparation	Primer – Per Manufacturer's Recommendations	1 coat, 2 MDFT
	Waterborne Acrylic Emulsion	1 coat, 3 MDFT

M. System No. 15 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 1	Alkali Resistant Bitumastic or Coal-Tar Epoxy Substitute	1 coat, 18 MDFT

N. System No. 16 Existing Concrete/CMU Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT
	Primer – Per Manufacturer's Recommendations	1 coat, 5 MDFT
	Top Coat – High Solids Epoxy	1 coat, 4 MDFT

O. System No. 17 New Concrete/CMU Exterior (as required by application schedule):

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT

	Intermediate Coat – High Solids Epoxy	1 coat, 4 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 3 MDFT

P. System No. 18 Concrete/CMU – Interior or Immersion Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Filler – Per Manufacturer's Recommendations	1 coat, 10 MDFT
	Intermediate Coat – High Solids Epoxy	1 coat, 6 MDFT
	Top Coat – Aliphatic Polyurethane	1 coat, 6 MDFT

Q. System No. 19 Concrete/CMU – Immersion Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 13	Per Manufacturer's Recommendations	As required by conditions
	Epoxy Novolac	2 coat, 40 MDFT Minimum or as called for on the Project Drawings.

3.20 SCHEDULE OF ITEMS NOT REQUIRING COATING

1. General: Unless specified otherwise, the following items do not require coating:
2. Items that have received final coat at factory and not listed to receive coating in field.
3. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless steel, chrome, Everdur, or lead.
4. Buried or encased piping or conduit.
5. Exterior concrete.
6. Galvanized steel wall framing, galvanized electrical conduits, galvanized pipe trays, galvanized cable trays, and other galvanized items:
 - a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:
 - 1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
 - 2) Apply 2 coats of a Galvanizing Zinc Compound in strict accordance with manufacturer's instructions.
7. Grease fittings.
8. Fiberglass ducting or tanks in concealed locations.
9. Steel to be encased in concrete or masonry.

3.21 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

- A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings. Color coat all piping according to owner preferences.

- B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

- C. Metal:
 - 1. System 4 – Exposed Metal – Mildly Corrosive
 - a. All proposed equipment and piping.

END OF SECTION

SECTION 11261 - DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Work, material, and procedures for disinfection of installed potable water lines.
- B. Related sections:
 - 1. Section 01330 – Submittal Procedures.

1.2 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Water Works Association (AWWA):
 - a. AWWA B300, Hypochlorites.
 - b. AWWA B301, Liquid Chlorine.
 - c. AWWA B303, Sodium Chlorite.
 - d. AWWA C651, Disinfecting Water Mains.
 - e. AWWA C652, Disinfection of Water-Storage Facilities.
 - f. AWWA C653, Disinfection of Water Treatment Plants.
 - g. AWWA C654, Disinfection of Wells.

1.3 QUALITY CONTROL SUBMITTALS

- A. Submittals shall be made as required in Section 01330, SUBMITTAL PROCEDURES. The following specific information shall be provided:
 - 1. Procedures and plans for disinfection and testing.
 - 2. Type of disinfecting solution and method of preparation.

1.4 SEQUENCING AND SCHEDULING

- A. Commence disinfection after completion of following:
 - 1. Completion and acceptance of internal painting of system(s).
 - 2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

PART 2 - PRODUCTS

2.1 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Owner will supply potable quality water, Contractor shall convey in disinfected pipelines or containers.

2.2 CONTRACTOR'S EQUIPMENT

- A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.3 MIXING DISINFECTANT

- A. Prepare solution by mixing any of following as described below. The purpose of the stock solution is to facilitate mixing and dilution to ensure a uniform disinfecting solution. The Contractor will not

be required to mix a stock solution if a liquid chlorine gas feed system that can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution is used.

1. Liquid chlorine gas conforming to AWWA B301 and water mixture.
 2. Dry chlorine gas conforming to AWWA B301.
 3. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.
- B. Feed dry chlorine gas through devices to regulate the rate of flow and ensure uniform diffusion of gas into water within the pipe or vessel being treated. Chlorinating devices for feeding chlorine gas solution or the gas itself shall prevent of water into chlorine cylinder.
- C. Use following proportions of hypochlorite or chlorine to water:
1. Chlorine Gas or Liquid (100 Percent Cl): 1 pound per 1 1.75 gallons water.
 - a. Apply liquid chlorine gas-water solution by means of a solution feed chlorinating device.
 2. Calcium Hypochlorite (65 to 70 Percent Cl): 1 pound per 7.5 gallons water.
 - a. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1 percent solution (10,000 ppm chlorine).
 3. Sodium Hypochlorite (5.25 Percent Cl): 1 gallon per 4.25 gallons water.
 - a. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution.

PART 3 - EXECUTION

3.1 GENERAL

- A. Disinfect pumps and pipelines, installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
1. Disinfect new pipelines that connect to existing pipelines up to the point of connection.
 2. Disinfect surfaces of materials that will contact finished water, both during and following construction using spray method described below.
 3. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- B. Prior to application of disinfectants, clean equipment and pipelines of loose and suspended material. Flush pipelines until clear of suspended solids and color. Use water suitable for flushing and disinfecting.
- C. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, and AWWA C654 for wells, except as modified in these Specifications.
- D. Allow freshwater and stock disinfectant solution to flow into the pipe or vessel at a measured rate so that the chlorine-water solution is at the specified strength. Do not place concentrated commercial disinfectant in the pipeline or vessel before it is filled with water.

3.2 PIPING AND PIPELINES

- A. Flushing:
1. Before disinfecting, flush all foreign matter from pipeline. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe, where it is impractical or impossible to flush the pipe at specified velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line.
 2. Flush pipelines through flushing branches and remove branches after flushing is completed. Operate valves during flushing process at least twice during each flush.

3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.
- B. Disinfecting Solution: Chlorine-water solution having a free chlorine concentration of not less than 50 ppm.
- C. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.
- D. Point of Application:
1. Inject chlorine mixture into pipeline to be treated at beginning of line through corporation stop or suitable tap in top of pipeline.
 2. Control water from existing system to flow slowly into pipeline during application of chlorine.
 3. Control rate of chlorine solution flow in proportion to rate of water entering pipe so that combined mixture shall contain not less than 50 ppm of free available chlorine.
 4. Prevent of chlorine solution into line supplying water.
- E. Retention Period:
1. Retain treated water in pipeline for at least 24 hours to destroy all nonspore-forming bacteria. At end of 24 hour period, disinfecting solution shall contain at least 10 ppm of free chlorine or the pipeline shall be recleaned, disinfecting solution shall be reapplied, and specified procedure repeated.
 2. Operate valves, hydrants, and appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pipeline, including dead-ends and areas that otherwise may not be treated.
 3. After disinfection, flush water from the permanent source until water through the pipeline is equal chemically and bacteriologically to permanent source of supply.

3.3 PUMPS

- A. Disinfecting Solutions: Minimum free chlorine concentration of 200 ppm.
- B. Disinfecting Procedure: In accordance with AWWA unless herein modified.
- C. Application:
1. Inject the disinfecting solution into the pump and associated piping and circulate for a minimum 2 hour period of time. At the end of the 2 hour period, the solution shall have a strength of at least 100 ppm free chlorine.
 2. Operate valves and/or pump appurtenances during disinfection to ensure that the disinfecting solution is dispersed into all parts of the pumps and lines.
 3. If the disinfecting solution contained in the pumps has a residual free chlorine concentration less than 100 ppm after the 2 hour retention period, reclean the pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
 4. After chlorination, flush the water from the pumps until the water through the units is chemically and bacteriologically equal to the permanent source of supply.

3.4 DISPOSAL OF DISINFECTING WASTEWATER

- A. Do not allow flow into a waterway without neutralizing disinfectant residual.
1. See AWWA C652 for acceptable neutralization methods.

3.5 TESTING

- A. Test Equipment:
1. Clean containers and equipment used in sampling and assure they are free of contamination.

2. Obtain sampling bottles with instructions for handling from laboratory.
- B. Chlorine Concentration Sampling and Analysis:
1. Sampling Frequency for Disinfecting Solution: Two samples per disinfecting procedure.
 2. Residual Free Chlorine Samples: Two samples per disinfecting procedure.
 3. Dechlorinated Disinfecting Wastewater Residual Samples: Two samples per disinfecting procedure.
 4. Sampling Locations: Each 1,000 feet of pipeline or each building.
 5. Analysis to be performed by the Owner's laboratory.
- C. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies. Samples shall be analyzed for coliform concentrations in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.
1. A minimum of two Samples on each of 2 consecutive days from each separable structure every 1,000 feet of pipeline will be obtained and analyzed by standard procedures outlined by state and local regulatory agencies.
- D. If the minimum Samples required above are not bacterially negative, the disinfecting procedures and bacteriological testing shall be repeated on the respective facilities until bacterial limits are met.

END OF SECTION

SECTION 15410 - DUCTILE IRON FORCE MAIN PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the Work necessary to completely furnish and install Ductile Iron force main pipe and fittings.

1.2 GENERAL

- A. Like items of ductile iron pipe provided hereinafter shall be the end products of one manufacturer to achieve standardization of appearance, operation, maintenance, and manufacturer's services.
- B. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- C. All pipe shall be circular and shall be of the sizes shown on the Plans and/or listed in the Unit Price Schedule. All pipe shall be new. Used pipe is prohibited.
- D. At the discretion of the Engineer, all pipe line and materials are subject to inspection and approval at the plant of the manufacturer.
- E. All materials shall equal or exceed the standards specified herein.
- F. During the process of unloading, all pipe materials shall be inspected by the Contractor and any damaged pipe set aside.
- G. After pipe lines are laid, the Contractor shall test for defects and leakage.
- H. Inspection of pipe at the manufacturer's plant, at the point of delivery, on the job site, or in place shall not relieve the Contractor of his responsibility and the material may be subject to rejection until final acceptance of the completed project.

1.3 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01330, SUBMITTAL PROCEDURES.
- B. In addition to the requirements of Section 01330, SUBMITTAL PROCEDURES, submit the following additional specific information:
 - 1. Quality Control Submittals:
 - a. Pipe size, class, and thickness.
 - b. Special shipping, storage and protection, and handling instructions.
 - c. Test procedures.
 - d. Test results, reports, and certifications.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Ductile iron force main pipe shall be provided to conform to materials of construction as specified herein.

- B. All force mains shall be installed with tracer wire.
- C. Weights and Marking:
 - 1. Weights of pipe and fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.
- D. Certification:
 - 1. The Contractor shall upon request furnish the Engineer with certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications for each.

2.2 DUCTILE IRON FORCE MAIN PIPE

- A. All pipe and pipe fittings furnished for underground sewer piping shall have either push-on or mechanical type joints.
- B. Flanged DIP and DI fittings shall be used only as indicated on the Plans. Flanged pipe and pipe fittings shall conform to ANSI/AWWA C115/21.15, Class 250 psi. Flanged drilling shall conform to ANSI B16.1, Class 125 flange.
- C. All DIP, 4-inch through 36-inch, shall conform to the requirements of ANSI/AWWA C150/A21.50 (Thickness Design of Ductile-Iron Pipe) and ANSI/AWWA C151/A21.51 (Ductile Iron, Centrifugally-Cast for Water).
- D. Ductile iron pipe for force mains shall have a minimum Pressure Class of 350.
- E. Standard laying lengths shall be 20 feet \pm 1 inch, unless otherwise specified.

2.3 FITTINGS FOR DUCTILE IRON FORCE MAIN

- A. All fittings over 3-inches shall be ductile iron, mechanical joint fittings and shall conform to the requirements of AWWA C153. All fittings shall have a minimum pressure rating of 350 pounds per square inch and shall be lightweight (compact) fittings unless otherwise shown on the Plans.
- B. All fittings shall be furnished with gaskets. MJ fittings shall also be furnished with bolts, nuts, and iron glands. All plugs, caps, tees, and bends deflecting 22-1/2° or more shall be provided with reaction backing.
- C. All casting and mating surfaces shall be smooth and of a workmanlike quality, free from cracks, holes, scale, shrinkage, distortion, grooves, scratches, and other defects. Fittings and other castings may be rejected if found to be unacceptable by the Engineer in accordance with these Specifications.
- D. Joints shall be mechanical joint, shall conform to AWWA C111, and shall be furnished with Mega-lug type retainer glands and gaskets.
- E. Special fittings shall be in accordance with the pipe manufacturer's recommendations and as approved by the Engineer.
- F. All fittings and appurtenances placed on sanitary sewer lines shall meet with the requirements of the type of pipe used and shall be installed in accordance with the manufacturer's recommendations and as approved by the Engineer.

- G. Connections between different kinds of pipe shall be detailed on the Plans and provide self-cleansing sanitary flow and watertight joints and connections.
- H. All fittings shall be fusion-bonded epoxy coated inside and outside in accordance with ANSI/AWWA C116/A21.16.
- I. All valves and fittings (including in-line valves) shall have Megalug style retainer glands or approved equal. Valves, bends, reducers and other hardware near bends shall be positively bolted, all-threaded, or mechanically joined to each other. Bolted includes single and double flanged adapters (such as Foster Adapters or Swivel Adapters) which provide a solid bolted or mechanical joint type connection.

2.4 DUCTILE IRON PIPE JOINTS

- A. Joints shall be mechanical joints (MJ) or push-on type joints which conform to ANSI/AWWA C111/A21.11 (Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings), unless otherwise specified.
- B. Joints shall have the same pressure rating of the pipe or fittings of which they are a part.
- C. All pipe joints other than those specified herein shall be made in strict accordance with the manufacturer's recommendations and as approved.
- D. All joints shall be made watertight in accordance with the latest applicable AWWA and ASTM standards.

2.5 GASKETS FOR DUCTILE IRON JOINTS AND FITTINGS

- A. Gaskets shall be made of vulcanized styrene butadiene rubber (SBR).
- B. Gaskets shall be marked for nominal pipe size, manufacturer, and year of manufacture.
- C. Gaskets shall comply with the requirements of AWWA C111 (Rubber-Gasket joints for Ductile Iron Pressure Pipe and Fittings).

2.6 DUCTILE IRON JOINT AND FITTING LUBRICANT

- A. Lubricant shall be provided by the pipe manufacturer and applied as per the manufacturer's recommendations in accordance with ANSI/AWWA C111/A21.11 (Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings).
- B. Lubricant shall be non-toxic, not support the growth of bacteria and have no deteriorating effects on the gasket or pipe material.
- C. Lubricant containers shall be appropriately identified and labeled with the manufacturer's name.
- D. Each lubricant container shall have printed instructions for usage and joint assembly.

2.7 COATINGS

- A. Interior Coatings
 - 1. All ductile iron pipe for force mains shall receive the following interior lining treatment:
 - a. Epoxy Lining

- 1) All DIP and DI fittings shall be lined with a high-build, multi-component amine-cured novalac epoxy lining, containing at least 20% ceramic quartz pigment, by volume.
 - 2) The lining system shall be Protecto 401 Ceramic Epoxy as manufactured by Vulcan Painters, Inc.
 - 3) The lining Applicator shall have a successful history of applying linings to the interior of DIP.
- b. Condition of Ductile Iron Prior to Surface Preparation
- 1) All DIP and DI fittings shall have a high-build protective lining on the interior. All DIP and DI fittings shall be delivered to the application facility without any lining on the interior surface. As removal of old linings may not be possible, the intent of this Specification is that the entire interior of DIP and DI fittings shall not have been lined with any substance prior to the application of the lining specified herein.
- c. Surface Preparation
- 1) Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, and other substances. Any areas where oil, grease, or another substance is detected and can be removed by solvent shall be solvent-cleaned using the guidelines outlined in SSPC-SP-1 (Solvent Cleaning).
 - 2) After the surface has been made free of grease, oil, and other substances, all areas to receive the protective compounds shall be abrasive blasted with sand or grit abrasive media.
 - 3) The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, and other sources of roughness shall be removed from the surface. If rust reappears before coating, the affected areas must be reblasted.
- d. Lining
- 1) Within eight (8) hours after surface preparation, the interior of the pipe shall receive approximately 40 mils dry film thickness of the protective lining.
 - 2) Lining shall not occur if the substrate or ambient temperature is below 40° F.
 - 3) The surface shall be dry and dustfree before lining.
 - 4) The linings shall not be used on the face of any flanged pipe or fitting, unless otherwise specified.
 - 5) All fittings shall be lined with approximately 40 mils of the protective lining. The 40 mils system shall not be applied in the gasket grooves.
- e. Coating Gasket and End Spigots
- 1) Due to the tolerances involved, the gasket area and exterior spigot end, up to six (6) inches back from the end of the spigot end, must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound, or approved equal.
 - 2) This coating shall be applied by brush to ensure coverage. Care shall be taken so the coating is smooth, without excess buildup in the gasket groove or on the spigot end.
 - 3) All materials for the gasket groove and spigot end shall be applied after the application of the lining.
- f. Number of Coats
- 1) The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The time between coats shall never exceed that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable without roughening of the surface.
- g. Touchup and Repair

- 1) Protecto Joint Compound, or approved equal, shall be used for touchup or repair. Procedures for touchup and repair shall be in accordance with manufacturer's recommendations.
- h. Inspection and Certification
 - 1) Inspection
 - a) All DIP and DI fitting linings shall be checked for thickness using a magnetic film thickness gage. The thickness testing shall be as set forth in SSPC-PA-2 (Measurement of Dry Coating Thickness with Magnetic Gages).
 - b) The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects shall be repaired prior to shipment.
 - c) Each pipe joint and fitting shall be marked with the date of application of the lining system and the numerical sequence of application on that date.
 - 2) Certification
 - a) The pipe or fitting manufacturer shall supply a certificate attesting that the Applicator met the requirements of these Specifications, the material used was as specified, and the material was applied as required.

B. Exterior Coatings

1. All ductile iron pipe shall have an exterior coating as set forth below.
 - a. Factory Primed Pipe
 - 1) Unless otherwise shown on the Plans, all exposed pipe and fittings within the limits of structure walls or exposed pipe and fittings located aboveground shall be delivered to the job site factory-blasted, cleaned, and primed with one (1) coat of Tnemec Series N140 Pota-Pox Plus, or approved equal compatible paint system.
 - b. Bituminous Coating
 - 1) All pipe and fittings indicated for buried service shall have a petroleum asphaltic coating approximately one (1) mil thick factory-applied to the outside of all pipe and fittings. The finished coating shall be continuous, smooth, neither brittle when exposed to the cold nor sticky when exposed to the sun, and shall be strongly adherent to the pipe or fitting. The bituminous coating shall not be applied to the first six (6) inches of the exterior of the spigot ends.
 - c. Field Painting
 - 1) Coat all exposed pipes, valves, and fittings with aliphatic polyurethane, @ 3 MDFT min.

PART 3 - EXECUTION

3.1 GENERAL

- A. All pipe and fittings shall be installed in accordance with these specifications and the Plans.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Comply with Section 01601, PRODUCT REQUIREMENTS.
- B. Delivery of Materials: Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.
- C. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.3 FIELD QUALITY CONTROL

- A. Contractor shall visually inspect all pipe and fittings upon delivery and set aside and damaged or flawed materials and shall not install any damaged or flawed material.
- B. Contractor shall test for defects and leakage.

3.4 INSTALLATION

- A. As specified on design sheets

END OF SECTION

SECTION 15900 – HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Work necessary to furnish and install a complete and functional horizontal split-case centrifugal pump(s) as specified here in. The pump system shall be supplied with the necessary equipment to make a complete and operable system. Any portion or part of the system, which does not operate as specified, shall be replaced and made operable at no additional cost to the Owner.
- B. Related Sections:
 - 1. Section 01330 – Submittal Procedures.
 - 2. Section 01601 – Product Requirements.
 - 3. Section 01780 – Operation and Maintenance Data.
 - 4. Section 01790 – Demonstration and Training.
 - 5. Section 09900 – Painting and Protective Coatings.
 - 6. Division 16 – Electrical.

1.2 GENERAL

- A. Equipment Numbers: See supplemental data sheet(s) at end of section.
- B. PUMP SIZES AND FITTING SIZES MAY BE DIFFERENT FROM THOSE SHOWN ON THE PLANS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE DIMENSIONS REQUIRED TO INSTALL THE PUMPS CORRECTLY.
- C. Like items of equipment provided hereinafter shall be the end products of manufacturer to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.
- D. Unit Responsibility: The Work requires that the horizontal split case pumps, motors, instruments, and components, complete with all accessories and appurtenances be the end product of one responsible system manufacturer or responsible system supplier. Unless otherwise indicated, the Contractor shall obtain each system from the responsible supplier of the equipment, which supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions without altering or modifying the Contractor's responsibilities under the Contract Documents. The Contractor is responsible to the Owner for providing the equipment systems as specified herein.
- E. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.
- F. The equipment specified herein is included in the MANUFACTURER/ SUBCONTRACTOR Form. Refer to the bid Form and the Instructions to bidders for additional requirements.

1.3 REFERENCES

- A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.4 SUBMITTALS

- A. General: Administrative, shop drawings, samples, quality control, and contract closeout submittals shall conform to the requirements of Section 01330, SUBMITTAL PROCEDURES.
- B. In addition to the requirements of Section 01330, SUBMITTAL PROCEDURES, submit the following additional specific information:
 - 1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - 2. Hydraulic Shop Testing: Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the specific pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
 - 3. Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
 - 4. Power and control wiring diagrams, including terminals and numbers.
 - 5. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - 6. Factory finish system.
 - 7. Quality Control Submittals:
 - a. Factory Functional and Performance Test Reports.
 - b. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
 - c. Special shipping, storage and protection, and handling instructions.
 - d. Manufacturer's printed installation instructions.
 - e. Manufacturer's Certificate of Proper Installation.
 - f. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
 - g. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
 - h. Operation and Maintenance manual.
 - 8. Contract Closeout submittals: Service records for maintenance performed during construction.

1.5 QUALITY CONTROL

- A. Factory Tests and Adjustments: Test all equipment actually furnished.
- B. Factory Test Report: Include test data sheets, curve test results, and performance test logs.
- C. Functional Test: Perform manufacturer's standard pump test on equipment. Include vibration test, as follows:
 - 1. Dynamically balance rotating parts of each pump and its actual driving unit before final assembly.
 - 2. Limits:
 - 3. Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.
 - 4. Complete Rotating Assembly Including Coupling, Drive Unit, and Motor: Less than 90 percent of limits established in the Hydraulic Institute Standards at all operating speeds.
 - 5. Shop Performance Test:
 - 6. Conduct on each pump with actual motor furnished.
 - 7. Perform under simulated operating conditions.
 - 8. Test for a continuous 3-hour period without malfunction.
 - 9. Test Log: Record the following for each flow head condition:

- 1) Total head.
- 2) Capacity.
- 3) Horsepower requirements.
- 4) Flow measured by factory instrumentation and storage volumes.
- 5) Average distance from suction well water surface to pump discharge centerline for duration of test.
- 6) Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
- 7) Calculated velocity head at the discharge flange.
- 8) Field head.
- 9) Driving motor voltage and amperage measured for each phase.
10. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards, if necessary.
11. Motor Test: Provide NEMA short commercial test. Document guaranteed efficiency by providing certified test report for test conducted on actual motor furnished.

1.6 OPERATION AND MAINTENANCE DATA

- A. O&M Manuals: Content, form, and schedule for providing as specified in Section 01780, OPERATION AND MAINTENANCE DATA.
- B. Maintenance summary Forms: As specified in Section 01780, OPERATION AND MAINTENANCE DATA.

1.7 WARRANTY

- A. Provide warranty for a period of 12 months after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer shall promptly repair or replace the defective equipment without additional cost to the Owner.
- B. Spare parts identified within this specification shall not be used to address warranty repairs.

PART 2 - PRODUCTS

2.1 HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

- A. Manufacturers:
 1. Advanced Engineered Pumps
- B. Design:
 1. General:
 - a. Pumps shall be furnished and installed, as shown on the plans with drip rim base, coupling, coupling guard, and premium efficiency motor. The pump(s) shall meet the following design criteria.
 - b. All related equipment in this Specification shall be furnished as a system complete and operable in every respect. Any portion or part of the system that does not operate properly shall be replaced and made operable at no additional cost to the Owner.
 - c. Furnish a coordinated operating system complete with pump, motor, and drive.
 - d. Coordinate pump requirements with motor manufacturers and be responsible for pump and motor requirements

- e. ANY EXCEPTIONS TO THESE SPECIFICATIONS MUST BE LISTED AND ATTACHED TO THE PROPOSAL. THE OWNER, BY ACCEPTANCE OF A SUBMITTED PROPOSAL, WILL REQUIRE THE SPECIFIED EQUIPMENT TO BE SUPPLIED UNLESS THOSE EXCEPTIONS DIFFERENT FROM THAT WHICH IS SPECIFIED ARE ATTACHED.
 - f. Compliance with the performance requirements of these Specifications will not relieve the manufacturer from his responsibilities to supply pumps, which have the structural, mechanical, and operational features specified. Equipment that is not considered an acceptable equivalent product in the opinion of the Engineer and Owner to the equipment specified will not be accepted.
 - g. All equipment herein shall be designed and installed in accordance with current OSHA standards.
2. Pump Casing:
- a. Pump casing shall be close-grained cast iron for working pressures up to 175 psig and shall be able to withstand stresses and strains at full operating pressures.
 - b. Casing shall consist of upper and lower half castings containing the volute and suction passages, and removable bearing housings that are doweled and securely bolted to the lower half casing. Additionally, bearing housing shall be cast integrally with the lower half of the casing. Inboard and out board bearing housings shall be replaceable without need for field alignment.
 - c. Casing shall be axially split along the horizontal shaft centerline with flat faced suction and discharge flanges and mounting feet cast integral with the lower half casing.
 - d. The upper and lower half casings shall be doweled to permit easy removal and accurate replacement of the upper half for inspection and maintenance. The upper half casing shall be completely removable without disturbing the suction or discharge piping connections. Removal of upper casing half shall allow removal of rotating elements without disconnecting suction or discharge piping.
 - e. Suction and discharge connections shall be sized to reduce friction losses and to reduce turbulence and pipe noise. All suction and discharge flanges shall be designed for straight through nut and bolt flange connections. Flanges shall be of 125# ASA Standard. Suction and discharge flanges shall be on a common centerline in both the horizontal and vertical planes.
 - f. Tapped and plugged holes shall be provided for priming, vent, draining and gauge connections.
 - g. Upper half casing shall have a drilled and tapped connection at the highest point on the casing for the purpose of pump priming and/or air release.
 - h. Lower half casing shall be drilled and tapped to allow for drainage piping.
3. Impeller:
- a. Impeller shall be of the double suction type made of bronze to minimize inlet losses and accommodate high suction lifts.
 - b. Impeller shall be hydraulically and statically balanced to reduce bearing loading.
 - c. Impellers shall be fixed axially along the shaft by sleeves and sleeve nuts, and secured to the shaft through a precision fit and full length key.
 - d. Impeller hub shall have sufficient metal thickness to allow machining for installation of impeller wear rings.
 - e. Maximum diameter shall be less than 94% of shaft to casing lip distance for quiet operation.
4. Shaft:
- a. The shaft shall be made of SAE-1045 steel of ample size to operate under load with a minimum of deflection.
 - b. Shaft shall be accurately machined along its entire length. A keyway shall be machined at the coupling end. Shaft shall not be threaded adjacent to the impeller.
 - c. Shaft sleeves shall be made of bronze and shall protect the shaft from wear and from contact with the pumped liquid. Shaft sleeves shall be locked in place by

- threaded bronze shaft sleeve nuts. An O ring shall be furnished under the sleeve to prevent leakage.
5. Stuffing Box Housings:
 - a. Stuffing box housings shall be made of cast iron separate from the casing and mounted in cylindrical fits in the casing.
 - b. Stuffing box/bearing brackets shall be drilled and tapped for drain connections.
 - c. Stuffing box shall consist of six rings of graphited acrylic yarn packing with a split gland to permit removal and access to packing.
 - d. Piping, valve and seal cages shall be supplied to provide packing lubrication and shall be mounted on the upper half of the casing.
 6. Bearings and Bearing Housings:
 - a. Bearings shall be ball type, single row inboard and double row outboard, selected to carry radial and thrust loads.
 - b. Bearing housings shall be accurately doweled and accurately positioned onto the bearing shoulders located on the lower half casing to ensure accurate alignment.
 - c. The outboard bearing shall be retained by a bearing nut and lock washer.
 - d. Bearing shall be grease lubricated.
 - e. Bearing housings shall be bolted to the ends of the bearing bracket/stuffing box and shall be male/female fitted for a full 360 degrees to assure positive alignment.
 - f. The housings shall provide a fit for the inboard bearing that allows freedom for thermal expansion while the outboard bearing shall be clamped in place to take all thrust loads and keep the rotating element in its proper axial location.
 - g. Openings for adding new grease and draining old grease shall be provided.
 7. Wear Rings:
 - a. Wear rings shall be provided on both the impeller and casing so that clearances can be maintained throughout the life of the rings and minimize recirculation.
 - b. Impeller wear rings shall be mounted on the hubs to provide for to provide for impeller clearances.
 - c. . Casing wear rings shall be installed with an anti-rotation device and designed to restrict leakage across the ring fit.
 - d. Wear rings shall be bronze.
 8. Baseplate, Coupling, and Guard:
 - a. The Baseplate shall be steel with drip rim, and designed to resist torsional movement and to support the combined weight pump and driver. Final alignment of pump and driver shall be made after grouting and installation, and shall be approved by the manufacturer/representative prior to operation.
 - b. The pump coupling shall be of the flexible type with steel flanges connected by a rubber sleeve for torque transmission. Coupling hubs shall be secured to the driver and driven shafts by a set screw located over the key.
 - c. Coupling guard shall be the all-metal type.

2.2 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Shall be provided on all modular section, including motor, and pump. Lugs shall be adequate to lift two times the equipment weight.

2.3 FACTORY FINISHING

- A. Prepare, prime, and finish coating and lining shall be in accordance with Section 09900, PAINTING AND PROTECTIVE COATINGS.

2.4 MOTOR REQUIREMENTS

- A. Motor shall be selected in accordance with the pump's non-overloading performance characteristics. Motor horsepower rating shall be chosen in keeping with the pump's possible peak horsepower requirements. In sizing the motor, the pump maximum brake horsepower shall not exceed the motor's nominal nameplate rating.
 - 1. Motor Rating
 - a. The motor shall be 200 HP.
 - b. The motor shall be 1800 RPM.
 - c. The motor shall be 460 Volts.
 - d. The motor shall have a TEFC enclosure.
- B. The motor shall be mounted with the pump on the baseplate at the pump manufacturer's plant and shipped as one unit.
- C. Motor shall be as specified in 16150 NEMA Frame Induction Motors and following supplement data sheets.

2.5 ELECTRICAL COMPONENTS AND ACCESSORIES

- A. General:
 - 1. Conform to Division 16, ELECTRICAL.
 - 2. Provide all necessary electrical components and wiring for a complete, functional system.
 - 3. Where indicated, motor starters for constant-speed, 460-volt motors shall be provided in a separate motor control center specified in Division 16, ELECTRICAL. Provide all necessary control functions to properly interface with this motor starter.
- B. Wiring: The Drawings and Specifications indicate the anticipated wiring for the equipment provided under this section. If additional wiring is required, or if required wiring does not match what is indicated, the Contractor shall make the necessary modifications to the electrical wiring and documentation as part of the lump sum price. Wiring shall meet the requirements of Division 16, ELECTRICAL, and NFPA 70. Insulation shall be rated 600 volts, minimum. Low-voltage (24V) signals shall be run in twisted, shielded pair cable.
- C. Electrical Raceways: Electrical wiring shall be installed in conduit meeting the requirements of Division 16, ELECTRICAL. Raceways shall be installed in accordance with Division 16, ELECTRICAL, and NFPA 70.

2.6 TOOLS AND SPARE PARTS

- A. Tools: The work includes furnishing two complete sets of special tools if recommended by the manufacturer for maintenance and repair of each separate type of equipment; tools shall be stored in tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box. Spare tools are not required.
- B. Spare Parts:
 - 1. All equipment, if recommended, shall be furnished with the specified manufacturer's spare parts as indicated in the individual equipment sections.
 - 2. Necessary spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer and subassembly component (as appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with hinged wooden cover and locking clasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the

equipment, equipment numbers and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

3. Provide at a minimum the following spare parts for the equipment:
 - a. Complete set packing.
 - b. Complete set pump bearings.
 - c. Complete set gaskets and lip seals.
 - d. Complete set of shaft sleeves.
 - e. Wear rings.

2.7 FABRICATION

- A. Shop Assembly: The system shall be factory assembled and tested.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The pump(s) shall be furnished for installation by the Contractor in accordance with the manufacturer's printed instructions, Plans and as specified herein. The Contractor shall furnish all necessary foundation bolts required of the size and type recommended by the pump manufacturer (minimum ASTM A307, Grade A), unless shown otherwise on the Plans. The bolts shall be carefully set by means of a jig or template. All pump foundations shall be Class "A" concrete. They shall be accurately located and all exposed concrete surfaces shall receive a rubbed finish which will be smooth and uniform and free from all form marks.
- B. The erection work shall include the furnishing of the necessary oil and grease for initial operation. The grades of fuel, oil, and grease shall be in accordance with the recommendations of the pump manufacturer.
- C. The pump and motor of each unit shall be assembled in its position and shall be carefully set and aligned by a competent mechanic. The base of the unit shall be shimmed or wedged to level position in all directions on the foundation blocks. Pump alignment shall be checked under the supervision of the pump manufacturer's representative before grouting.
- D. Adjust alignment of pump and motor shafts for angular and parallel alignment by use of calibrated laser alignment equipment and procedures shall comply with the method specified in the Hydraulic Institute's Standards for Centrifugal, Rotary & Reciprocating Pumps - "Instructions for Installation, Operation and Maintenance."
- E. The base shall be grouted by the deep grouting method using "Embeco", a product of Master Builders or "Ferrolith G", a product of Sonneborn-Contach or equal as an admixture in the cement mortar grout to prevent shrinkage. The admixture shall be used in accordance with the recommendations of the manufacturer using a mix of one part admixture, one part cement, and one part sand. Grout shall be placed under the entire base being careful to fill all voids and space.
- F. After the base has been grouted, the alignment of the unit shall be rechecked. If the connected shafts of the pump and motor are found to be in true alignment, the motor and pump shall be secured by approved means.
- G. Install automatic air release valve (Val-Matic or equal) at the top of pump casing and plumb to drain any air/water vented by the ARV.

3.2 FINISHING

- A. Painting of all pumps and motors shall be as specified in SECTION 09900, PAINTING AND PROTECTIVE COATINGS of these Specifications.

3.3 FIELD QUALITY CONTROL

- A. Initial operation of the pumps shall take place in the presence of a representative of the pump manufacturer, and in the presence of a licensed electrician. The operation shall be intermittent to the extent that each pump shall be started and stopped at least three (3) times. The operation shall extend over a long enough period to assure that the equipment has been installed properly and is in satisfactory condition. Power and water will be furnished by the Owner. All other costs shall be borne by the Contractor.
- B. Functional Tests: Conduct on each pump.
1. Alignment: Test complete assemblies of actual pump with motors furnished for correct rotation, proper alignment and connection, and quiet operation.
 2. Vibration Test:
 3. Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop vibration exceeding limits specified in HI 9.6.4 at all operating speeds.
 4. If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.
 5. Flow Output: Measured by pump station instrumentation.
 6. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.
- C. Performance Test: In accordance with Hydraulic Institute Standards, latest standard.

3.4 MANUFACTURER'S SERVICES

- A. A manufacturer's representative for the equipment specified herein shall be present at the job site for the minimum person-days listed for the services herein under, travel time excluded:
1. Installation, Startup, and Testing Services:
 2. 1 person day for installation assistance, inspection, and Certificate of Proper Installation.
 3. 1 person-day for functional and performance testing.
 4. Provide Qualifications of Manufacturer's Representative.
 5. Training Services:
 - 1 person-day of prestart classroom or jobsite training of Owner's personnel.
 - Training of Owner's personnel shall be at such times and at such locations as required and approved by the Owner.

3.5 MANUFACTURER'S CERTIFICATES

- A. Provide Manufacturer's certificate(s) in accordance with Section 01790, DEMONSTRATION AND TRAINING.

3.6 SUPPLEMENT

- A. The supplement listed below, following "End of Section," is a part of this Specification.
1. Horizontal Split-Case Pump Data Sheet.

END OF SECTION

Section 15900.1: HORIZONTAL SPLIT-CASE PUMP DATA SHEET

PROJECT:	<u>Addison Surveyor Pump Station Improvements</u>
OWNER:	<u>Town of Addison</u>
EQUIPMENT NAME(S):	<u>High Service Pump #2</u>
EQUIPMENT TAG NUMBER(S):	<u>HSP-1</u>
TOTAL PUMPS REQUIRED:	1

Pump: Advance Engineered Pump12x10x17 8000 Series SC80 horizontal split case pump rated 3000GPM @ 175' TDH @ 1800 rpm. 80% efficiency. Cast iron casing. Bronze impeller with bronze impeller wear rings. Bronze casing wear rings. SAE 1045 shaft with bronze shaft sleeves. Graphite asbestos packed stuffing box. 3/4" automatic air release valve.

Baseplate: Stealth Industry fab steel baseplate.
83.250" long X 24.00" wide X 0.500" thick.

Coupling: Woods EPDM #12 Sure-Flex Plus coupling.

Motor: TECO Westinghouse 200 hp, 1800 rpm, 460 volts, inverter duty in a TEFC enclosure. Motor to have Class F insulation, NEMA Design B, NEMA KVA Code Letter G with a minimum 95.4% efficiency.

Factory test: Non-witness factory performance test.

Paint: A-C Blue standard machinery enamel coating.

**SECTION 16000
ELECTRICAL – GENERAL**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required to install, test and provide an operational, electrical system as specified and as shown on the Drawings.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.
- C. All electrical work provided under any Division of the Specifications shall fully comply with the requirements of Division 16.
- D. The work shall include furnishing, installing, and testing the equipment and materials detailed in each Section of Division 16.
- E. The work shall include furnishing and installing the following:
 - 1. Contractor shall coordinate shutdowns for disconnection, reconnection to the existing secondary service ductbank with the owner.
 - 2. Provide a complete raceway system, rewire and field reconnect all existing cables and conduit for all existing motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions. Coordinate construction schedule and electrical interface with the supplier of electrical equipment specified under other Divisions as required by the Contract Documents.
 - 3. Provide a complete raceway system, rewire, and then reconnect all existing terminations for all existing field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions as required by the Contract Documents.
 - 4. Provide a complete raceway system for the Data Cables and specialty cable systems, including those furnished under other Divisions. Install the Data Cables and other specialty cable systems, in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the Process Control System supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install the cables in separate raceways as required by the Contract Documents.

5. All bidders shall visit the site of the project, prior to submitting a bid, and satisfy themselves as to any question that they might have, relating to existing equipment, condition, or construction.
 6. Power monitoring for the Owner's facilities shall be performed by a new Electrical Power Monitoring and Control System (PMCS). Monitoring information from equipment specified in the individual Sections of Division 16, and as shown on the Drawings, shall be interfaced to the monitoring system.
 7. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in each area. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.
 8. All bidders shall visit the site of the project, prior to submitting a bid, and satisfy themselves as to any question that they might have, relating to existing equipment, condition or construction.
 9. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment as specified in Section 16060.
- F. Maintain the Owner's process operations during all construction including any required electrical or control system outages. Prior to bidding, obtain all needed process operational requirements and restrictions from the Owner's staff during the site visits to determine the effect the operational restrictions may have on the construction schedule and/or bid price. Verify any process related information which may be shown or specified. If the obtained information conflicts with information in the Contract Documents, notify the Engineer in writing prior to bidding. As a minimum, include in the Contract Schedule and Bid Price the following items required to comply with operational requirements:
1. Additional Time and/or Expense
 2. Additional Expense for after-hours work,
 3. Additional equipment, materials, and personnel.
 4. Standby generation with fuel.
- G. Provide all tools, equipment, supplies, and shall perform all labor required to install the equipment specified in the Contract Documents to install, test, and place into satisfactory operation in the time specified for completion in the Contract Documents. Failure of any of the participants in executing the requirements of this Contract to perform the work as specified shall not constitute an acceptable reason for the Owner to grant any change in the Contract Price or additions to the Contract Time.
- H. The work includes demolition of existing electrical equipment, associated conductors, and raceway. Remove wiring from abandoned conduit.

I. The Owner reserves First Right of Salvage.

1.2 ELECTRICAL WORK REQUIRED IN OTHER DIVISIONS

A. References made to other sections which may contain related work does not negate other related sections which may not be mentioned. The Contract Documents, which is defined to include both the Drawings and the Specifications, shall be taken with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, provide such information or additional work as may be required in those references, and include such information or work as may be specified. Examine all Sections of the Specifications and Drawings and determine the power and wiring requirements and provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, provide the additional conductors, raceways and/or wiring, and include in the Contract Price and Schedule.

B. Process Divisions

1. Examine all Process Equipment Specifications and Drawings, determining power and wiring requirements. Provide external wiring and raceways, as required to provide a fully functioning Process Control System. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, furnish the additional conductors, raceways and/or wiring, with no change in Contract Price or Schedule.

C. Mechanical Divisions

1. Examine all Mechanical Equipment Specifications and Drawings, determining power and wiring requirements. Provide external wiring and raceways, as required to provide fully functioning Mechanical Equipment Control Systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, furnish the additional conductors, raceways and/or wiring with no change in Contract Price or Schedule.

1.3 SUBMITTALS

A. Submit Shop Drawings, in accordance with Division 1 requirements, for equipment, materials and all other items furnished under each Section of Division 16 except where specifically stated otherwise. An individually packaged submittal shall be made for each Section and shall contain all the information required by the Section. Partial submittals will not be accepted and will be returned without review.

B. Submittals will not be accepted for Section 16000.

- C. Each Section submittal shall be complete, contain all the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned without review.
- D. Check shop drawings for accuracy and contract requirements prior to submittal to the Owner/Engineer. Errors and omissions on approved shop drawings shall not provide relief from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section may be made per transmittal.
- E. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered, or shop work started if the related shop drawings are marked "APPROVED AS NOTED CONFIRM", "APPROVED AS NOTED RESUBMIT", "REVISE AND RESUBMIT", "REJECTED", or "NOT APPROVED".
- F. All approved shop drawings shall be maintained on site for the Owner's Inspector and for the Owner's Engineer to verify at the time of delivery of equipment to the job site.
- G. Up-to-date Record Drawings shall be promptly furnished when the equipment installation is complete. Payment will be withheld until Record Drawings have been furnished and approved.
- H. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files including a Table of Contents which is indexed and hyperlinked to the various sections submitted on flash drives. Electronic submittals are mandatory and those which are received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Amount or Contract Time will be allowed for delays due to unacceptable submittals.

1.4 REFERENCE CODES AND STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:
 - 1. National Electrical Safety Code (NESC)
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. National Fire Protection Association (NFPA)
 - 4. National Electrical Manufacturers Association (NEMA)

5. American National Standards Institute (ANSI)
 6. Insulated Cable Engineers Association (ICEA)
 7. International Society of Automation (ISA)
 8. Underwriters Laboratories (UL)
 9. Factory Mutual (FM)
 10. Town of Addison Electrical Code
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding, unless otherwise directed by the Owner/Engineer.
- E. In accordance with the intent of the Contract Documents, compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, full compliance with all Laws and Regulations at all times.

1.5 SERVICE AND METERING

- A. No power outages are allowed without notifying the Owner at least 14 calendar days in advance using the Owner-provided shutdown forms. Total outages of more than 15 minutes at any facility are prohibited unless approved by the Owner. Standby generation shall be provided for all outages longer than 15 minutes. Liquidated Damages will be applied as specified for outages longer than 15 minutes when caused by the Contractor's construction activities.

1.6 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.7 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.8 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.
- B. The Record Drawings shall be reviewed in a meeting with the Owner/Engineer monthly.
- C. Record Drawings shall accurately show the installed condition of the following items:
 - 1. One-line Diagram(s).
 - 2. Raceways and pull boxes.
 - 3. Conductor sizes and conduit fills.
 - 4. Panel Schedule(s).
 - 5. Control Wiring Diagram(s).
 - 6. Underground raceway and duct bank routing. The drawings shall include the following:
 - a. The measured width and height of the duct bank.
 - b. Survey the centerline of the duct bank at intervals not to exceed 50 feet along the entire length of the duct bank with the coordinates tied to the project coordinates shown on the Civil Drawings.
 - c. Survey the elevation of the top of the duct bank at intervals not to exceed 50 feet along the entire length with the coordinates tied to the project coordinates shown on the Civil Drawings.
 - d. Changes in direction between termination points shall be surveyed and recorded on the record drawings. Changes in direction shall include the start of the radius, center of the radius and termination of the radius in addition to the 50ft interval requirements specified.
 - 7. Planview, measured dimensions and locations of switchgear, distribution transformers, substations, motor control centers and panelboards. Provide actual coordinates of each corner of the equipment pad to show the location of the pad and provide the actual equipment mounting base measurements to the corners of the equipment pad.

8. Modifications to controls systems or any piece of electrical equipment including field-verified existing controls and all changes clearly identified.
 9. All protective device and electrical system monitoring device settings. Provide a hard copy of the settings and an electronic copy of the settings on an Excel spread sheet.
- D. Submit a typical example of a schedule of control wiring raceways and wire numbers, including the following information:
1. Circuit origin, destination, and wire numbers.
 2. Field wiring terminal strip names and numbers.
- E. As an alternate, submit a typical example of point to point connection diagrams in place of the schedule of control wiring raceways and wire numbers. The information shall include the following:
1. Circuit origin, destination, and wire numbers.
 2. Field wiring terminal strip names and numbers
- F. Submit as a part of the record drawings and the schedule of control wiring raceways and wire numbers (or the point to point connection diagram) to the Owner/Engineer.
- G. The point-to-point connection diagrams are a required line item on the contractors pay estimate will not be considered complete until all of the documentation has been submitted to and approved by the Owner/Engineer.
- H. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.

1.9 EQUIPMENT INTERCONNECTIONS

- A. Furnish and install all equipment interconnections.

1.10 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.
- B. Material or equipment from a manufacturer, not submitted and approved for this project shall not be brought on site. Use of any such material or equipment, will be rejected, and shall be removed and replaced, with the approved material and equipment, with no change allowed in the Contract Price or Schedule.
- C. Material and equipment shall be UL listed, where such listing exists.

- D. All material, products, equipment and workmanship being furnished for the project shall be replaced if it does not meet the requirements of Contract Documents even if installed, with no change in Contract Price or Schedule.

1.11 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, successfully complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will be rejected and shall be removed and replaced with no change in Contract Price or Schedule.
- B. Equipment and materials shall be handled and stored in accordance with the manufacturer's instructions, and as specified in the individual Specification Sections.

1.12 WARRANTIES

- A. Manufacturer's warranties shall be provided as specified in each of the Specification Sections.

1.13 EQUIPMENT IDENTIFICATION

- A. Identify all equipment (disconnect switches, separately mounted motor starters, control stations, etc.) furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc., shall have nameplate designations as shown on the Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INTERPRETATION OF DRAWINGS

- A. The Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each three-phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Unless otherwise approved by the Owner/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Submit a Request for Information for any conduit route which is not clearly identified as concealed or exposed in the Contract Documents prior to its installation.
- D. Circuits are shown as "home-runs" shall be field routed. The raceway system provided shall include all necessary fittings, supports and boxes for a complete code-compliant raceway installation. Field routed raceway shall avoid blocking

- access to equipment either existing or spaces planned for future equipment and shall avoid blocking personnel egress through doors or access hatches.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
 - F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Determine exact locations and obtain approval from the Owner/Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Owner/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
 - G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.
 - H. Redesign of electrical or mechanical work, which is required due to the use of a pre-approved alternate item shall include the arrangement of equipment and/or layout other than that which is specified or shown herein. All additional work and materials required shall be provided with no change in the contract price or schedule. Redesign and detailed plans shall be submitted to the Owner/Engineer for approval.
 - I. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring. Homeruns, as shown on the Drawings, identify raceways to be run exposed and raceways to be run concealed. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.
 - J. Provide all conduit and conductors or data highway cables to RTU and/or PLC termination cabinets, where designated on the Drawings or otherwise required by the Specifications, the manufacture of the equipment, or submitted and approved systems. The conduit and conductors or data highway cables as shown on the interface drawings may not necessarily be shown on the floor plan.
 - K. Install conductors carrying low voltage signals (typically twisted shielded pair cables) in raceways totally separate from all other raceways containing power or 120-Volt control conductors. Do not combine conductors carrying low voltage signals in wireways without barriers or NEC code-compliant separation for their entire length in the wire way, and/or provide separate wireways to provide separation of the conductors. Low voltage signal conductors routed through manholes or hand holes shall be bundled and separated from other conductors.

- L. Raceways and conductors for thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. All raceways and power conductors shall be in accordance with Division 16. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats and controls.
- M. Raceways and conductors for the fire alarm, sound and page party systems are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. All raceways and power conductors shall be in accordance with Division 16. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in process spaces.

3.2 EQUIPMENT PADS AND SUPPORTS

- A. Electrical equipment pads and supports, of concrete or steel including structural reinforcing and lighting pole foundations, are shown on the Structural Drawings.
- B. Electrical equipment or raceways shall not be attached to or supported from, sheet metal walls.
- C. Electrical equipment pads shall be provided for all free-standing equipment. Dimensions shall be 3³/₄ -inches high. With 3-inch extension from front of equipment for equipment mounted against the wall and 3-inch extension on front and rear sections when equipment is rear accessible. Include a ³/₄-inch chamfered edge on all exposed sides.

3.3 SLEEVES AND FORMS FOR OPENINGS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Install sleeves perpendicular to the finished surface. Locate all necessary slots for electrical work and form before concrete is poured. Coordinate the location of sleeves to match the location of the slots so conductors enter without having to bend them.
- B. Unless measurements are shown on the drawings, the locations for stubbing up and terminating concealed conduits which are shown on the drawings are approximate. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates and locate the concealed conduit before the floor slab is poured.
- C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Owner/Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No change in Contract Price or Schedule for such change will be allowed.
- D. Seal all openings, sleeves, penetration and slots as specified in Section 16110.

3.4 CUTTING AND PATCHING

- A. Coordinate with Divisions 2 and 3 for cutting and patching.
- B. Core drill holes in concrete floors and walls as required. Obtain written permission from the Owner/Engineer before core drilling any holes larger than two inches.
- C. Schedule the installation of work to provide the minimum amount of cutting and patching.
- D. Cutting or drilling holes for the installation of raceway through joists, beams, girders, columns or any other structural members is strictly prohibited. If a structural member is cut or drilled, restore the structural member to its previous condition in complete accordance with the instructions of the Structural Engineer, with no change in contract price or schedule regardless of the extent of the repairs required to restore the member to its previous condition.
- E. Cut opening only large enough to allow easy installation of the conduit.
- F. Patching shall be of the same kind and quality of material as was removed.
- G. The completed patching work shall restore the surface to its original appearance or better.
- H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.
- I. Remove rubble and excess patching materials from the premises.
- J. Fill existing conduits cut at the floor line of a wall with a suitable patching ground material approved by the Structural Engineer.

3.5 INSTALLATION

- A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No change in Contract Price or Schedule will be allowed for making these changes.
- B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- C. Electrical equipment shall always be protected against mechanical or water damage. Electrical equipment shall not be stored outdoors. Electrical equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install electrical equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and tested as directed by the Owner/Engineer or shall be replaced with no change in Contract Price or Schedule, at the Owner/Engineer's discretion.

- D. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.
- E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.
- F. NEMA 3R, 4 or 4X enclosures shall not have raceways entering from the top if the enclosure is installed in a damp or wet area. Should raceways be installed entering the top, the enclosure shall be replaced, and raceways re-routed to enter the side or bottom. Conductors, if installed, shall be removed, and replaced. Correction of raceways entering the top and conductor replacement shall be provided with no change in Contract Price or Schedule.
- G. Conduits exiting tray in airconditioned indoor electrical rooms will enter the top of electrical enclosures. The location of these conduits shall be coordinated with the HVAC duct vents such that cold air will not blow on the conduits causing condensation which will enter the electrical enclosures. After installation, inspect the conduits while the HVAC system is running to ensure no condensation is forming and entering any electrical enclosure. Re-direct the air flow if possible or re-route the conduits to avoid condensation. Conductors in re-routed conduits shall be replaced, re-terminated, retested and the operation of the equipment retested with no change in the Contract Price or Schedule.

3.6 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 16120.

3.7 MANUFACTURER'S SERVICE

- A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section. All settings, including those settings required by the Power System Study, shall be made to the equipment, and approved by the Owner/Engineer prior to energizing of the equipment.
- B. Provide arc flash labels with the settings from the power system study on electrical equipment as specified.
- C. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer's warranty repairs.

3.8 TESTS AND SETTINGS

- A. Test systems and equipment furnished under Division 16 and repair or replace all defective work. Adjust the systems as specified and/or required.

- B. All tests required by the individual specification Sections shall be completed prior to energizing electrical equipment. Submit a sample test form or procedure. and submit the required test reports and data to the Owner/Engineer for approval at least two weeks prior to the startup of the tested equipment. Include names of all test personnel and initial each test.
- C. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.
- D. Check wire and cable terminations for tightness.
- E. Check rotation of motors prior to energization. Disconnect driven equipment if damage could occur due to wrong rotation. If the motor rotates in the wrong direction, the rotation shall be immediately corrected, or tagged and locked out until rotation is corrected.
- F. Verify all terminations at transformers, equipment, capacitor connections, panels, and enclosures by producing a 1 2 3 rotation on a phase sequenced meter when connected to "A", "B" and "C" phases.
- G. Provide mechanical inspection, testing and setting of circuit breakers, disconnect switches, motor starters, control equipment, etc. for proper operation.
- H. Check interlocking, control, and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematic and wiring diagrams.
- I. Check the ampere rating of thermal overloads for motors and submit a typed record to the Owner/Engineer of same, including MCC cubicle location and load designation, motor service factor, horsepower, full load current, temperature rise rating and starting code letter. If inconsistencies are found, new thermal elements shall be supplied and installed.
- J. Verify motor power factor capacitor ratings.
- K. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.
- L. Refer to the individual equipment sections for additional specific testing requirements.
- M. Adjust the systems and instruct the Owner's personnel in the proper operation of the systems.

3.9 TRAINING

- A. Provide manufacturer's training as specified in each individual section of the Specifications.

END OF SECTION

SECTION 16045 ELECTRICAL SUPPORT HARDWARE

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install electrical support hardware, as shown on the Drawings and as specified herein.
- B. Hardware shall include anchor systems, adhesive anchor systems, metal framing systems, and other electrical support systems, as shown on the Drawings and specified herein.

1.2 RELATED WORK

- A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.
- B. Other Divisions
 - 1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.

4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted in accordance with the requirements of Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
- D. Shop Drawings
1. Submit catalog data of all support hardware components specified under this Section. Catalog data shall show compliance with the referenced codes and standards. All selections, options and exceptions shall be clearly indicated.
 2. The submittal information for anchor systems shall contain manufacturer's specifications and technical data as follows:
 - a. Acceptable base material conditions (i.e. cracked, un-cracked concrete)
 - b. Acceptable drilling methods
 - c. Acceptable bore hole conditions (dry, water saturated, water filled, under water)
 - d. Manufacturer's installation instructions including bore hole cleaning procedures and adhesive injection.
 - e. Cure and gel timetables
 - f. Temperature ranges (storage, installation, and in-service).

1.4 REFERENCE CODES AND STANDARDS

- A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. NFPA 70 National Electrical Code (NEC)
 2. NFPA 70E Standard for Electrical Safety in the Workplace
 3. ASTM E 488-96 (2003); Standard Test Method for Strength of Anchors in Concrete and Masonry Elements, ASTM International.
 4. ASTM E 1512-93, Standard Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors, ASTM International
 5. AC308; Acceptance Criteria for Post-Installed Anchors in Concrete Elements, Latest revision.

6. SAE 316 Stainless Steel Grades

- B. All equipment components and completed assemblies having a UL standard specified in this Section of the Specifications, shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

- A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, a list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, all submittal requirements shall be complete, and an approved copy of all such submittals shall be available to the Owner/Engineer prior to delivery of the equipment. Delivery of equipment not completely constructed, onsite factory work, or failed factory tests will not be permitted.

- B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Adhesive Anchor Systems.

1. Deliver materials undamaged in Manufacturer's clearly labeled, unopened containers, identified with brand, type, and ICC-ES Evaluation Report number.
2. Coordinate delivery of materials with scheduled installation date, minimizing storage time at job-site.
3. Store materials under cover and protect from weather and damage in compliance with Manufacturer's requirements, including temperature restrictions.
4. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
5. Do not use damaged or expired materials.
6. Storage restrictions (temperature range) and expiration date must be supplied with product

D. Metal Framing Systems

1. Material shall be new and unused, with no signs of damage from handling.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its

installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 ANCHORING SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. HILTI Kwik Bolt 3
 - b. Approved equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Torque controlled expansion anchor consisting of anchor body, expansion element (wedges), washer and nut. Anchor shall be used for anchor sizes less than 3/8 inch.
2. All parts shall be 316 stainless steel materials conforming to SAE 316.
3. UL 203 Rated.

2.2 ADHESIVE ANCHORING SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. HILTI HIT-RTZ with HIT-HY 200 MAX.
 - b. Approved equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Anchor body with helical cone shaped thread on the embedded end and standard threads on the exposed end, with washer and nut, inserted into Injection adhesive. Anchor shall be used for anchor sizes 3/8 inch and larger.
2. All parts shall be 316 stainless steel materials conforming to SAE 316 standards.

2.3 STRUT SUPPORT SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - a. Tyco Unistrut
 - b. B-Line
 - c. Super-Strut
 - d. Approved equal
 - e. No equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Metal framing system for use in the mounting or support of electrical systems, panels and enclosures, and including lighting fixture supports, trapeze hangers and conduit supports.
2. Components shall consist of telescoping channels, slotted back-to-back channels, end clamps all threads and conduit clamps.
3. Minimum sizes shall be 13/16-inch through 3-1/4 inch.
4. Components shall be assembled by means of flat plate fittings, 90-degree angle fittings, braces, clevis fittings, U-fittings, Z-fittings, Wing-fittings, Post Bases, channel nuts, washers, etc.
5. Field welding of components will not be permitted.
6. Unless otherwise specified or shown on the Drawings, all parts shall be 316 stainless steel material conforming to SAE 316.
7. Framing systems for chlorine and ammonia rooms shall be manufactured of structural fiberglass.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment strictly in accordance with the manufacturer's instructions and the Contract Drawings.
- B. The locations of devices are shown as general on the Drawings and may be varied within reasonable limits as to avoid any piping or other obstruction without change in the Contract Price or Schedule, subject to the approval of the Owner and Engineer. Coordinate the installation of the devices for piping and equipment clearance.
- C. No electrical equipment or raceways shall be attached to or supported from, sheet metal walls.
- D. Install required safety labels.
- E. Electrical support channel shall be used to construct support assemblies as shown on the drawings. Horizontal braces attached to concrete or CMU walls or structural building steel are permitted if the space between the back of the support structures and the attachment points are too small to permit a walk space. No attachments to sheet metal are permitted as specified above. Incorporate additional channel materials and/or provide assemblies of double channel with enough vertical and horizontal members to form a rigid structure whether such additional materials or the use of double channel materials are shown or specified. Support structures shall be rigid without the use of channels to form angle supports between the back or front of the assembly and the ground. Angle supports are strictly prohibited because they provide tripping hazards.

3.2 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.3 POST INSTALLED ANCHOR SYSTEMS

- A. Prior to installation of the anchor systems, the hole shall be clean and dry in accordance with the manufacturer's instructions.

3.4 CLEANING

- A. Remove all rubbish and debris from inside and around the installation. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

END OF SECTION

SECTION 16060 ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish, install and test all equipment, wiring and appurtenances as may be required to perform the electrical demolition shown on the Drawings and as specified herein.
- B. Make all required field verifications specified and/or as necessary to determine all the requirements as specified for the continued operation of the Owners facilities during the construction process prior to bidding. All costs and time required to perform the work shall be included in the Contract Price and Schedule.

1.2 SCHEDULES

- A. Schedule all required shutdowns with the Owner/Engineer to coordinate the system demolition and installation of temporary facilities with the Owner's operational requirements.

1.3 STANDARDS

- A. Temporary wiring of systems to maintain operation of facilities while undergoing modifications and demolition shall be provided in accordance with:
 - 1. American National Standards Institute / National Fire Protection Association (ANSI/NFPA), No. 70 – National Electrical Code (NEC), Article No. 590 – Temporary Wiring.

1.4 QUALITY ASSURANCE

- A. Verify field measurements and circuiting arrangements are as shown on the Drawings.
 - 1. Demolition drawings are based on casual field observation and existing record documents. Discrepancies shall be reported to the Owner/Engineer before disturbing the existing installation.
 - 2. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Beginning demolition, signifies the existing conditions have been accepted and warrants that service to equipment and items not scheduled or indicated for removal will be maintained. Temporary shutdowns and demolishing of any equipment shall be arranged and approved by the Owner to not interrupt critical process operations.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

2.2 DESIGN AND CONSTRUCTION

- A. Provide temporary electrical conductors and raceway as required to maintain continued operation in accordance with the Owner's operational requirements and meeting the requirements of the NEC.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.
- B. Coordinate utility service outages with the Utility Company. Continuous service to operating equipment shall be provided as required by the Owner's process operational needs which may include the temporary use of portable generation as specified herein.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner/Engineer at least two weeks in advance, before partially or completely disabling system.
- E. The Owner's process operations shall continue without interruption throughout the project demolition and construction as required by the Owner and/or regulating bodies including but not limited to the EPA, and State or Local authorities having jurisdiction.
 - 1. As required to meet the Owner's process requirements, provide on-site generation with the capacity and voltage required by the Owner's power system to prevent process interruptions unacceptable to the Owner. Include all engine-generator fluids and fuel and rental expenses for the duration required by the work in the Contract Price.
 - 2. Examine the Contract Documents and make any site visits necessary, including interviews with Owner's Personnel to determine what process are required to remain in service prior to bidding. Include all costs to keep the required process in operation including all materials, labor, expenses required by the electric Utility serving the project site and on-site generation in the Contract Price and Schedule. The determination of the requirements for

continued process operations prior to bidding is required. No increase in Contract Time or Price will be allowed if this requirement is not met.

3. If failure to provide adequate power to keep the process in operation which causes a regulatory body to levy fines against the Owner, Owner shall be reimbursed. No increase in Contract Price for such expenses will be accepted.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring from the load to the source of supply.
- C. Remove exposed abandoned raceways, boxes, and fittings, including those located above accessible ceiling finishes. Cut abandoned conduit flush with walls and floors, and patch surfaces to match the existing surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned conductors. Remove abandoned outlets if raceway system serving them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment. Remove all associated raceways and conductors and the supporting means. Patch the wall, floor, or other surfaces where the equipment and associated raceway were attached to match the existing surfaces.
- F. Disconnect and remove electrical devices associated with mechanical equipment that has been removed. Remove all associated raceway and conductors. Patch the wall, floor, or other surfaces where the electrical devices and associated raceway were attached to match the existing surfaces.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing installations which remain active. Modify installation or provide access to panels as appropriate.
- I. Where the demolition or revision of any portion of a raceway or box in the raceway system, in classified area, causes the raceway system of the area to no longer comply with the classification or specification requirements of the area, provide and install such boxes, fittings, etc. as may be necessary to return the raceway system to compliance with the classification of the area and with these specifications.
- J. Extend existing installations using materials and methods as specified for new work. Using existing raceways is acceptable where extension of existing raceways is shown or specified only if the existing raceways are in accordance with the specifications for the new raceways. Replace existing raceways which do not meet these specifications.

- K. All work shall be done in an orderly and careful manner. Hold noise, dust, and vibration to a minimum and conduct the work to avoid any damage to the surroundings. Remove all items and parts as shown and noted on the Drawings and as otherwise may be required to be removed to complete the work as specified.
- L. Salvaged Equipment and Materials
 - 1. The Owner shall have the right to retain any or all electrical and instrumentation equipment shown or specified to be removed from the site.
 - 2. Prior to starting demolition, the Contractor and Owner/Engineer shall jointly visit the areas of demolition and the Owner/Engineer will designate those items that are to remain the property of the Owner.
 - 3. Equipment and material designated by the Owner to remain the property of the Owner shall be removed from the work area and transported to a designated location on the site and stored for the Owner's use. Store on wood runners raised above the surrounding grade and cover with weather resistant covering and tie securely or store inside Owner furnished storage as directed by the Owner/Engineer.
 - 4. Take necessary precautions in removing Owner designated property to prevent damage during the demolition process. Remove steel structural members by unbolting, cutting welds, or cutting rivet heads and punching shanks through holes. Do not use a cutting torch to separate the Owner's equipment or material unless approved by the Owner/Engineer.
 - 5. If possible, items to be salvaged shall be removed in one piece or in a manner that does not prevent their reuse. Loose components may be removed separately. Controls and electrical equipment may be removed from the equipment and handled separately. Large units may be handled separately.
- M. Equipment not otherwise designated to remain the property of the Owner in accordance with the pre-demolition identification process shall become the property of the Contractor. Material that has become the property of the Contractor shall be promptly removed from the construction site.
- N. Refurbish and replace any existing facility to be left in place which is damaged by the demolition operations with no change in Contract Price or Schedule. The repair of such damage shall result in the parts being returned to such a condition which is at least equal to that found at the start of the Work.

3.3 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are specified or shown to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for

vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

- C. Motor Control Centers, Switchboards and Switchgear: Check the tightness of electrical connections. Provide new doors on motor control centers cubicles as shown or required. Provide new tags that match the existing tags for spaces or cubicles which have become spares or spaces.

END OF SECTION

**SECTION 16105
POWER SYSTEM STUDY**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Provide a Power System Study for the electrical power system, including a Short Circuit Study, Coordination Study, Arc Flash Hazard Study, Load Flow Study, and additional studies as listed below.
- B. For new electrical systems connecting to an existing electrical system, confirm and include all pertinent data of the existing electrical system at the point of connection. If during field investigations conflicts between the Contract Documents and the field conditions are encountered, immediately notify the Owner/Engineer for a resolution to the conflict. Copies of the data obtained, shall be organized, and submitted to the Owner/Engineer at the same time of transmittal to the Study Engineer, to show that all the requested data gathering work has been completed.
- C. The electrical power system shall be deemed to include the utility company's transformer, the Owner's entire power distribution system, all existing and new system components, including any on-site standby generation. The short circuit and coordination study reports shall provide an evaluation of the electrical power systems and the model numbers and settings of the protective relays or devices and metering or motor monitoring devices for all motor protective relays and electric system monitoring devices.
- D. Obtain and provide all pertinent data necessary for the successful completion of the Power System Studies, including information on all existing or new equipment and wiring pertinent to the Study. This includes all cable and raceway data, data for existing or new motors, data from all existing or new switchgear, motor control centers, panel boards, and separately mounted fuses, starters, and circuit breakers. Obtain all existing or new protective device information to include all present settings. Obtain any needed data or information from Contract Documents, various suppliers, the Electric Utility and from conducting his own field investigations. If during field investigations conflicts between the Contract Documents and the field conditions are encountered, immediately notify the Owner/Engineer for a resolution to the conflict. Copies of the data obtained, shall be organized, and submitted to the Owner/Engineer at the same time of transmittal to the Study Engineer, to show that all the requested data gathering work has been completed.
- E. The Study shall model all electrical equipment down to and including 480-Volt utilization equipment. All motors and constant loads shall be modeled individually, including disconnect switches, if present. Motors and constant loads 240V and below may be combined as a lump load.
- F. The Power System Study shall be performed using SKM Power*Tools.

1.2 RELATED WORK

- A. Refer to Division 16000 and the Contract Drawings, for related work and electrical coordination requirements.
- B. Provide all the information required, to the Study Engineer in a timely manner.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000,

the Contract Documents and as specified herein.

- B. The following submittals shall be submitted in the order shown.
1. Qualifications: No more than four weeks after the contract has been awarded, provide a submittal of the engineering firm, name, and qualifications of the Study Engineer, for approval. No submittals required under this section will be accepted until this requirement is met, and if submitted will be returned without review. The qualifications shall not be submitted along with the preliminary study.
 2. Preliminary Study: The second submittal shall consist only of the Short Circuit Study results and equipment evaluation, based upon sound engineering reasonable assumptions, where known values are not available. This submittal shall be used by the Study Engineer to ascertain the short circuit current rating of the related equipment. This submittal shall be made and approved prior to any shop drawing submittal being reviewed for electrical equipment for which the results of this preliminary study are required. The submittal and approval of the Preliminary Study is a critical milestone in the Construction Schedule. Failure to submit an acceptable study in a timely manner may delay the Project Schedule. No exceptions will be made for the specified sequence of the submittal of the Study prior to the submittal of shop drawings, and any delays caused by a late submittal of the Study will not be a cause for the Engineer / Owner to allow any extension of the Contract Time or Contract Price.
 3. Final Study: The final submittal shall be the Final Study and shall include all items listed under "Scope of Work" in this Section. No electrical equipment for which the results of the final study are required, shall be energized until such results have been reviewed and approved by the Engineer / Owner, and applied to such electrical equipment, and certified as Settings Complete by the manufacturer's field representative. This submittal is required to include a PDF of the study report and coordination curves and an electronic copy of the computer model raw data input files.
- C. All shall be submitted in accordance with the requirements listed in Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- D. Upon completion of the studies, submit the studies for approval to the Owner/Engineer. The study submittal shall include all the input and output data files in electronic format for use directly with the specified study software. The Study shall include an actual size sample of an Arc Flash and Shock Hazard label with typical information shown. Allow not less than three calendar weeks for review of the both the Preliminary and Final Studies by the Owner/Engineer. The submittal shall not contain unresolved questions, conflicts, or selective device coordination conflicts. A submittal containing such questions or conflicts will be returned unreviewed and shall not be resubmitted until such questions or conflicts have been resolved. Delays in the Construction Schedule due to the submittal of unacceptable Power System Studies will not be a cause for the Engineer / Owner to approve any changes in the Contract Time or Contract Price.
- E. The completed, sealed, and signed studies, with all known issues resolved, shall be submitted to the Owner/Engineer for approval, not less than 30 days prior to site delivery of any equipment containing protective devices requiring selections and settings for certification by the manufacturer. Final copies shall be in electronic form (Adobe PDF formatted files). model data files, including any custom forms, labels, formats, and libraries, shall be provided at the same time in electronic format as specified herein. All individual arc flash labels, ready for installation, shall be provided with this submittal.
- F. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and

Maintenance Manual.

- G. Owner/ Engineer reserves the right to request a copy of the computer model of the study during construction for review.

1.4 REFERENCE CODES AND STANDARDS

- A. The specified studies shall be in accordance with the latest versions of the following codes and standards.
 - 1. IEEE Standard 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations, Including Amendment 1584a.
 - 2. NFPA-70E - Standard for Electrical Safety Requirements for Employee Workplaces.
 - 3. ANSI/NFPA 70 – National Electrical Code
- B. The studies shall be performed using the latest version of the computer software used for the power system study.

1.5 QUALITY ASSURANCE

- A. The studies shall be performed by an Electrical Engineering Services firm, who is regularly engaged in power system studies. The studies shall be performed by a Licensed Professional Electrical Engineer (PE) in the regular employment of the firm with proficiency in electrical power systems engineering and shall seal and sign the final completed power system studies. The Study Engineer shall be licensed to practice Electrical Engineering in the State of Texas.
- B. The PE shall comply with the State PE Law in the submittal of the Preliminary and Final Studies. The Preliminary Study shall bear the name and registration number of the PE who will be sealing the work along with the statement acceptable to the State PE Board which indicates the work is "Preliminary, Not for Construction" and is "Issued for Review". The final report shall bear the Engineer's Seal, Registration Number, Original Signature and Date in accordance with the State PE Laws.
- C. Computer Model Revision Control
 - 1. The Study Engineer shall check out and receive from the Owner, prior to executing the Study, the base model computer file to be used for the study. The Study Engineer shall be responsible for the return of this computer file to Owner upon completion of the Study and acceptance of the Report by the Owner/Engineer. Field verify all existing protective equipment, protective device settings and conductors shown in the model which are in series with the new equipment all the way from the Utility and or Generator power sources to the connection point of the new equipment. Field verify the name plate data on all existing motors connected to the same bus or any upstream bus which is in series with the new equipment. The same criterion applies to all existing equipment modified under this Contract. Notify the Owner/Engineer of any discrepancies discovered which exist between the Owner's power system model and existing field conditions prior to the submittal of any Studies for review.
 - 2. The Study Engineer shall incorporate the Study conducted for this Contract into the overall base model computer file. The updated file shall be returned to the Engineer for review along with the Report Submittal. It is unacceptable to add the branches of the new equipment provided under this Contract in a stand-alone or separated configuration from

the overall power system and adding in the available fault current at the point of attachment. All revisions and the addition of all new equipment shall be tied into the existing power system model by the Study Engineer.

3. The Study Engineer shall forward the updated base model computer files to the Owner with the submittal of the Preliminary Study for the Engineer to check, and again the final model shall be submitted upon approval of the Final Report Submittal. This shall constitute checking this file back in to the Owner. Should the Report Submittal be rejected for any reason, the base model computer file shall be checked out again and returned to the Study Engineer for further use.

1.6 SCHEDULE OF WORK

- A. The selection of the Study Engineer shall be submitted to the Owner/Engineer for approval in a timely manner, in accordance with the time specified. The Study shall be completed and submitted in the phases as specified above.
- B. The completed studies, with all known issues resolved, shall be submitted to the Owner/Engineer for approval, as specified above.

PART 2 - STUDIES

2.1 ELECTRICAL ENGINEERING SERVICES FIRMS

- A. The work experience resume of the Study Engineers who will be doing the work and the Professional Engineer who will be sealing the Final Study shall be submitted along with his / her PE registration number in the State where the equipment is to be installed. Subject to compliance with the Contract Documents, the following services firms are acceptable:
 1. Cutler Hammer Engineering Services
 2. ABB Industrial Engineering Services
 3. Schneider Electric Engineering Services
 4. Allen Bradley Co. Engineering Services
 5. Strategic Engineering, Jeffery Wilbanks
 6. Approved Equal

2.2 SHORT CIRCUIT STUDY

- A. Provide a complete short circuit study. Include three phase, phase-to-ground calculations, and X/R ratios. Provide an equipment interrupting or withstand evaluation based on the actual equipment and model numbers provided on this project including any existing equipment modified in any way under this project. Field verify the name plate data of all existing transformers, protective device equipment and the size and length of any existing conductors in series with the new or modified equipment in the Contract. Conductor lengths in concealed conduit shall be estimated from field observations and any available existing conformed to construction record drawings. Generic devices or values are not acceptable. Normal system operating method, alternate operation, and operations that could result in maximum fault conditions, shall be thoroughly addressed in the study. Provide single phase to ground and three phase to ground fault information. The study shall assume all motors are operating at rated voltage with the exception that motors, clearly identified as "standby," shall

not be included. Electrical equipment bus impedances shall be assumed as zero. Short circuit momentary duties and interrupting duties shall be calculated based on maximum available fault current at the switchgear busses, switchboard busses, motor control centers and panelboards. Provide the short circuit results using the worst-case scenario of the model. The study shall be performed using actual available short circuit currents as obtained from the Electric Utility. An assumption of infinite bus for the purposes of the Preliminary or Final study is not acceptable.

- B. Provide an equipment evaluation study to determine the adequacy of the fault bracing of all bus from the panel board level up to the main switchgear or protective device. Include circuit breakers, controllers, surge arresters, busway, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents.
- C. As a minimum, each short circuit study shall include the following:
 - 1. One-Line Diagram: The presentation of the One Line Diagram shall be on one or more 22 x 34-inch drawings with match lines if on multiple sheets, using font sizes which are easily readable. Include the following information and activities listed below:
 - a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
 - b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.
 - c. Power and voltage ratings, impedance, primary and secondary connections (Delta, Wye, Grounded Wye, Zig-Zag, etc.) of all transformers. Use the ratings of the actual transformers being provided where available. The Final Study shall use the name plate information on the transformers provided. Use the actual name plate information on all existing transformers. Generic transformer data on new or existing transformers are not acceptable.
 - d. The type, manufacturer, and ratio of all instrument transformers energizing each relay shall be included. Field verify this information on all existing protective devices which are in series with the new equipment provided under this Contract.
 - e. Nameplate ratings of all motors and generators with their sub transient reactance. Field verify the name plate information of all existing generator providing power to the new equipment, and field verify the name plate motor information on all motors connected to the bus of existing equipment which is in series with the new equipment.
 - f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors. Provide short circuit studies using each source of power separately. The study shall determine if there is sufficient short circuit current to adequately cause interruption of a protective device using the weaker power source (typically local generation) and shall determine if the equipment can safely interrupt the fault if the greater power source is connected. Additional short circuit calculations shall include emergency as well as normal switching conditions as well as normal and emergency power sources described here in.
 - g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, disconnect switches etc. shall be included.
 - h. Arrange for the shutdown of the equipment requiring field verification with the Owner,

Investigations shall be done at a time, including after hours if necessary, which do not significantly interrupt the Owner's process operations.

2. Impedance Diagram: The presentation of the Impedance Diagram shall be on one or more 22 x 34-inch drawings with match lines if on multiple sheets, using font sizes which are easily readable. Include the following:
 - a. Available fault current or impedance from the utility company.
 - b. Local generated capacity impedance.
 - c. Transformer and/or reactor impedances.
 - d. Cable impedances.
 - e. System voltages.
 - f. Grounding scheme (resistance grounding, solid grounding, or no grounding).
3. Calculations: Include the following:
 - a. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the three-phase and line-to-ground short circuits of each case.
 - b. Calculate the maximum and minimum fault currents.

2.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide a protective device coordination study. The study shall include all electrical equipment provided under this Contract as well as the existing system, including Control Panels containing power and protection equipment, power panels and lighting panels. The Study shall include any upstream or downstream equipment that has an impact on the Coordination Study. The study shall show transformer damage curves, cable short circuit-withstand curves and motor starting curves. The phase overcurrent and ground fault protection shall be included, as well as settings for all other adjustable protective devices. All motor monitoring relays and protective or monitoring devices that are a part of a supplier's equipment, such as soft starters or adjustable frequency drives shall be included. Include the last protective device in the Electric Utilities' system feeding each facility being considered. Include all medium voltage switchgear, medium voltage motor control centers, 480V distribution switchgear and switchboards, 480V motor control centers and 480 Volt panelboard main circuit breakers. The phase overcurrent and ground-fault protection shall be included, as well as settings for all other adjustable protective devices.
- B. Selective device coordination is required between protective devices in equipment specified in each Section of the Electrical Specifications, and between each piece of electrical equipment supplied for this project. Include settings for the protective devices in existing equipment feeding any piece of new equipment and provide recommended settings for the existing protective device. If the Study Engineer, during his work, determines that selective coordination cannot be obtained in or between pieces of existing and new equipment as specified, the Owner/Engineer shall immediately be notified, Provide the supporting information to the Owner/Engineer for resolution of the problem.
- C. Provide Time-Current Curves (TCC) on 8-1/2 x 11 log-log paper.

1. The Time Current Curves shall be presented in series only. Parallel branches shall not appear on the same TCC presentation.
2. Do not put more than one branch of protective devices on any one coordination curve.
3. Show a maximum of seven devices in series on one TCC. Include a one-line diagram and the names of each protective device in the branch on the coordination curve drawing. Use the same color for the same protective device appearing on different TCC presentations.
4. Provide separate drawings for ground fault coordination curves.
5. Use the names designated in the Contract Documents.
6. Include motor starting curves and transformer inrush and damage curves, generator decrement curves, and cable short circuit withstand curves.
7. Provide TCCs for any energy-reducing systems being utilized such as RELT switches or Zone-Interlocking systems.

2.4 ARC FLASH HAZARD STUDY

- A. The Power System Study shall include an Arc Flash Hazard Study that shall present the level of arc flash hazard for each item of electrical equipment, and the appropriate level of protection required per OSHA standards.
- B. The analysis shall be performed with the aid of computer software intended for the purpose, to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.
- C. The analysis shall be performed under each possible condition and shall identify the worst-case Arc-Flash condition. The preliminary report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- D. The calculations shall be performed in accordance with IEEE 1584 and safe approach requirements determined in accordance with NFPA-70E. (Latest versions)
- E. Results of the Analysis shall be submitted in tabular form, and shall include, device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment and AFIE levels. The analysis shall be presented on paper and included with the specified electronic format files.
- F. After approval of the Study, provide the Arc Flash Hazard Warning Labels. The Study Engineer shall oversee the installation of the required labels for each item of electrical equipment furnished on the project and for each item of existing equipment for which the arc flash hazard has changed. A typical warning label shall be submitted with the Study for approval, and shall include the information listed below, at minimum.
 1. Flash Hazard Protection Boundary.
 2. Limited Approach Boundary.
 3. Restricted Boundary.
 4. Incident Energy Level.
 5. Required Personal Protective Equipment Rating.
 6. Type of Fire Rated Clothing.
 7. Glove Class

8. Fault Current at the particular bus
9. Date that the study was performed
- G. Labels shall be affixed to the enclosures, in a readily visible location, for all power-handling equipment as follows.
 1. Switchgear
 - a. One label for the line side of the main breaker
 - b. One label on each vertical section, indicating the data for the switchgear bus
 2. MCCs
 - a. One label for the line side of the main breaker
 - b. One label on each vertical section, indicating the data for the MCC bus
 3. Switchboards
 - a. One label for the line side of the main breaker
 - b. One label for the load side of the main breaker showing line-side value
 - c. One label on each vertical section, indicating the line-side value of the main-breaker
 4. 480V Panelboards
 - a. Single label for the line side of the main breaker of the panelboard
 - b. Label to indicate data for line side of the main breaker
 5. Panelboards (240V and below)
 - a. Single label for the line side of the main breaker of the panelboard
 - b. Label to indicate data for line side of the main breaker
 6. Control panels, including combination starters
 - a. Single label at each unit operated at 480 Volts or above.
 - b. Label to indicate data for the line side of the disconnect device.
 7. Disconnect switches
 - a. Single label at each disconnect switch operated at 480 Volts or above.
 - b. Label to indicate data for the line side of the switch
- H. Size of each label shall be not less than 4 inches wide and 3 inches tall.
- I. Coordinate the final locations of the labels with the Owner/Inspector

2.5 LOAD FLOW ANALYSIS

- A. Perform a load flow analysis of the new distribution system installed under this contract.

- B. The load flow shall include all motor loads, HVAC loads, Dry-Type Transformers loaded at 75%, constant loads, lighting loads, and all other pertinent electrical equipment.
- C. Provide a summary of findings and include in the report.

PART 3 - EXECUTION

3.1 FIELD SERVICES

- A. Label Installation Certification
 - 1. When the label installation is complete, the Contractor, the Contractor's Study Engineer and the Owner/Engineer shall jointly inspect each location and show to the Owner/Engineer's satisfaction that labels are installed in all the specified locations, and in any additional recommended locations indicated in the Study.
- B. The cost of Field Services shall be included in the Contract Price shall be included in the Contract Schedule.

END OF SECTION

**SECTION 16110
RACEWAYS, BOXES, ENCLOSURES, AND FITTINGS**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein. A raceway system shall consist of materials designed expressly for containing wires and cables, including but not limited to, conduit, device bodies, conduit bodies, raceway boxes, enclosures containing electrical devices, controls and related materials.

1.2 RELATED WORK

- A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

- B. Other Divisions

- 1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.

4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
- D. Submit to the Owner/Engineer, shop drawings and product data, for the following:
 1. Submit catalog data of all conduit, conduit fittings, boxes, enclosures, and accessories, specified under this Section.
 2. Catalog data shall show compliance with the referenced codes and standards.
 3. All selections, options and exceptions shall be clearly indicated.

1.4 REFERENCE CODES AND STANDARDS

- A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 1. NFPA 70 – National Electrical Code (NEC)
 2. NFPA 70E – Standard For Electrical Safety in the Workplace
 3. UL 6A – Electrical Rigid Metal Conduit
 4. ANSI C80.5 – Electrical Rigid Aluminum Conduit
 5. UL 514B – Outlet Bodies
- B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

- A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.

- C. The installer of materials specified herein, shall have a minimum of five years' experience in the installation of each type of material. Proof of experience shall be submitted, upon request of the Owner/Engineer, prior to installation.
- D. Used materials are unacceptable, will be rejected and shall be removed from the job site. Used materials, if installed, shall be removed and replaced with new materials. If new materials are installed with used materials, and the removal of the used materials renders the new materials in an unacceptable condition, such as new conductors installed in used raceway components, (determined by the Engineer/Owner alone) then the new materials shall be removed along with the used materials and replaced. No increase in the Contract Price nor in Contract Schedule will be allowed.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.
- B. Materials shall be handled and stored in accordance with manufacturer's instructions.
- C. Materials shall not be stored exposed to sunlight. Such materials shall be completely covered.
- D. Materials showing signs of previous use, jobsite storage at another location, or exposure to the elements or other damage will be rejected.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Raceways and fittings shall be as shown on the Drawings, with a minimum 3/4-inch trade size.
- B. Device entries less than 3/4 inch shall be provided with an adaptor to connect 3/4-inch or larger conduit. The following adaptors are acceptable:
 - 1. REA12SA, Cooper Crouse Hinds for aluminum

2. ADAPT ADU302930, REDAPT for 316 stainless.
3. Approved equal

2.2 CONDUIT RACEWAY

A. PVC Coated Rigid Aluminum Conduit (CRMC)

1. PVC coated rigid aluminum conduit shall have a minimum 0.040-inch thick, polyvinyl chloride coating permanently bonded to rigid aluminum conduit and an internal chemically cured urethane or enamel coating which shall be a minimum of 2 mil thickness on the interior of the conduit and the interior of fittings, conduit, covers, and bodies.
2. Rigid Aluminum conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FED Spec WW-C-540C, ANSI C80.5 and UL 6A.
3. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.
4. Elbows and couplings shall be PVC coated by the same manufacturer supplying the conduit PVC coating system. Elbows and couplings used with PVC coated conduit shall be furnished with a PVC coating bonded to the aluminum, the same thickness as used on the coated aluminum conduit.

B. Liquid tight Aluminum Flexible Metal Conduit (LFMC)

1. Liquid tight aluminum flexible metal conduit shall have an interlocked aluminum core, PVC jacket rated for 60 degrees C, and meeting NEC Article 351.
2. Fittings used with liquid tight flexible aluminum conduit shall be copper-free aluminum and shall conform to FEDSPEC AA50552, and UL-514B.

C. Aluminum Flexible Metal Conduit (FMC)

1. Aluminum flexible metal conduit shall have an interlocked aluminum core, meeting NEC Article 348, UL 1 and Federal Specification WW-C-566C.
2. Fittings used with aluminum flexible metal conduit shall be copper-free aluminum shall conform to FEDSPEC AA50552.

D. Rigid Aluminum Conduit (RMC)

1. Rigid Aluminum conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FED Spec WW-C-540C, ANSI C80.5 and UL 6A.

E. Rigid PVC Schedule 40 Conduit (RNC}

1. Schedule 40 PVC Rigid Nonmetallic Conduit (RNC) shall be designed for use underground as described in the NEC, resistant to sunlight. The conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B. Conduit shall have a UL Label.

F. Rigid PVC Schedule 80 Conduit (RNC)

1. Schedule 80 PVC Rigid Nonmetallic Conduit (RNC) shall be designed for use above ground and underground as described in the NEC, resistant to sunlight. The conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B

2.3 WIREWAYS

- A. All wireways shall be NEMA 4X 316 stainless steel, with gasketed hinged covers and stainless steel screws stainless steel quick-release type latches. Wireway shall have two Breather/Drains for each ten feet of wireway. Breather/Drain shall be in the bottom, near the ends of the wireway. Wireways shall have integral welded mounting lugs. Bolted-on mounting lugs are unacceptable

B. Manufacturers

1. Industrial Enclosure Corporation
2. Cooper B Line
3. Approved equal

C. Breather/Drains

1. Eaton Crouse-Hinds 316 stainless steel
2. Approved equal

- D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.4 RACEWAY BOXES AND EQUIPMENT ENCLOSURES

- A. The term box and enclosure are synonymous for this specification. Boxes and enclosures specified herein, include terminal boxes, junction boxes pull boxes, and boxes for switch, receptacles and lighting. Enclosures used for electrical and instrumentation equipment, other than terminal boxes, shall be provided as described in this section with references to this specification in other specification sections. All raceway boxes and equipment enclosures shall be provided with a common ground point and shall be UL rated.

- B. NEMA Type 4X boxes shall be 316 stainless steel or aluminum only as otherwise specified or shown with mounting lugs or brackets welded on the box, suitable for wall mounting, or have mounting feet where self-standing. Boxes for wall-mounting shall have integral welded-on mounting lugs. Enclosures with mounting feet shall have the mounting feet brackets for the attachment of mounting feet welded on. Boxes manufactured with holes intended for mounting using bolted-on mounting lugs or feet are not acceptable. Drilling through the back of the box to mount is strictly prohibited. Drilled boxes shall be removed and replaced. All boxes shall have continuously welded seams ground smooth, and shall have continuous hinged, gasketed doors. Box bodies shall not be less than 16 gauge. Boxes larger than 24 inches X 20 inches shall have a three-point type latch with handle. Boxes 24 inches X 20 inches or smaller shall have 316 stainless steel luggage type quick release latches, or three-point latch system with all components 316 stainless steel. Latch systems requiring tools to open or close are unacceptable.

C. Manufacturers

1. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
2. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
 - a. Eaton Crouse Hinds
 - b. Hoffman
 - c. Appleton Electric
 - d. EMF Company
 - e. NEMA Enclosures Company
 - f. Cooper B Line
 - g. Rittal EMF Company
 - h. NEMA Enclosures Company
 - i. Approved equal
 - j. The following are non-metallic enclosure manufacturers:
 - 1) Allied Molded Products, Inc.
 - 2) Cantex
 - 3) Hubbell-Wiegmann Non-Metallic

4) Approved equal

D. NEMA 4X 316 Stainless Steel enclosures

1. Use for all locations unless otherwise shown or specified
2. Type 316 stainless steel, body and door
3. Stainless steel continuous hinge
4. Foam in-place gasket
5. Single point quarter turn latches (20-inch X 24-inch and smaller). All others shall have three-point

E. NEMA 4X Aluminum (Where shown on the Drawings) boxes shall be constructed as follows:

1. Type 5052 aluminum, body and door
2. Stainless steel continuous hinge
3. Foam in-place gasket
4. Single point quarter turn latches (20-inch X 24-inch and below). All others three-point latch

F. NEMA 12 boxes (Where shown on the Drawings) shall be constructed as follows:

1. Type 5052 aluminum, body and door
2. Stainless steel continuous hinge
3. Foam in-place gasket
4. Single point quarter turn latches (20-inch X 24-inch and below). All others three-point latch

G. NEMA 4X 316 Stainless Steel enclosures (for all other locations).

1. Type 316 stainless steel, body and door
2. Stainless steel continuous hinge
3. Foam in-place gasket
4. Single point quarter turn latches (20-inch X 24-inch and below). All others three-point

H. NEMA 1 or NEMA 1A boxes shall not be used.

I. Malleable iron boxes shall not be used.

2.5 DEVICE BOXES

- A. Device boxes installed in aluminum raceway systems for switches and receptacle, etc., shall be copper free cast aluminum, and shall have tapered, threaded, hubs, with integral bushings. Boxes shall have internal grounding screw, and a minimum of two mounting feet. Boxes shall be type FD.
- B. Manufacturers
 - 1. Eaton Crouse-Hinds
 - 2. Appleton
 - 3. Approved equal

2.6 CONDUIT OUTLET BODIES

- A. Conduit outlet bodies and covers shall be Form 7, copper-free aluminum, with captive screw-clamp cover, neoprene gasket and stainless-steel screws and clamps for conduits up to and including 2-1/2 inches.
- B. Manufacturers
 - 1. Eaton Crouse-Hinds Form 7 with Mark 7 wedge-nut cover
 - 2. Appleton
 - 3. Approved equal
- C. Provide junction boxes for conduits larger than 2-1/2 inches.
- D. All outlet boxes and covers for Class 1 Division 2 areas shall be rated NEMA 4X aluminum or 316 stainless steel.
 - 1. Manufacturers
 - a. Eaton Crouse-Hinds
 - b. Approved equal

2.7 CONDUIT HUBS

- A. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw
- B. Manufacturers
 - 1. T&B H150GRA Series
 - 2. Approved equal

- C. Conduit hubs for use on outlet boxes or boxes containing electrical or instrumentation equipment shall be watertight, threaded steel, insulated throat, hub of the female-female type, with locking nipple of male construction. Hubs shall be T&B HT Series, or approved equal. Hubs with female locking nipples, where the hub projects into the box, will not be acceptable.

2.8 GROUNDING BUSHINGS

- A. Grounding bushings shall be insulated lay-in lug grounding bushings with tin-plated copper grounding path. Bushings shall have integrally molded noncombustible phenolic insulated surfaces rated 150°C. Each bushing shall be furnished with a plastic insert cap. The size of the lug shall be sufficient to accommodate the maximum ground wire size required by the NEC for the application.
- B. Manufacturers
 - 1. O-Z/Gedney Type ABLG
 - 2. Approved equal

2.9 RACEWAY SEALANT

- A. Raceway sealant for use in the sealing of raceway hubs, entering or terminating in boxes or enclosures where such sealing is shown or specified, shall be 3M 1000NS Watertight Sealant, or approved equal.

2.10 CONDUIT PENETRATION SEALS

- A. Conduit wall and floor seals
 - 1. O.Z./Gedney Co. Series CSM
 - a. Type CSML-XXXP shall be used for all applications that do not require a recessed sealing bushing.
 - b. Type CSMI-XXXP shall be used for all applications that require a recessed sealing bushing.
 - 2. Approved equal

2.11 EXPANSION-DEFLECTION COUPLING

- A. Combination expansion-deflection fittings with 3/4-inch axial expansion and contraction movement, 3/4-inch parallel misalignment movement, and up to 30 degrees of angular movement in any direction. It shall be copper-free aluminum, with exterior tinned copper braid bonding jumper and 316 stainless grounding straps
- B. Manufacturers
 - 1. Cooper Crouse- Hinds Model XD

2. Robroy
 3. Approved equal
- C. Provide an aluminum cover over the fitting to protect the rubber portions from exposure to direct sun light. Secure the aluminum sun shield with a minim of two stainless steel tie wraps. See detail on the Drawings
- D. Nylon tie wraps are not acceptable.

2.12 EXPANSION FITTINGS

- A. Expansion fittings shall provide eight-inch movement, shall be made of copper-free aluminum, with exterior tinned copper braid bonding jumper and 316 stainless grounding straps. Provide internal grounding. Nylon tie wraps are not acceptable.
- B. Manufacturers
1. Crouse-Hinds Co. Type XJGSA
 2. Robroy
 3. Approved equal

2.13 EXPLOSION-PROOF SEALS, BREATHERS AND DRAINS

- A. Explosion proof fittings shall be designed for Class 1 Division 1, Group D, hazardous locations. Fittings shall be copper-free aluminum, with seals, breathers and drains. Provide type ED, or as required for the application.
- B. Manufacturers
1. Eaton Crouse-Hinds Co.
 2. Appleton Electric Co.
 3. O.Z./Gedney Co.
 4. Approved equal

2.14 KELLEMS GRIPS

- A. Kellems grips cables supports shall be 316 stainless steel.

2.15 CONDUIT MOUNTING EQUIPMENT

- A. Pull and junction box supports, spacers, conduit support rods, clamps, hangers, channel, nut, bolts, washers, etc. and shall be 316 stainless steel. Nylon tie wraps are not acceptable.

2.16 CONDUIT IDENTIFICATION TAGGING

- A. Use the tagging formats for conduits as shown on the Drawings. Where modifications or additions are made to existing equipment replace existing tags with new modified tags.
- B. Conduit identification plates shall be embossed stainless steel with stainless steel band, permanently secured to the conduit without screws. Nylon tie wraps are not acceptable.
- C. Identification plates shall be as manufactured by the Panduit Corp. or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATIONS

- A. Unless exact locations are shown on the Drawings, coordinate the placement of raceway systems and related components with other trades and existing installations.
- B. Raceway Systems for the installation of Fiber Optic Cables shall not contain conduit bodies, device boxes, or raceway boxes containing less than twelve inches of bend radius.
- C. Unless shown on the Drawings or specified otherwise, the raceway type installed with respect to the location shall be as follows, including all materials:

Raceway System	Location
1. Rigid Galvanized (RSC) Type	Not acceptable for use on this Project RSC is acceptable where specifically required by the utility company, for use on primary conductors.
2. PVC Coated Aluminum (CRMC) Type	All embedded raceway bends, underground duct bank bends of more than 20 degrees, and all raceway stub-ups to a minimum of six inches above finished floor or grade and in Chlorine and Caustic rooms.
3. Liquid tight Flexible Aluminum (LFMC) Type	Raceway connection to vibrating equipment, and as shown on the Drawings in all areas.
4. Rigid Non-metallic, Schedule 80 PVC (RNC) Type	Underground encased in red dyed reinforced concrete.
5. Rigid Non-metallic, Schedule 80 PVC (RNC) Type	For use only in Chlorine and Caustic Rooms.

Raceway System	Location
6. Flexible Aluminum (FMC) Type	Fixture whip connection to lighting fixtures in NEMA 12 areas (maximum 3-feet). BX or AC type prefabricated cables are not permitted.
7. Aluminum Rigid Metal (RMC) Type	All above grade areas, except for concrete embedded and those areas described in Locations 2 through 6 above.

D. All conduit of a given type shall be the product of one manufacturer.

3.2 BOX APPLICATIONS

- A. All raceway junction pull and terminal boxes and electrical equipment enclosures shall have NEMA ratings for the location in which they are installed, and as specified herein.
- B. The distance between each raceway entry inside the box and the opposite wall of the box shall not be less than eight times the metric designator (trade size) of the largest raceway in a row. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually, and the single row that provides the maximum distance shall be used.
- C. Provide cast aluminum conduit fittings for exposed switch, receptacle and lighting outlet boxes.
- D. All raceway boxes and wall – mounted electrical equipment enclosures shall be provided with factory mounting integral welded mounting lugs. Bolt-on gasketed mounting lugs attached through factory-drilled holes are not acceptable for any raceway box or electrical equipment enclosure. Drilling through the back of any box or enclosure is prohibited, and if so installed, shall be removed and replaced, with no increase in the Contract Price or Construction Schedule.
- E. No penetrations shall be made in the top of boxes or electrical equipment enclosures in wet locations.

3.3 DEVICE BOX APPLICATIONS

- A. Device boxes shall be used for mounting wiring devices such as receptacles, switches, thermostats, lighting and other permanently mounted devices. All device boxes shall be installed with a minimum of 1/4-inch air space between the back of the box and the wall or back panel on which it is installed. The space may be created with enough 316 stainless steel washers to provide the required air space or may be mounted using 316 stainless steel slotted channel.

3.4 CONDUIT OUTLET BODIES APPLICATIONS

- A. Conduit outlet bodies may be used on conduits up to and including 2-1/2 inches, except where junction boxes are shown or otherwise specified. For conduits larger than 2-1/2 inches, junction boxes shall be provided.

3.5 CONDUIT HUB APPLICATIONS

- A. Unless specifically stated herein or described on the Drawings, all raceways shall terminate at an outlet with a conduit hub. Locknut or double locknut terminations will not be permitted.
- B. When conduits contain equipment grounding conductors the wire shall be grounded to the hub(s) associated with that grounding conductor.

3.6 INSULATED GROUNDING BUSHING APPLICATIONS

- A. Insulated grounding bushings shall be provided and used to terminate raceways where the raceways enter pad-mounted electrical equipment or switchgear from the bottom where there is no wall or floor pan on which to anchor or terminate the raceway.
- B. All other raceways shall terminate on enclosures with a conduit hub, except for NEMA 7/4X areas.
- C. Grounding bushing caps shall remain on the bushing until the wire is ready to be pulled.

3.7 CONDUIT FITTINGS APPLICATIONS

- A. Combination expansion-deflection fittings shall be installed where conduits cross structure expansion joints, and where installed in exposed conduit runs such that the distance between expansion-deflection fittings does not exceed 150 feet of conduit run. Expansion-deflection fittings are acceptable in indoor locations out of exposure to direct sunlight or other outdoor locations which are shaded.
- B. Expansion-deflection fittings are not acceptable for use outdoors unless approved in writing on a case-by-case basis from the Engineer/Owner. Where combination expansion-deflection fittings with exposed non-metallic sections, are approved by the Engineer/Owner for use where exposed to sunlight or other outdoor locations which are shaded, an aluminum wrap shall be installed loosely over the non-metallic portion, extending at least two inches beyond the ends. The wrap shall be loosely secured, to permit movement, with at least two 316 SS fasteners. Nylon tie-wraps are not acceptable.
- C. Provide an expansion fitting with a minimum of six inches available movement shall be installed on the exposed side of under to above grade conduit transitions. Expansion-deflection fittings shall not be provided unless approved and protected as specified above.

3.8 CONDUIT PENETRATION SEALS APPLICATIONS

- A. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.
- B. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

3.9 EXPLOSION-PROOF SEALS, BREATHERS AND DRAINS APPLICATIONS

- A. Fittings consisting of sealing fittings, breathers, drains, with sealing compound and fiber, as specified herein, shall be used as required to meet all the requirements of the National Electrical Code.

3.10 CONDUIT TAG APPLICATIONS

- A. All conduits shall be tagged within one foot of the entry of equipment, and wall and floor penetrations.
- B. Tag all underground conduits and ducts at all locations, exiting and entering from underground, including manholes and handholes.

3.11 RACEWAY SEALING

- A. All raceways entering junction boxes, terminal junction boxes, electrical equipment enclosures or control panels containing electrical or instrumentation equipment shall be connected to the box, enclosure or panel using conduit hubs and shall be sealed with Raceway Sealant, as specified herein.

3.12 PVC RACEWAY TO PVC COATED ALUMINUM RACEWAY TRANSITIONS IN CONCRETE ENCASEMENT

- A. Transitions from PVC raceway to PVC coated aluminum raceway in concrete encasements shall be made as follows:
 - 1. Terminate the PVC conduit in a threaded PVC female adapter.
 - 2. Terminate the PVC coated aluminum conduit in a threaded male adaptor.
 - 3. Thread the male PVC-coated aluminum conduit adaptor into the female threaded PVC adapter.
- B. Tighten the joint securely, then double layer wrap the joint with two-inch vinyl electrical tape for a distance of two inches each side of the threaded joint to prevent any contact between any exposed aluminum threads and concrete.

3.13 RACEWAY INSTALLATION

- A. Do not install pull wires and conductors until the raceway system is in place. No wire shall be installed between outlet points, junction points or splicing points, until all raceway sections are complete, and all raceway covers are installed for protection of conductors from damage or exposure to the elements. Conductors

installed into incomplete raceway systems are considered improperly installed and are in violation of the NEC. The occurrence of wire installed in an incomplete installation, shall require the removal of such conductors from the project site, and replacement of the conductors at with no increase in Contract Price or Schedule. The raceway system shall be completed and inspected by the Engineer/Owner before new conductors are installed.

- B. No conduit smaller than 3/4-inch electrical trade size, shall be used, nor shall any have more than the equivalent of three 90-degree bends in any one run. Pull boxes shall be provided as necessary. Conduit reducers which are the same type of the raceway shall be installed where manufacturer-provided enclosures are not available with conduit hubs larger than 1/2-inch at the enclosure to terminate 3/4-inch conduit. The raceway fill shall be adjusted to accommodate the smaller opening in the manufacturer-provided enclosure. Notify the Engineer/Owner prior to the installation of the raceway into enclosures with openings smaller than the specified minimum. Raceways installed without notice are considered unacceptable and may be required to be removed at the Engineer's/Owner's discretion with no increase in the Contract Price or Schedule allowed.
- C. All raceways, installed underground, shall be installed in accordance with Section 16600 Underground System, and be a minimum size of two-inch trade size unless otherwise shown in the plans.
- D. Raceways entering or leaving the raceway system, which could be subjected to the entry of moisture, rain or liquid of any type, shall be tightly sealed, using 3M 1000NS Watertight Sealant, or approved equal at any possible moisture entry point both before and after the installation of cables to prevent the entry of water or moisture to the Raceway System at any time. Any damage to new or existing equipment, due to the entrance of moisture from unsealed raceways, shall be corrected by complete replacement of such equipment. No increase in the Contract Price or Schedule will be allowed. Cleaning or drying of such damaged equipment will not be acceptable.
- E. Conduit supports, other than for underground raceways, shall be spaced at intervals no further apart than as required by the NEC and closer together as required to obtain rigid construction. Conduits shall be supported near the entry into any enclosure in accordance with the NEC. Conduits shall not be used to support other conduits, nor shall conduits be supported from cable tray.
- F. Single conduits shall be supported by means of one-hole conduit clamps in combination with one-screw back plates, to raise conduits from the surface.
- G. Multiple runs of conduits shall be supported on trapeze type hangers with horizontal members and threaded hanger rods. The rods shall be not less than 3/8-inch diameter. Multiple conduits mounted on walls shall be supported using strut and 316 stainless steel conduit clamps, screws, nuts and washers.
- H. Surface mounted panel boxes, junction boxes, conduit, etc. shall be supported as specified herein.

- I. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, anchors shall be as specified in Section 16045 Electrical Support Hardware.
- J. No electrical equipment enclosures, boxes, terminal junction boxes or raceways shall be attached to or supported from, sheet metal walls.
- K. All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. Offsets in conduit runs shall all be done at the same point and shall all be the same angle, so the entire installation appears to be parallel or concentric at every point. All conduits shall be run perfectly straight and true.
- L. Conduits terminated into enclosures shall be perpendicular to the walls where flexible liquid tight or rigid conduits are required. The use of short seal tight elbow fittings for such terminations will not be permitted, except for connections to instrumentation transmitters, where multiple penetrations are required.
- M. Conduits containing equipment grounding conductors and terminating in boxes shall have insulated throat grounding bushings. The grounding conductor shall be grounded to the box.
- N. Conduits shall be installed using threaded fittings. Running threads will not be permitted.
- O. Provide glued type conduit fittings on PVC conduit.
- P. Conduits installed which are not in compliance with these requirements shall be removed and reinstalled at the Engineer's/Owner's discretion. If conductors are installed when the improper installation is discovered, the conductors shall be removed from the raceway, discarded and removed from the job site, replaced, re-terminated, retagged, and retested in accordance with the specifications. The function of the system shall be retested in its entirety. No increase in Contract Time or Schedule will be allowed.
- Q. Liquid tight flexible metallic conduit shall be used for the primary and secondary of transformers, generator terminations and other equipment where vibration is present. Use in other locations is not permitted, except for connections to instrumentation transmitters, where multiple penetrations are required. Liquid tight flexible metallic conduit shall have a maximum length not greater than that of a factory manufactured elbow of the conduit size being used. The maximum bending radius shall not be less than that shown in the NEC Chapter 9, Table 2, "Other Bends". BX or AC type prefabricated cables will not be permitted.
- R. Seal the remaining openings or spaces of conduits passing through openings in walls or floor slabs to prevent the passage of flame or smoke where additional openings or space around the conduits are present.
- S. Conduit ends exposed to the weather or corrosive gases shall be sealed with conduit sealing bushings.

- T. Raceways terminating in Control Panels or enclosures which contain electrical equipment or terminal blocks, shall not enter from the top of the enclosure.
 - 1. Locations: Outdoors or any wet or damp location or any location where plant process equipment is located or any location not otherwise specifically designated as a dry electrical room, control room or office space.
 - 2. All raceways entering the enclosures specified above shall be sealed with a watertight sealant as specified herein.
 - 3. Enclosures entered from the top where top entry is prohibited, will be rejected and shall be removed and replaced regardless of the Division which contains the specification for the enclosure. The use of UL Listed conduit closures to restore the NEMA rating of the enclosure will not be accepted.
 - 4. Conduit entering the top of the enclosures shall be removed and re-routed to enter the enclosure from the side or bottom. Conductors installed in top entering conduits shall be pulled back to the nearest conduit body or junction box and re-routed with the conduit, provided the conductors are long enough to be re-terminated. Conductors found to be insufficient in length to be re-terminated shall be completely removed and replaced, re-tested, re-tagged, re-tested and the control function of the panel shall be re-tested.
 - 5. If the enclosure is provided by an OEM, the enclosure and its contents shall be returned to the OEM for a new enclosure.
 - 6. No increase in Contract Price or Schedule will be allowed for making these corrections.
- U. All conduits from external sources entering or leaving a multiple compartment enclosure shall be stubbed up into the bottom horizontal wire way or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated. Conduits entering from cable tray shall be stubbed into the upper section.
- V. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 4X or 7 and all wet locations.
- W. A conduit identification plate shall be installed on all power, instrumentation, alarm and control conduits at each end of the run and at intermediate junction boxes, manholes, etc. Conduit plates shall be installed before conductors are pulled into conduits. Exact identification plate location shall be coordinated with the Owner/Engineer at the time of installation to provide uniformity of placement and ease of reading. Conduit numbers shall be exactly as shown on the Drawings.
- X. Mandrels shall be pulled through all existing conduits that will be reused and through all new conduits two inches in diameter and larger prior to installing conductors.
- Y. 3/16-inch polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.

- Z. All conduit that may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc. shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits at the point of attachment to the equipment.
- AA. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc. shall be sealed with Watertight Sealant as specified herein.
- BB. Conduits shall be located a minimum of three inches from steam or hot water piping. Where crossings are unavoidable, the conduit shall be kept at least one inch from the covering of the pipe crossed.
- CC. Conduits terminating at a cable tray shall be supported independently from the cable tray and shall have a clamp to secure it to the cable tray in accordance with NEC requirements. Provide a conduit support within one foot of the cable tray. The weight of the conduit shall not bear on the cable tray. The end of the conduit shall terminate within 6-inches of the cable tray. Conduits shall be grounded to the cable tray.
- DD. All changes of direction on PVC coated conduit greater than 20 degrees shall be accomplished using long radius bends. Any field bends shall be made using equipment designed to prevent damage to the PVC coating.

END OF SECTION

**SECTION 16120
WIRES AND CABLES (1000 VOLT MAXIMUM)**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

1.2 RELATED WORK

- A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified

- B. Other Divisions

- 1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.

- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submit to the Owner/Engineer, shop drawings and product data, for the following:
 - 1. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
 - 2. Submit catalog data of all wire and cable, connectors, lugs, and accessories, specified under this Section with all selections, options and exceptions clearly indicated. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Catalog data shall show compliance with the referenced codes and standards.
 - 3. Provide a written description of the megger testing procedure that will be used for testing and the model and type of megger tester that will be used. Include this description in the wire and cable submittal.
- D. Certified Tests
 - 1. Submit a report of pulling tensions for all wire and cable installed with mechanical means monitored by pulling tension equipment.
 - 2. Submit a test report of all installed wire insulation tests.

1.4 REFERENCE CODES AND STANDARDS

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 - 1. NFPA 70 – National Electrical Code (NEC)
 - 2. NEMA WC-5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
 - 3. ANSI/TIA/EIA 606A – Standard for telecommunications Infrastructure

1.5 QUALITY ASSURANCE

- A. The general construction of the wire, cables and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.
- B. Wire and cable with a manufacture date of greater than 12 months previous will not be acceptable.
- C. Wire and cable shall be in new condition, with the manufacturer's packaging intact, stored indoors since manufacture, and shall not have been subjected to the weather. Date of manufacture shall be clearly visible on each reel.

- D. The manufacturer of these materials shall have produced similar electrical materials for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.
- B. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Do not drop reels from any height.
- C. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the wire and cable.
- D. Store cable on a solid, well drained location. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wires and cables shall be annealed, 98% conductivity, soft drawn copper.
- B. All conductors shall be Class B stranded.
- C. Except for control, signal and instrumentation circuits, wire smaller than #12 AWG shall not be used.

2.2 POWER & BUILDING WIRE

- A. All building wire shall be stranded copper conductors, Type XHHW-2

2.3 TRAY CABLE

- A. Cable for tray use shall be stranded copper conductors, Type XHHW-2 insulation, rated as UL Type TC cable. Cable shall be sunlight resistant and approved for direct burial.

2.4 GROUNDING ELECTRODE CONDUCTOR

- A. Grounding electrode conductor shall be stranded copper conductor, Type XHHW-2 with green insulation.

2.5 BONDING JUMPER

- A. Bonding Jumper shall be bare tinned stranded copper conductor.

2.6 CONTROL WIRE AND CABLE

- A. Control wire shall be NEC Type XHHW-2.
- B. Multi-conductor control cable, shall be stranded, #14 AWG 600-volt, XHHW-2, insulated, PVC outer jacket overall, Type TC, UL rated for underground wet location.

2.7 INSTRUMENTATION CABLE

- A. Cables for 4-20 ma, RTD, potentiometer and similar signals shall be PLTC rated and shall be:
 - 1. Single pair cable:
 - a. Conductors: Two #16 AWG stranded, tinned and twisted on two-inch lay
 - b. Insulation: PVC with 600-volt, 90°C rating
 - c. Shield: 100% Mylar tape with drain wire
 - d. Jacket: PVC with manufacturer's identification
 - e. UL1685 listed for underground wet location use
 - 2. Three conductor (triad) cable:
 - a. Conductors: Three #16 AWG stranded, tinned and twisted on two-inch lay
 - b. Insulation: PVC with 600-volt, 90°C rating
 - c. Shield: 100% Mylar tape with drain wire
 - d. Jacket: PVC with manufacturer's identification
 - e. UL1685 listed for underground wet location use

3. Multiple pair cables (where shown on the Drawings):
 - a. Conductor: Multiple pairs, #16 AWG stranded, tinned and twisted on a two-inch lay
 - b. Insulation: PVC with 600-volt, 90°C rating
 - c. Shield: Individual pairs shielded with 100% Mylar tape and drain wire
 - d. Jacket: PVC with manufacturer's identification
 - e. UL1685 listed for underground wet location use

2.8 COMMUNICATION CABLES

A. Cables for Ethernet and RS485 shall be rated and shall be:

1. Category 5e above Grade shielded Cable
 - a. Conductors: Four bonded pair #24 AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Shield: 100% aluminum foil polyester tape with drain wire
 - d. Jacket: PVC with 600-volt rated and manufacturer's identification
 - e. UL21047 and UL1666 listed for indoor and dry locations use
2. Category 5e above Grade un-shielded Cable
 - a. Conductors: Four bonded pair #24 AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Jacket: PVC with 300-volt rated and manufacturer's identification
 - d. NEC CMR
 - e. UL1666 listed for indoor and dry locations use
3. Category 6 above Grade shielded Cable
 - a. Conductors: Four bonded pair #23 AWG Bare Copper
 - b. Insulation: Polypropylene
 - c. Shield: 100% aluminum foil polyester tape with drain wire
 - d. Jacket: PVC with 600-volt rated and manufacturer's identification
 - e. Transmission Standards: Category 6 - TIA 568.C.2

- f. NEC CMR
 - g. Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
4. Category 6 above Grade un-shielded Cable
- a. Conductors: Four bonded pair #23 AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Jacket: PVC with 300-volt rated and manufacturer's identification
 - d. Transmission Standards: Category 6 - TIA 568.C.2
 - e. Nominal Velocity of Propagation: 72%
 - f. Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
5. Category 5e below Grade shielded Cable
- a. Conductors: Four pair #24 AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Shield: 100% aluminum foil polyester tape with drain wire
 - d. Jacket: LLPE (Linear Low Density Polyethylene) with 300-volt rated and manufacturer's identification
 - e. Misc.: NEMA WC-63.1, listed for outdoor and wet locations use
 - f. Water Blocking compound and listed for direct bury applications.
6. Category 5e below Grade unshielded Cable
- a. Conductors: Four pair #24 AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Jacket: LLPE (Linear Low-Density Polyethylene) with 300-volt rated and manufacturer's identification
 - d. Misc.: NEMA WC-63.1, listed for outdoor and wet locations use.
 - e. TIA-568-C.2 Category 5e compliance
 - f. Water Blocking compound and listed for direct bury applications.
7. Category 6 below Grade Cable

- a. Conductors: 4 pair 23AWG Bare Copper
 - b. Insulation: Polyolefin
 - c. Shield: 100 percent aluminum foil polyester tape with drain wire
 - d. Jacket: Polyethylene with 300 volts rated and manufacturer's identification
 - e. Misc.: Gel filled and NEMA WC-63.1, listed for outdoor and wet locations use
8. 485 Communications Cable
- a. Conductors: One pair #24 AWG Tinned Copper
 - b. Insulation: Polyethylene
 - c. Shield: 100% aluminum foil polyester tape with tinned copper drain wire
 - d. Jacket: PVC with 300-volt rated and manufacturer's identification
 - e. Misc.: UL2919 listed for indoor and dry locations use
- B. Color code for Ethernet communications cables shall be as follows.
1. Green – CAT5e Phone / Data
 2. Red – CAT5e SCADA
 3. Blue – CAT6 – Phone / Data
 4. White – CAT6 - SCADA

2.9 TERMINATION MATERIALS

- A. Power Conductors: Termination materials, of conductors at equipment, shall be as specified in the relevant equipment Section.
- B. Control and Instrumentation Conductors (including graphic panel, alarm, low- and high-level signals): Termination connectors shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type, with end barriers, dual side terminal block numbers and terminal group identifiers. Terminals to be UL Listed for stranded conductor terminations. Rated for a maximum of 2 #14 stranded conductors. Color of terminals to comply with NFPA 79.
- C. Motor Conductors: Motor connections with conductors #12 AWG up to #6 AWG shall be ring type compression terminations on the motor leads and secured with bolt, nut and spring washer. Connections shall be -30°C rubber insulated, half lap, and two layers minimum of Scotch 33 or equal vinyl tape. Motor terminations for conductors #8 AWG and larger shall be in accordance with paragraph "Lugs and Connectors" below. Motors provided on this project per specification 16150 and /

or 16151 shall have motor terminals enclosures with bus and NEMA one-hole or two-hole pads to accommodate the conductor terminals specified herein.

D. Lugs and Connectors

1. All lugs and connectors shall meet the following requirements:
 - a. Tin plated copper.
 - b. Crimped type, installed with standard industry tooling.
 - c. Lugs and connectors shall match the wire size used and shall be clearly identified and color coded on the connector.
 - d. All connections shall be made for stranded wire and shall be made electrically and mechanically secured.
 - e. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75°C.
 - f. Lugs for #14 AWG up to #6 AWG shall be ring terminals.
 - g. Conductors #4 AWG and larger shall be terminated with two-hole long barrel lugs with NEMA spacing.
 - h. All lugs shall be the closed end construction to exclude moisture migration into the cable conductor.

2.10 SPLICE MATERIALS

A. Power Conductors

1. Circuits shall be pulled from terminal to terminal, without splicing, except where splicing is shown on the Drawings.
2. No other splicing will be permitted.
3. For wires sizes #8 AWG and smaller, provide color coded wire nuts, with metal inserts, 3M or Ideal, rubber insulated with half lap and two layers minimum of Scotch 33 tape.
4. For wires greater than #8 AWG, provide a heat shrink insulated, color-coded, die-crimped splice lug, T&B 54XXX, or equal, rubber insulated, with half lap and two layers minimum of Scotch 33 tape.

B. Control and Instrumentation Conductors (including graphic panel, alarm, low- and high-level signals):

1. No splicing of control and instrumentation conductors will be permitted.

2.11 WALL AND FLOOR SLAB OPENING SEALS

- A. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp. or equal.

2.12 WIRE AND CABLE TAGS

- A. Use the tagging formats for wire and cable as shown on the Drawings. Where modifications or additions are made to existing wire and cable runs, replace existing tags with new modified tags.
- B. Wire tags for wire sizes, #2 AWG and smaller, shall be heat shrink type Raychem TMS-SCE, or approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8-inch in height. Hand written tags shall not be acceptable. Where ends are not available, attach cable tags with nylon tie cord.
- C. Tags for wires larger than #2 AWG and all cables shall be thermally printed polyethylene type, Brady TLS 2200 or approved equal, nylon zip tied in accordance with the manufacturer's instructions.
- D. Tags relying on adhesives or taped-on markers are not acceptable.
- E. Tagging shall be done in accordance with the execution portion of these Specifications.

2.13 WIRE COLOR CODE

- A. All wire shall be color coded or coded using electrical tape in sizes #8 or greater, where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.
- B. The following coding shall be used:

<u>System</u>	<u>Wire</u>	<u>Color</u>
1-Phase, 3 Wire	Phase A	Black
	Phase B	Blue
	Neutral	White
208Y/120, Volts 3-Phase, 4 Wire	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
480/277, Volts 3-Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
	Neutral	Gray/White with one or more colored stripes

2.14 CABLE TAG COLOR CODE

- A. All cable tags shall be white in color with black printing.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not install conductors until the raceway system is in place. No conductor shall be installed between outlet points, junction points or splicing points, until raceway sections have been completed, and raceway covers are installed for protection of conductors from damage or exposure to the elements. Any conductor installed in an incomplete raceway system shall be removed from the raceway system and from project site. A complete inspection of such raceway sections shall be completed before new conductors are installed.
- B. Installed unapproved wire shall be removed and replaced at no additional cost to the Owner.
- C. Completely swab raceway system before installing conductors. Do not use cleaning agents and lubricants which have a deleterious effect on the conductors or their insulation.
- D. Pull all conductors into a raceway at one time, using wire pulling lubricant as needed to protect the wire.
- E. Except for hand-pulled conductors into raceways, all wire and cable installation shall be installed with tension-monitoring equipment.
 - 1. Wire and cables shall not be installed using winches, vehicles or any other mechanical devices not intended for the installation of wire or cables. The use of pulling tension monitoring equipment for the installation of wire or cable pulled in using mechanical means is mandatory.
 - 2. Submit pulling tension records for each wire or cable pull done using mechanical means monitored by pulling tension equipment.
 - 3. Conductors which are found to have been installed using mechanical means without tension-monitoring shall be immediately removed from the raceways, permanently identified as rejected material, and removed from the jobsite. New conductors and cables shall be reinstalled, tagged and raceways resealed, with no change in the Contract Price or Schedule allowed.
- F. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved.
- G. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

- H. Single conductors and cables in manholes, hand holes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, shall be bundled throughout their exposed length with nylon, self-locking, releasable, cable ties placed at intervals not exceeding four inches on centers.
- I. All wire and cable installed in cable trays shall be UL Listed as Type TC, for cable tray use.

3.2 CONDUCTORS 1000 VOLTS AND BELOW

- A. Provide conductor sizes indicated on Drawings, as a minimum.
- B. Use crimp connectors on all stranded conductors.
- C. Soldered mechanical joints insulated with tape are not acceptable.
- D. Arrange wiring in cabinets and panels neatly cut to proper length Surplus wire shall be removed unless noted otherwise. Conductors shall be bridled or bundled and secured in an acceptable manner. Identify all circuits entering motor control centers and all other control enclosures in accordance with the conductor identification system specified herein.
- E. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.
- F. Attach compression lugs, larger than #6 AWG, with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.
- G. Cap spare conductors and conductors not terminated with the UL listed end caps.
- H. Remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors passing through holes or over edges in sheet metal enclosures.
- I. Provide at least 6 feet spare conductors in freestanding panels and at least two feet spare in other assemblies for all conductors which are to be terminated by others. Provide additional conductor length in any assembly where it is obvious that more conductor will be needed to reach the termination point.
- J. Do not combine power conductors in the same raceway unless shown on Drawings. Do not run signal conductors carrying voltages less than 120 volts AC in the same raceway as conductors carrying higher voltages regardless of the insulation rating of the conductors. Do not share neutrals on branch circuits.

3.3 GROUNDING

- A. Conduits and other raceways shall contain wire type equipment grounding conductor whether the raceway is metallic or not. Conduits, motors, cabinets, outlets, and other equipment shall be properly grounded in accordance with NEC

requirements and specification 16660. Ground wires exposed to mechanical damage shall be installed in rigid aluminum conduit. Make connections to equipment with solderless connections. Connections to ground rods shall be of the fused type equal to the Cadweld process.

3.4 TERMINATIONS AND SPLICES

- A. No splices of wire and cable will be permitted, except where specifically permitted by the Owner/Engineer in writing, or as shown on the Drawings.
- B. Power conductors: Terminations shall be made with connectors as specified. Splices, where specifically allowed as stated above, shall be made in a Termination Cabinet (TC).
- C. Control Conductors: Splices of control conductors will not be permitted between terminal points. Terminations shall be made with approved terminals as specified.
- D. Instrumentation Signal Conductors (including graphic panel, alarm, low- and high-level signals): Splices of Instrumentation conductors will not be permitted between terminal points. Terminations shall be made with connectors as specified. The shield of pair shielded, and triad shielded shall be terminated on terminal strips. Provide dedicated terminal block to every conductor including shields. Double lugging terminations is not acceptable.

3.5 INSTRUMENTATION CABLES

- A. Instrumentation cables shall be installed in raceways as specified. Unless specifically shown on the Drawings, all instrumentation circuits shall be installed as single shielded twisted pair cables or single shielded twisted triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.
- B. Terminal blocks shall be provided at all instrument cable junction boxes, and all circuits shall be identified at such junctions.
- C. Shielded instrumentation wire, coaxial cable, data highway cable, discrete I/O, multiple conductor cable, and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels. The shield shall be continuous for the entire run.
- D. Shields shall be grounded at the PLC/RTU. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Individual circuit shielding shall be provided with its own block.
- E. Shield wire shall be wrapped and taped at the transmitter end of the signal run. Before termination, peel back the outer sheath, leaving the shield intact. Wrap the drain wire around the conductors, leaving approximately two inches exposed. Wrap the drain wire with two layers of Scotch 33 tape.

3.6 WIRE TAGGING

- A. All wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure; box or space designed for wire or cable pulling or inspection and includes pull boxes, manholes, and junction boxes.
- B. Wire tags shall show both origination and destination information to allow for a wire or cable to be traced from point in the field. Information regarding its origination shall be shown in parenthesis.
- C. For multiconductor cables, both the individual conductors and the overall cable shall be tagged. Conductors that are part of a multiconductor cable shall reference the cable identification number that they are a part of, as well as a unique conductor number within the cable.

3.7 CABLE TAGGING

- A. All cables shall be tagged at all termination points and at all major access points in the electrical raceways as defined in the wire tag section of this Specification.
- B. The cable tag shall be installed where the cable enters and leaves each access point (e.g., junction box, manhole, etc.). In cases of limited access space, a single tag may be used that shows both equipment tag origination and destination. In the case where the jacket is stripped for terminations, the tag shall be installed at the end of the jacket.

3.8 RACEWAY SEALING

- A. Raceways entering junction boxes or control panels containing electrical or instrumentation equipment shall be sealed with 3M 1000NS Watertight Sealant or approved equal.
- B. This requirement shall apply to for all raceways in the conduit system.

3.9 FIELD TESTS

- A. Conductors under 600 volts
 - 1. Perform insulation resistance testing of all power circuits below 1000 volts with a 1000-volt megger, in accordance with the recommendations of the wire manufacturer.
 - 2. Prepare a written test report of the results and submit to the Owner/Engineer prior to final inspection. Provide a written description of the megger testing procedure that will be used for testing and the model and type of megger tester that will be used. Include this description in the wire and cable submittal.

3. Minimum acceptable value for insulation resistance is 100 megohms. Lower values shall be acceptable only by the Owner/Engineer's specific written approval.
 4. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.
- B. Tests: After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests to ensure that instrumentation cable shields are isolated from ground, except at the grounding point in the instrumentation control panel. Remove all improper grounds.

END OF SECTION

**SECTION 16150
NEMA FRAME INDUCTION MOTORS, 600 VOLTS AND BELOW**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Provide electric motors, accessories, and appurtenances complete and operable, in conformance with the individual driven equipment specifications and other sections of the Contract Documents.
- B. The provisions of this Section shall apply to all low voltage NEMA Frame AC squirrel cage induction motors, except as indicated otherwise.

1.2 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review
- D. Submittals shall be made in accordance with the requirements of the process equipment division of these Specifications, and as specified herein.
- E. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned without review.
- F. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.
- G. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Name of Drive
2. Horsepower of Motor
3. Phase
4. Efficiency at 1/2, 3/4 and full load
5. Voltage
6. Power Factor at 1/2, 3/4, and full load
7. Speed
8. NEMA Design Starting Torque
9. NEMA Frame and Dimensions
10. Full Load Current
11. Locked Rotor Current
12. Insulation Class
13. Temperature Rise at 1.0 Service Factor
14. Enclosure
15. Bearing design life
16. Special features (i.e., space heaters, RTDs, oversize conduit box and corrosion resistant features).
17. Nameplate Drawing with Information as listed herein.
18. Maximum power factor correction capacitor kVAR that can be switched with the motor. Assembly drawings
19. Anchor bolt location drawings
20. Equipment weights
21. Catalog data Nondestructive test procedures
22. Acceptance test procedure
23. Surface preparation and painting procedure
24. Shipping, handling, and storage procedures
25. Installation/erection procedure Electrical equipment heat run test records

26. Nameplate data

27. Performance/acceptance test report

H. Suppliers of fractional horsepower motors below frame 143T will not be required to submit operational characteristics.

I. Factory Tests. Submittals shall be made for factory tests as specified above.

J. Field Test Reports. Submittals shall be made for field tests specified herein.

K. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:

- a. Manufacturer's contact address and telephone number for parts and service.
- b. Instruction books and/or leaflets
- c. Recommended renewal parts list
- d. Record Documents for the information required by the submitted motor information above.

1.3 REFERENCE STANDARDS

A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standards:

1. National Electrical Manufacturers Association Inc. (NEMA)

- a. NEMA MG-1 - Motors and Generators.
- b. NEMA MG-1 Part 9 – Sound Power Limits and Measurement Procedures.
- c. NEMA MG-2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

2. National Fire Protection Association (NFPA)

- a. NFPA-70 - National Electrical Code.

3. Underwriters Laboratories, Inc. (UL)

- a. UL-1004 - Electric Motors. UL547 - Thermal Protectors for Motors
- b. UL674 - Electric Motors and Generators for Use in Hazardous Locations, Class I Groups C and D, Class II Groups E, F and G

4. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

- a. IEEE Std. 1 - General Principles for Temperature Limits in the Rating of Electric Equipment.
 - b. IEEE Std 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - c. IEEE Std. 112 – Standard Test Procedure for Polyphase Induction Motors and Generators.
 - d. IEEE Std. 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-wound Pre-insulated Stator Coils, Machines Rated 6,900 V and Below.
 - e. IEEE Std. 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
 - f. IEEE Std. 1349 – Guide for the Application of Electric Motors in Class 1, Div 2 Hazardous Locations.
5. Anti-Friction Bearing Manufacturer's Association Inc. (AFBMA):
- a. AFBMA-9 & 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 DEFINITIONS

- A. Motors specified herein are three-phase, squirrel cage induction type for 1/2 HP and above, and single phase for less than 1/2 HP, except as specifically specified elsewhere in these Specifications.
- B. The word "Drive" shall be construed to mean the driven equipment, i.e. pump, hoist, fan, compressor, or adjustable frequency drive connected with the motor.
- C. If there is inconsistency of size on different Drawing sheets or between Drawings and other sections of Specifications, relating to the horsepower designation, then the larger size shall be required.

1.5 QUALITY ASSURANCE

- A. Motor Compatibility. Verify that the motor included with the drive is compatible with driven equipment and complies with these Specifications. If the motors described in these Specifications cannot be applied to the application or equipment offered, an exception may be submitted, clearly stating the deviations and the reasons for such deviations. The acceptance or rejection of such deviations shall be at the sole discretion of the Owner/Engineer.
- B. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for mounting the motor and driven equipment as a complete

unit, correctly aligned, and coupled with the coupling or sheave specified on the driven equipment data sheet, and for designing vibration, special, or unbalanced forces resulting from equipment operation.

- C. Motors manufactured more than 24 months prior to the date of this Contract will not be acceptable. Date of manufacture, of each motor shall be on the nameplate.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.,
- B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner. The instructions shall include detailed assembly instructions including but not limited to wiring interconnection diagrams, rigging for lifting, skidding, jacking, and moving using rolling equipment to place the equipment, bolt torquing requirements for bus and all other components which require the installation of bolted connections, and instructions for storing the equipment prior to energizing.
- C. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.
- D. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.
- E. If motors are shipped as an integral part of the associated mechanical equipment, the motors shall be stored and handled in accordance with the manufacturer's instructions
- F. If motors are shipped separately, the motor shall be installed in its permanent, finished location shown on the Drawings within 14 calendar days of arriving onsite. If the equipment cannot be installed within 14 calendar days, the equipment shall not be delivered to the site, but stored offsite, until such time that the site is ready for permanent installation of the equipment. Motors stored off site shall not be included in any pay applications. Payment for motors will not be allowed until delivered to the job site.
- G. Provide temporary electrical power and operate space heaters, during storage and after motors are installed in permanent location, until equipment is placed in service. Unless stored in a heated air-conditioned space, space heaters shall be energized within 24 hours of arrival. Failure to energize space heaters as required shall constitute improper storage and the motors are subject to rejection and are subject to be returned to the Factory for inspection and re-testing. Improperly stored motors may be inspected and tested in the field. The choice to return equipment or conduct an inspection and test in the field lie solely with the Engineer

/ Owner. No pay applications for improperly stored motors will be accepted prior to receiving the manufacture's report of inspection, testing and certification that the motors are acceptable for installation with full warrantee still in force. Storage and transportation to the storage site and from storage to the job site shall be provided with no change in Contract Price or Contract Time allowed.

- H. The motor shaft shall be rotated monthly, if such is recommended or required by the motor manufacturer; the date recorded, and copies of the record provided to the Owner/Engineer and the manufacturer. The manufacturer shall confirm receipt of the rotation record.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for three years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.
- B. Where the equipment manufacturer furnishes the motor and control as an integral part of the equipment package, the motor(s) shall have the same warranty as the equipment package.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. ABB
 - 2. TECO – Westinghouse
 - 3. Baldor Reliant
 - 4. US Motors
 - 5. Approved equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 GENERAL REQUIREMENTS

- A. Each motor provided shall have an Identification Tag Number, conforming to the numbering system and equipment name shown on the Drawings.

- B. Specific motor data such as horsepower, speed, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.
- C. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall clearly indicate all the items of information enumerated in NEMA Standard MG-1, as applicable, including but not limited to the following information:
 - 1. Horsepower (output).
 - 2. RPM at full load.
 - 3. Time rating.
 - 4. Frequency.
 - 5. Number of phases.
 - 6. Model number.
 - 7. Rated voltage.
 - 8. Service factor.
 - 9. Full load amps.
 - 10. Insulation class.
 - 11. NEMA design Letter.
 - 12. NEMA code Letter.
 - 13. Temperature Rise at 1.0 Service Factor.
 - 14. NEMA Frame size.
 - 15. Motor Weight
 - 16. Date of manufacture.
 - 17. Thermal protection (if supplied).
 - 18. Nominal Efficiency
 - 19. Enclosure
- D. Where frequent starting occurs, the design for frequent starting duty shall be equal to the duty service required by the driven equipment.
- E. Altitude: Under 3300 feet. For applications above 3300 feet, motors shall be specifically designed and certified for operation at the specific altitude.

- F. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions, without exceeding the nameplate rating of the motor and without use of the service factor.
- G. Motors shall have a breather drain in each end bracket of the TEFC motor enclosure. Stainless steel automatic breather drains shall be provided in the lowest part of both end brackets to allow drainage of condensation.
- H. Motors shall be slide rail mounted for all belt or chain-driven applications.
- I. Air inlets and outlets shall be protected by vermin-proof, corrosion resistant louvers. The air inlets shall be located on end or side as required by the application.
- J. Motors shall have an oversized, gasketed, cast iron conduit box, field adjustable in 90-degree increments unless the box contains equipment, diagonally split with tapped NPT threaded conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001. Neoprene conduit box cover gasket and neoprene lead seal gasket with flexible nipples to ensure the seal is maintained as the leads are moved shall be furnished. Provision for grounding shall be provided in the conduit box utilizing a mounted clamp-type lug. Provide the size and number of threaded conduit openings or integral conduit hubs for the conduits containing the motor power conductors.
- K. Lugs, terminators, etc., shall be in accordance with Section 16120 for 600 Volt conductors.
- L. Provide one-hole lugs for connection to conductors #12 AWG through #8 AWG. Provide termination pads to terminate NEMA two-hole long barrel lugs for conductors #6 AWG and larger.
- M. Motor frames, end brackets, and conduit box shall be of cast-iron.
- N. Provide lifting lugs on the motor frame.
- O. Motors shall be NEMA Design B standard, unless otherwise specified in the process equipment division of these Specifications.
- P. Service factor shall be 1.15 for all motors.
 - 1. In sizing motors, no portion of a motor's service factor above 1.0 shall be used in normal continuous operation of the motor.
- Q. Motors shall be of the Energy Efficient type and shall meet or exceed efficiencies as listed in the Table at the end of this Specification. (Part 4)
- R. All motors shall be continuous time rated suitable for operation in a 40°C ambient, unless specified otherwise in the process equipment division of these Specifications.
- S. Unless otherwise indicated or specified, motors shall be totally enclosed fan cooled (TEFC), for all applications. See the process equipment division of these

Specifications for pumps and other equipment that require additional enclosure requirements.

- T. All TEFC Motors shall have corrosion resistant enclosures, fan, cover, epoxy paint, corrosion resistant fittings and stainless steel or aluminum nameplates similar to "Mill and Chemical", "Corro-Duty", "Chemical Processing" motors, or equal.
- U. Motors are to be bi-directional. If the fan must be unidirectional, it shall be the motor manufacturer's responsibility to obtain the direction required from the drive manufacturer.
- V. Guards
 - 1. Exposed moving parts shall be provided with guards in accordance with the requirements of OSHA. Guards shall be fabricated of flattened expanded metal screen, 3/4-inch No. 10, to provide visual inspection of moving parts without removal of the guard.
 - 2. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Windows shall be provided in the guard for access to the lubricating fittings.

2.3 FRACTIONAL HORSEPOWER MOTORS – LESS THAN 1/2 HORSEPOWER

- A. Motor voltage shall be single phase, 115 volts, 60 Hertz, unless otherwise shown on the Drawings.
- B. Enclosures shall be TEFC or TENV.
- C. Motors shall have NEMA standard Class "F" insulation with a maximum temperature rise of 90°C above a 40°C ambient, on a continuous operation or intermittent duty, at nameplate horsepower.
- D. Motors shall have a built-in manual or automatic reset thermal protector, or an integrally mounted, enclosed manual reset, motor overload switch.

2.4 MOTORS 1/2 HORSEPOWER AND LARGER

- A. Motor voltage shall be three-phase, single voltage, random wound sized as shown on the Drawings, and in compliance with IEEE 841 (Mill & Chemical).
- B. Motors shall have NEMA standard Class "F" insulation with a maximum temperature rise of 90°C above a 40°C ambient, on a continuous operation or intermittent duty, at nameplate horsepower.
- C. Motors shall have non-hygroscopic encapsulated windings of copper. Motor leads shall be Class F rated, with permanent identification.
- D. Motor rotors and assembly shall be dynamically balanced.

- E. Motors less than 15 HP shall have a locked rotor inrush not exceeding MG-1. Motors 15 HP and larger shall have a locked rotor inrush kVA` not exceeding Code G (6.29 kVA/HP).
- F. Motors shall meet or exceed the Minimum Guaranteed Efficiencies, listed in the Table of Part 4 of this Section, at the approximate nameplate current values at 460 volts.
- G. The motor insulation system for motors controlled with Variable Frequency Drives (VFDs) shall have full capability to handle the common mode voltage conditions imposed by the VFD. Motor insulation system shall conform to all the requirements of the latest version of NEMA MG1, Part 31 for peak voltage withstand capability.
- H. All motors controlled with VFDs, or soft starters shall have a minimum 1600 Volt insulation systems.
- I. The critical speed of the shaft and rotor assembly shall exceed the operating speed by a minimum of 10%.
- J. The no-load sound pressure level, based on the A-weighted scale at three feet, when measured in accordance with NEMA MG1 Section 1 Part 9, shall not exceed the values listed in Table 9-1.
- K. Vibration limits shall not exceed 0.2-inches/second at any frequency.
- L. Motors shall have a minimum of one grounding pad on each motor frame. Motors larger than 75 HP shall have a minimum of two brass grounding pads on each motor frame.
- M. Bearings
 - 1. Motors 1/2 through 5 HP shall have permanently lubricated sealed antifriction ball-bearings with L10 lifetime of 50,000 hours.
 - 2. Motors larger than 5 HP shall have oil or grease-lubricated antifriction ball-bearings with L10 lifetime of 50,000 hours.
 - 3. Vertical motor thrust and guide bearings shall conform to AFBMA standards and shall have L10 lifetime ratings as specified for ball-bearings of the same horsepower range. Down thrust information shall be provided to the motor manufacturer by the equipment supplier.
 - 4. Anti-friction motor bearings shall be designed to be regreaseable and initially shall be filled with grease suitable for the motor ambient temperature specified.
 - 5. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type as manufactured by the Alemite Division of the Stewart Warner Corporation.

6. Sealed bearings shall be contact seal (lip) or non-contact labyrinth type.
7. Motors operating on VFDs shall have the opposite drive end bearing insulated and a shaft grounding brush installed at the drive end of the motor.

N. Space Heaters

1. Space heaters shall be supplied with all three-phase motors and shall conform to the following:
 - a. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 volts, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor accessory lead junction box. Provide integral conduit hubs or threaded openings 3/4-inch minimum.

O. Stator Temperature Detection

1. Bi-metallic switch type winding temperature detectors shall be provided for all NEMA Frame motors 100 HP and up, and for all NEMA Frame motors controlled by variable frequency drives. Provide the detectors factory installed, embedded, with leads terminating in the main conduit box. Device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts, or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.

- P. Where specified elsewhere or shown on the Drawings, provide analog vibration sensors mounted at the motor bearing to monitor radial vibration. The analog vibration sensor shall be piezoelectric type vibration sensor with a loop powered 4-20mA output as manufactured by PMC/Beta or equal. The analog signal shall be proportional to the vibration velocity with a range of 0 to 1.6 inches per second and an accuracy of +/- 10%. The analog vibration sensor shall be appropriate for pump operation from about 300 to 600 RPM and shall be mounted according to the instructions of both sensor and pump manufacturers. The analog vibration sensor shall have a stainless steel, NEMA 4X housing. The analog vibration sensors shall be compatible with the motor protection relay and have adequate output for the cable lengths required. The velocity levels between 0.05 to 0.2 inches per second shall be monitored and be field-adjustable.

- Q. Where specified elsewhere or shown on the Drawings, provide analog vibration sensors mounted at the motor bearing to monitor axial vibration. The analog vibration sensor shall be piezoelectric type vibration sensor with a loop powered 4-20mA output as manufactured by Industrial Monitoring Instrumentation IMI or equal. The analog signal shall be proportional to the vibration acceleration with a range of 0 to 5 g and an accuracy of +/- 10%. The analog vibration sensor shall be appropriate for pump operation from about 300 to 600 rpm and shall be mounted according to the instructions of both sensor and pump manufacturers. The analog vibration sensor shall have a stainless steel, NEMA 4X housing. The analog vibration sensors shall be compatible with the motor protection relay and have

adequate output for the cable lengths required. The acceleration levels monitored shall be field adjustable.

- R. For motors utilizing power factor correction capacitors connected to the starter output terminals, the motor overload elements or trip settings shall be adjusted downwards to reflect the reduction in line current resulting from power factor correction. Power factor correction capacitors shall not be applied to the load side of adjustable frequency drives.

2.5 FACTORY TESTING

- A. Motors rated 100 HP and larger shall be standard motor tested. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the Engineer for approval.
- B. As specified herein, provide a complete test per NEMA MG1 and IEEE Standard 112, consisting of the following:
 - 1. Full Load Heat Run
 - 2. Temperature Test (Actual loading method)
 - 3. Performance Test
 - 4. Locked Rotor Test
 - 5. No Load Saturation
 - 6. Speed Torque
 - 7. Winding Resistance (A 118 and 43)
 - 8. High Potential
 - 9. Noise Test (A 85)
- C. Balance and vibration shall meet NEMA standards MG1-12.05 and MG1-12.06.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors in accordance with the manufacturer's instructions.
- B. Make a visual and mechanical inspection.
- C. Check for physical damage.

- D. Compare equipment nameplate information with single line diagram and report any discrepancies.
- E. Inspect for proper mounting, grounding, connection, and lubrication.
- F. Inspect each motor for the proper installation, rated voltage, phase, and speed.
- G. Check for proper phase and ground connections. Check to see that multi-voltage motors are connected for the proper voltage.
- H. Motor connections shall be ring type compression terminations on the motor leads and secured with bolt, nut, and spring washer. Connections shall be rubber Scotch 33 tape insulated, half lapped with a minimum of two layers of tape, minimum.
- I. All lugs and connectors shall be copper and shall be crimped type, with standard industry tooling. Lugs and connectors shall match the wire size where used and shall be clearly identified and color coded on the connector. All connections shall be made for stranded wire and shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75 degrees C. Lugs larger than 4/0 AWG shall be two-hole lugs with NEMA spacing. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.
- J. Space heaters shall be continuously energized as specified.

3.2 TESTS

- A. Test for proper rotation prior to connection to the driven equipment.
- B. Test the insulation (megger test) of all new motors, 10 HP and above, in accordance with NEMA MG-1. Test voltage shall be 1000 volts AC plus twice the rated voltage of the motor.
- C. For motors 100 HP and larger, test duration shall be for ten minutes with resistances tabulated every 15 seconds for the first minute and then every minute for the next ten. The megohm rating at the end of the ten minutes shall be at least twice as high as the 1-minute reading. Dielectric absorption ratio and polarization index shall be calculated. Testing shall be in accordance with IEEE Standard 43. A polarization index of 3.0 or greater is required for acceptance.
- D. Perform a rotation test to ensure proper shaft direction.
- E. Where a motor is inverter fed, the direction of rotation shall be checked by momentary application of voltage to the motor, to confirm that the phase sequence is the same as the incoming power to the inverter.
- F. Measure running current and evaluate relative to load conditions and nameplate full load amperes.

- G. Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run.
- H. Monitor motors during startup and commissioning to record operating amps, voltage and operating vibration levels.
- I. Submit test report and all recorded field data. Submit copies of the raw data recorded in the field, signed by the person recording the data, and typewritten certified reports. The motors will not be accepted until the reports are submitted and approved.

PART 4 - TABLE OF MOTOR EFFICIENCIES

MOTOR FULL-LOAD EFFICIENCIES				
	2-POLE (3600 RPM)	4-POLE (1800 RPM)	6 POLE (1200 RPM)	8 POLE (900 RPM)
HP	Min. Efficiency	Min. Efficiency	Min. Efficiency	Min. Efficiency
1.0	72.0	80.0	77.0	70.0
1.5	80.0	81.5	82.5	74.0
2.0	81.5	81.5	84.0	80.0
3.0	82.5	85.5	85.5	81.5
5.0	85.5	85.5	85.5	82.5
7.5	87.5	87.5	87.5	82.5
10.0	88.5	87.5	87.5	86.5
15.0	89.5	89.5	88.5	87.5
20.0	88.5	89.5	88.5	87.5
25.0	89.5	91.0	90.2	87.5
30.0	89.5	91.0	90.2	89.5
40.0	90.2	91.7	91.7	89.5
50.0	91.0	91.7	91.7	90.2
60.0	91.7	92.4	92.4	90.2
75.0	91.7	93.0	92.4	91.7
100.0	92.4	93.6	93.0	91.7
125.0	93.6	93.6	93.0	92.4
150.0	93.6	94.1	94.1	92.4
200.0	94.1	94.1	94.1	93.0
500.0	94.5	95.0		--

END OF SECTION

SECTION 16195 POWER METERING AND PROTECTIVE RELAYS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section of the Specifications describes the requirements for power metering and protective relays to be furnished under other Sections of the Specifications to which reference is made in the Related Work paragraph of this Section.
- B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

- A. Refer to Division 16000 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
- D. The Engineer will provide the Power System Study which will include the required short circuit values for each piece of equipment and the protective device settings to the Contractor. Equipment submitted shall have short circuit ratings which meet or exceed the values provided by the Engineer. The protective device settings provided by the Engineer shall be applied by the Contractor prior to energizing the equipment containing protective devices.
- E. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., enough to confirm that the meter or relay provides every specified requirement. Any options or exceptions shall be clearly indicated.
 2. Submit a load calculation showing the sizing of the control power transformer.
- F. Operation and Maintenance Manuals.
1. Operation and Maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals above.

1.4 REFERENCE CODES AND STANDARDS

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. NEMA/ISCI – 109 Transient Overvoltage Withstand Test
 2. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests
 3. IEC 255.4 Surge Withstand Capability Tests
- B. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
- C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner

PART 2 - PRODUCTS

2.1 GENERAL

A. Metering and Protective Relay Enclosures

1. Enclosures for meters and protective relays located within the associated equipment shall have the same Enclosure Types as specified for the associated equipment.
2. Enclosures for meters and protective relays separately mounted shall be provided with enclosures which meet the requirements of Section 16110 Raceways, Boxes, Enclosures and Fittings.

B. Control and Instrument Power Transformers

1. Control power transformers shall be furnished as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the circuit breakers.
2. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
3. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100 VA.
4. Submit a load calculation showing that the sizing of the control power transformer complies with this requirement.
5. All control power transformers shall have vacuum cast primary and secondary coils using epoxy resin. Voltage and control power transformers of the quantity and ratings indicated. Control power transformers shall be 120 volts grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.
6. Voltage transformers shall be mounted in draw out drawers contained in an enclosed auxiliary compartment. The voltage transformer primary connections shall utilize epoxy insulated bus bar. Rails shall be provided for each drawer to permit easy inspection, testing, and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn. A mechanical interlock shall

be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

C. Current Transformers

1. Current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The location for the current transformers shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections.
2. Current transformers for power quality meters shall be instrument accuracy.
3. Meters and relays shall not be placed on the same current transformer circuit. Provide separate current transformers for relays and for meters.
4. Provide separate current transformers for differential relays shown on the drawings.
5. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

D. Settings

1. The settings will be provided by the Engineer

2.2 POWER METERING SYSTEM (PM1-1)

- A. Subject to compliance with the Contract Documents, the Power Metering System Manufacturer is to be the same manufacturer as the Motor Control Center Manufacturers as per specification section 16480.
- B. The use of MCC Manufacturer provided products does not imply acceptance of products that do not meet the specified ratings, features, and functions.

C. General

1. Full featured Metering with Power Measurement

D. Monitoring and Metering

1. Metering Functions with accuracy of 0.5% for A & V and 1.0% for power parameters
 - a. Average 3-phase voltage
 - b. A-B voltage
 - c. B-C voltage
 - d. A-C voltage

- e. Average 3-phase line current
- f. A-phase current
- g. B-phase current
- h. C-phase current
- i. 3-phase real power (kW)
- j. 3-phase reactive power (kVAR)
- k. 3-phase apparent power (kVA)
- l. 3-phase energy
- m. Frequency
- n. Power Factor
- o. THD

E. Communication

1. For remote monitoring, the following communication ports shall be provided:
 - a. One Industry Standard port for meter and relay programming using a laptop computer.
 - b. One RS-485 port.
 - c. One integral 10/100BaseT Ethernet port. The connection shall support Modbus TCP, Ethernet IP, and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
 - d. The manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.
2. The protocol interface shall implement Modbus-TCP Protocol with the following as minimum capabilities:
 - a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
 - b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
 - c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.

- d. Software tools shall be configurable to write a single register as either function 6 or 16.
 - e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.
3. The media protocol converter shall meet the following criteria:
- a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
 - b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
 - c. The converter shall have LED status for serial, signals, power, and Ethernet.
 - d. The converter housing shall be UL 1604, Class 1 Div. 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
 - e. Converter shall be Digi One IAP or approved equal.
 - f. equal.

2.3 PHASE FAILURE RELAY (PFR)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Taylor Phase-Guard Model P
 - 2. Approved equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Protection
 - 1. Indicators - LED
 - a. Normal – Green.
 - b. Phase loss or Low Voltage – Yellow.
 - c. Reverse Phase – Red.

2. Enclosure
 - a. As required in accordance with the Area Classification and Enclosure Types specified herein.
3. Functions.
 - a. Automatic Reset
 - b. Phase Loss.
 - 1) 12% or more.
 - 2) Delay 1-1/2 seconds.
 - a. Low Voltage Protection
 - 1) Drop at 70% of normal
 - 2) Reset at 90% of normal
 - a. Time Delays
 - 1) Adjustable
 - a. Over Voltage Protection
 - 1) Greater than 15%

2.4 HOURMETER (ETM)

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 1. Veeder-Root Model 779536-201
 2. Approved equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. Indicator
 1. 6 Digit Electromechanical
- D. Input 120 VAC (Range $\pm 10\%$), 60Hz
- E. Resolution
 1. One-tenth hour

F. Accuracy

1. 0.02%

G. Capacity

1. Up to 9999.9 Hours, automatic recycle at zero.

H. Operating Temperature

1. -40° to +185°F

I. Rectangular 0.95" x 1.45," screw terminals

2.5 ACCESSORIES

- A. Furnish nameplates for each device as indicated on drawings. Color schemes shall be as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.
- B. Enclosure Mounting Requirements:
 1. Mount all wall-mounted enclosures with an air gap between the enclosure and wall or mounting plate. Create the air space with slotted channel or several stainless-steel washers which together will make at least a ¼-inch space.
 2. Provide mounting feet for floor mounted enclosures.
 3. Mount all enclosures with integral welded-on mounting lugs. Drilling through the back of any enclosure to provide a mounting means is prohibited. Any enclosure drilled to provide a mounting means will be rejected and shall be replaced with no change in Contract Time or Price even if the enclosure installation is complete with raceway attached and conductors installed.
 4. Penetrations in any enclosures with a NEMA 3R, 4 or 4X rating which is located in any wet or damp area or in any process area whether it appears to be dry or not shall be in the sides or bottom only. Top penetrations in any enclosure located as described herein shall not be done for any reason, including raceway entries or equipment mounting. Top penetrations made in the field or by the original equipment manufacturer in the factory are all prohibited. Any enclosure with a top penetration located in the areas specified will be rejected, shall be removed, and replaced, even if it requires a return to the factory. Raceway penetrating the top shall be re-routed and re-installed. All installed conductors in re-routed raceway shall be removed and re-routed in the re-routed raceway. Conductors found to be too short to be re-terminated shall be

removed back to their source or load as the case may be and shall be replaced. Splicing is prohibited and unacceptable. All specified corrective measures shall be provided with no change in Contract Time or Price.

3.2 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, in accordance with settings designated in a coordinated study of the system as provided by the Engineer. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

END OF SECTION

**SECTION 16196
LOW VOLTAGE AC SURGE PROTECTIVE DEVICES (SPDS)**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section of the Specifications describes the requirements for low voltage AC surge protective devices (SPDs 1 kV and less), to be furnished under other Sections of the Specifications.
- B. All equipment described herein shall be submitted, and factory installed, as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

- A. Refer to Division 16000 for related work and electrical coordination requirements.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
- D. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned unreviewed. Unmarked cut sheets will cause rejection of the submittal and its return for revision.
- E. Submit to the Owner/Engineer, shop drawings and product data, for the following:
 - 1. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs,

outputs, displays, etc., enough to confirm that the SPD provides every specified requirement. Any options or exceptions shall be clearly indicated, with the reason for such deviations. Acceptance of any deviation will be at the sole discretion of the Owner/Engineer. Shop drawings, not so checked and noted, will be returned unreviewed.

2. Dimensional drawing of each SPD type.
3. UL 1449 Third Edition Listing, Standard for Safety, Surge Protective Devices, documentation. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL).
4. UL 1283 Listing, Electromagnetic Interference Filters, documentation.
5. ANSI/IEEE C6241 and C6245, Category C3 (20kV-1.2/50, 10kA-8/20 μ s waveform) clamping voltage test results.

F. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals above.

1.4 REFERENCE CODES AND STANDARDS

- A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. UL 1449 Third Edition – Surge Protective Devices
 2. UL 1283 Electromagnetic Interference Filters
 3. ANSI/IEEE C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits
 4. ANSI/IEEE C62.45-2002 – IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
 5. NEC Article 285 - Surge Protective Devices
 6. NEMA/ISCI – 109 Transient Overvoltage Withstand Test
 7. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests

8. IEC 255.4 Surge Withstand Capability Tests

- B. All SPDs and their installation shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.
- C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the SPD shall be the same as the manufacturer of the service entrance and distribution equipment in which the devices are installed and shipped. The protected electrical equipment, after installation of the SPD, shall be fully tested and certified to the following UL standards:
 - 1. UL 67 - Panelboards.
 - 2. UL 845 - Motor Control Centers.
 - 3. UL 891 - Switchboards.
 - 4. UL 1558 - Low Voltage Switchgear.
- C. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

1.6 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 1 and Type 2):
 - 1. Eaton
 - 2. ABB

3. Schneider Electric Company
4. Rockwall
5. Approved equal.

2.2 SERVICE ENTRANCE AND DISTRIBUTION EQUIPMENT

A. General

1. All SPDs shall be internal to the equipment being protected. Externally housed SPDs will not be acceptable.
2. All SPDs shall be marked with a short-circuit current rating and shall meet or exceed the available fault current at the connection point.
3. UL 1449 Usage Classifications.
 - a. Type 1 – Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device and intended to be installed without an external overcurrent protective device.
 - b. Type 2 – Permanently connected SPDs intended for installation on the load side of service equipment overcurrent device; including SPDs located at the branch panel.
 - c. Type 3 – Point of utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters) is exclusive of conductors provided with or used to attach SPDs.
4. Construction of Type 1 and Type 2.
 - a. Fully Integrated Component Design: All the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.
 - b. Overcurrent Protection: The unit shall contain thermally protected MOVs. The thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
 - c. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries

are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.

- d. **Balanced Suppression Platform:** The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules are not acceptable.
- e. **Electrical Noise Filter:** Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
- f. **Internal Connections:** No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
- g. **Power and ground connections** shall be prewired within the protected equipment.
- h. **Local Monitoring:** Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.
- i. **Surge Counter:** The SPD shall indicate user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. To prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of two seconds in order to clear the surge count total. The ongoing surge count shall be stored in non-volatile memory or UPS backup.
- j. **Remote Monitoring:** For remote monitoring, the SPDs shall provide the same discrete and analog signal and control functions as specified for local monitoring and the surge counter, to a terminal strip for outgoing connection to a PLC as shown on the Drawings. The functions shall be converted as specified for interface to the monitored equipment.
- k. The voltage surge suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to

system upset or create any environmental hazards.

- I. SPD shall be Listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
- m. Integrated surge protective devices (SPD) shall be Component Recognized in accordance with UL 1449 Third Edition, Section 37.3.2 and 37.4 at the standard's highest short circuit current rating (SCCR) of 200 kA, including intermediate level of fault current testing.
- n. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50µs, 10kA-8/20µs).
- o. SPD shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems (7 Mode).

B. Applications.

1. Service Entrance Rated Equipment (Type 1).

- a. This applies to switchgear, switchboards, panelboards, motor control centers, and other devices installed as service entrance equipment where the SPD is to be permanently connected between the secondary of the service transformer and the line side of the service equipment overcurrent device.
- b. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
- c. The SPD shall be of the same manufacturer as the equipment
- d. The SPD shall be factory installed inside the equipment, at the assembly point, by the original equipment manufacturer
- e. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bars.
- f. The SPD shall be connected through a UL approved disconnecting means. The disconnect shall be in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
- g. The SPD shall be integral to the equipment as a factory standardized design.
- h. All monitoring and diagnostic features shall be visible from the front of the equipment.

2. Distribution Equipment Applications (Type 2).

- a. This applies to switchgear, switchboards, panelboards, motor control centers, and other non-service entrance equipment where the SPD is to be

permanently connected on the load side of the equipment overcurrent device.

- b. The SPD shall be of the same manufacturer as the equipment.
 - c. The SPD shall be included and mounted within the equipment by the manufacturer.
 - d. The manufacturer shall size and provide the overcurrent and disconnecting means for the SPD.
 - e. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
 - f. The SPD shall be located within the panelboard, unless otherwise shown on the Drawings. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 - g. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 - h. All monitoring and diagnostic features shall be visible from the front of the equipment.
3. Mechanical Equipment Manufacturer's Provided Control Panels (MEMs) and Electrical Manufacturer's Provided Control Panels (OEMs) Applications (Type 1, Type 2, and Type 3)
- a. Where any such panel is installed as service entrance equipment, a Type 1 SPD shall be installed.
 - 1) The same requirements for other service entrance equipment listed above apply to this application except for the requirement that the Type 1 SPD shall not be required to be of the same manufacturer as the panel.
 - b. Where any such panel is installed as non-service entrance equipment, but within 50' of wire length of the incoming power line when that line is overhead.
 - 1) The same requirements for other non-service entrance equipment listed above apply to this application except for the requirement that the Type 2 SPD shall not be required to be of the same manufacturer as the panel.
 - 2) Where a Type 1 SPD is installed, a Type 2 SPD is not required on the same panel unless otherwise specifically shown on the drawings.
 - c. Where any such panel includes a PLC, a Type 3 SPD shall be installed.

- 1) The same requirements for other individual control panel and related equipment listed above apply to this application.
- 2) The SPD shall be integral to the MEM or OEM panel, as a factory standardized design.

C. Ratings

1. Unit Operating Voltage: Refer to drawings for operating voltage and unit configuration.
2. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
3. Minimum surge current rating shall be 240 kA per phase (120 kA per mode) for service entrance and 120 kA per phase (60 kA per mode) for distribution applications.
4. UL 1449 clamping voltage must not exceed the following: Voltage Protection Rating (VPR)

<u>Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
240/120	1200/800V	800V	800V
208Y/120	800V	800V	800V
480Y.277	1200V	1200V	1200V
600Y/347	1500V	1500V	1500V

5. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.
6. Minimum UL 1449 3rd edition withstand Nominal Discharge Current (In) rating to be 20kA per mode

2.3 ACCESSORIES

- A. Furnish nameplates for each device as indicated on drawings. Color schemes shall be as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in the individual equipment Specification.

- B. Types 1 and 2 shall be grounded and bonded as a part of the individual equipment as specified in the individual equipment Section. Type 3 shall be grounded and bonded in accordance with the SPD manufacturer's instructions.

END OF SECTION

SECTION 16475
LOW VOLTAGE ENCLOSED CIRCUIT BREAKERS AND SAFETY SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install low voltage enclosed circuit breakers and disconnect switches, together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.
- B. All equipment specified in this Section of the Specifications shall be the product of one manufacturer and shall be factory constructed and assembled by that manufacturer.

1.2 RELATED WORK

- A. Refer to Division 16000 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review
- D. Submittals shall be made in accordance with the requirements of the process equipment division of these Specifications, and as specified herein.
- E. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned without review.

- F. The original equipment manufacturer, (OEM) shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer's logo, drawing file numbers, and shall be maintained on file in the OEM's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.
- G. Time-current coordination curves for protective device relays, circuit breakers, and fuses submitted shall be included as a part of these submittals.
- H. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual. Shop Drawings and Product Data.
- I. The following information shall be submitted to the Engineer:
 - 1. Product data sheets and catalog numbers for overcurrent protective trip devices on circuit breakers and switches, relaying, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project.
 - 2. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
 - 3. Provide plan and elevation drawings of each controller or enclosure, with dimensions, exterior and interior views, showing component layouts, controls, terminal blocks, etc..
 - 4. Schematic diagram
 - 5. Nameplate schedule
 - 6. UL Listing of the completed assembly.
 - 7. Component list with detailed component information, including original manufacturer's part number.
 - 8. Conduit entry/exit locations
 - 9. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current

10. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
11. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
12. Key interlock scheme drawing and sequence of operations
13. Busway connection and amperage rating.
14. Instruction and renewal parts books.
- J. Factory Tests. Submittals shall be made for factory tests specified herein.
- K. Field Test Reports. Submittals shall be made for field tests specified herein.
- L. Operation and Maintenance Manuals.
 1. Operation and maintenance manuals shall include the following information:
 - a. Manufacturer's contact address and telephone number for parts and service.
 - b. Instruction books and/or leaflets
 - c. Recommended renewal parts list
 - d. Record Documents for the information required by the Submittals paragraph above.
- M. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.4 REFERENCE CODES AND STANDARDS

- A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
 1. NEMA Standard AB1 – Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures
 2. NFPA 70 – National Electrical Code (NEC)
 3. NFPA 70E – Standard For Electrical Safety in the Workplace

4. IEEE 242 – Protection and Coordination of Industrial and Commercial Power Systems
 5. IEEE 399 – Power Systems Analysis
 6. UL 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures
 7. UL 1066 – Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.
- B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

- A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and “brand labeled” shall not be acceptable.
- C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.
- E. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.
- B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner. The instructions shall include detailed assembly instructions including but not limited to wiring interconnection diagrams, rigging for lifting, skidding, jacking, and moving using rolling equipment to place the equipment, bolt torquing requirements for bus and all other components which require the installation of bolted connections, and instructions for storing the equipment prior to energizing.

- C. Equipment shall be stored indoors and protected from moisture, dust and other contaminants.
- D. Equipment shall not be installed until the location is finished and protected from the elements.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years except for variable frequency drives which shall be for two years, from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. ABB
 - 2. Eaton
 - 3. Schneider Electric Company
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
- C. All equipment furnished under this Section shall be from the same manufacturer.

2.2 RATINGS

- A. The service voltage shall be as shown on the Drawings. The overall short circuit withstand, and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the circuit breaker or switch. Systems employing series connected ratings for main and feeder devices shall not be used.
- B. Circuit breakers, safety switches and associated devices shall be designed for continuous operation at rated current in a 40°C ambient temperature.
- C. Furnish heavy duty devices.
- D. For additional ratings and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, components; protective relays, voltage ratings of devices, components, and assemblies; and other required details.
2. Furnish lugs for incoming wiring, sizes as shown on the Drawings. Allow adequate clearance for bending and terminating of cable size and type specified, Lugs for #12 AWG up to #6 AWG shall be ring terminals. Conductors #4 AWG and larger shall be two-hole long barrel lugs with NEMA spacing. All lugs shall be the closed end construction to exclude moisture migration into the cable conductor. See also Section 16120 Wires and Cables (1000 Volt Maximum) for additional requirements.
3. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
4. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inch, or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.

B. Enclosures

1. General
 - a. Enclosures shall meet the requirements specified in Section 16110 Raceways, Boxes Enclosures and Fittings.
 - b. Provide 316 SS hardware for all enclosures.
 - c. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
 - d. Enclosures shall not have holes or knockouts for conduit entry.
 - e. All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
 - f. All enclosures shall be provisioned with hardware for a padlock.
 - g. All enclosures shall have integral welded mounting lugs.
2. NEMA 4X Stainless Steel were not otherwise Defined

- a. Where an enclosure is not otherwise defined or shown on the Drawing
 - 1) NEMA 4X Stainless Steel
 - 2) Type 316 stainless steel, body and door
 - 3) Stainless steel hinge
 - 4) Foam in-place gasket
 - 5) Single point quarter turn latches
 3. NEMA 1 or NEMA 1A boxes shall not be used.
 4. Malleable iron boxes shall not be used.
 5. Provide a disconnect operating handle with mechanical interlock having a bypass that will allow the enclosure door to open only when the circuit breaker or switch is in the OFF position. The circuit breaker or switch shall have the capability of being bypassed after the door has been opened.
- C. Internal Wiring
1. Wiring: Stranded copper, minimum size No. 14 AWG, with 600 Volt, 90°C, flame retardant, Type MTW thermoplastic 600-volt insulation, NEMA Class II, Type B wiring. Line side power wiring shall be sized for the full rating or frame size of the connected device.
 2. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type like Raychem TMS-SCE, or equal. Wire tags shall be machine-printed. Wire tags relying on adhesives of any type are unacceptable.
 3. All wiring shall be neatly bundled with tie wraps and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
- D. Field Installed Internal Wiring
1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring. Wiring shall not be supported using adhesive supports. Adhesive wire supports are unacceptable, and if installed shall be removed and replaced with a non-adhesive support with no increase in Contract Price or Time.

2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal. Wire tags shall be machine-printed. Wire tags relying on adhesives of any type are unacceptable.
3. In general, all conduit entering or leaving equipment shall be stubbed up into the bottom of the enclosure directly below the area in which the conductors are to be terminated, or from the top if shown on the Drawings and not located in a wet, damp or any process area. Conduits shall not enter the side unless approved in writing by the Owner/Engineer.

2.4 CIRCUIT BREAKERS

A. Insulated Case Circuit Breakers (ICCBs)

1. Unless otherwise shown on the Drawings, circuit breakers, larger than a 1200 ampere rating, shall be insulated case (ICCB), three-pole, 600-volt, fixed type, with stored energy closing mechanism.
2. Breakers shall be manually operated unless indicated as electrically operated (EO) on the Drawings.
3. All insulated case circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes, with individual interrupting capacity as shown on the Drawings. Insulated case circuit breakers without an instantaneous trip element adjustment shall be equipped with a fixed internal instantaneous override set at the upper limit.
4. All insulated case circuit breakers shall be constructed and tested in accordance with UL 489. The circuit breakers shall carry a UL label.
5. All insulated case circuit breakers shall have an adjustable long time pickup, and delay; adjustable short time pickup and delay; short time i²t switch; high range instantaneous (fixed at the breaker's short time withstand rating), adjustable ground fault pickup and delay, and overload, short circuit, and ground fault indicator lights.

B. Molded Case Circuit Breakers (MCCB's)

1. Unless otherwise shown on the Drawings, circuit breakers 225 ampere frame rating and larger, shall be molded case (MCCB), three-Pole, 600-volt, fixed type, with stored energy closing mechanism. Breakers shall be manually operated unless indicated as electrically operated (EO) on the Drawings. Trip device shall be solid state with adjustable long time pickup, and delay; adjustable short time pickup and delay; short time i²t switch; adjustable instantaneous pickup, adjustable ground fault pickup and delay, and ground fault delay and pickup trips for selective tripping.
2. Unless otherwise shown on the Drawings, circuit breakers less than 225 ampere frame rating shall be molded case, three-Pole, 600-volt, fixed type,

manually operated with stored energy closing mechanism. Circuit breakers shall have inverse time and instantaneous tripping characteristics.

3. Where shown on the Drawings or specified in the Contract Documents, breakers shall be Provide breakers rated for 100% continuous duty with a UL 489 listing.

2.5 SAFETY SWITCHES

- A. Safety switches shall be heavy duty, quick make, quick break, visible blades, 600-volt, three-pole with full cover interlock, interlock defeat and flange mounted operating handle.

2.6 FUSED SAFETY SWITCHES

- A. Fused safety switches shall be heavy duty, quick make, quick break, visible blades, 600 volt, three-pole with full cover interlock, interlock defeat and flange mounted operating handle.
- B. Fuses shall be rejection type, 600 volts, 200,000 A.I.C., dual element, time delay.
- C. Fuses
 1. Eaton
 2. Ferraz Shawmut Fuses
 3. Littlefuse Incorporated
 4. Busman
 5. Approved equal

2.7 SPARE PARTS

- A. Provide the following spare parts:
 1. Three – Fuses of each type used.
- B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.8 FACTORY TESTING

- A. The circuit breakers and all switches shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

- B. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

- A. Installer shall be specialized in installing low voltage circuit breakers and disconnect switches with minimum five years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the equipment.
- B. Verify that the equipment is ready to install.
- C. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations and Contract Drawings.
- B. Install required safety labels.
- C. Conduit entry into the top of any NEMA 4/4X rated enclosure in any outdoor, damp, wet or process area is strictly prohibited. Any enclosure entered from the top will be removed, the conduit and conductors re-routed, or conductors replaced if too short. No increase in Contract Price or Contract Time will be allowed.

3.4 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.5 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The adjustable breakers shall be set in the field by a qualified representative of the manufacturer, in accordance with settings designated in a coordinated study of the system as provided by the Engineer. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

3.6 FIELD TESTING

- A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.
- B. Megger and record phase to phase and phase to ground insulation resistance. Megger, for one minute, at minimum voltage of 1000 volts DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer's maximum test voltages be exceeded.
- C. Test the ground fault protection system using a high current injection method.
- D. Test the rating plug for correct rating.

3.7 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.8 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

END OF SECTION

**SECTION 16480
LOW VOLTAGE MOTOR CONTROL CENTERS**

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish and install assemblies of low voltage motor control centers (MCCs), together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.
- B. All hardware shown on the Drawings or defined by specification shall be factory installed by MCC Manufacturer.
- C. Motor control centers shall be sized to include all equipment, spares and spaces shown on the Drawings.

1.2 RELATED WORK

- A. Refer to Division 16000 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.
 - 3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 - 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review
- D. Submittals shall be made in accordance with the requirements of the process equipment division of these Specifications, and as specified herein.
- E. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned without review.

- F. The original equipment manufacturer, (OEM) shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturers logo, drawing file numbers, and shall be maintained on file in the OEM's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.
- G. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Qualifications and Preliminary Study submittals required in the Power System Study specified under Section 16105. Submittals made prior to such approval will be returned unreviewed.
- H. The Engineer will provide the current Power System Study Model to be updated by the Contractor to reflect the equipment being provided under this contract. The overcurrent protective device settings resulting from the protective device coordination study defined in Specification 16105 Power System Study are to be implemented prior to energizing the equipment.
- I. Provide field investigation to obtain the following information of existing equipment connected to new equipment either as a feeder or a load:
 - 1. Short circuit ratings of existing equipment
 - 2. Time-current curves and the current settings for existing relays including CT ratios.
 - 3. Time-current curves and amperage for non-adjustable breakers,
 - 4. Time-current curves and the current settings for circuit breakers
 - 5. Time-current curves and amperage for existing fuses
 - 6. Submit this information to the Engineer prior to submitting equipment required under this specification.
- J. Time-current coordination curves for protective device relays, circuit breakers, and fuses submitted shall be included as a part of these submittals.
- K. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual. Shop Drawings and Product Data.
- L. The following information shall be submitted to the Engineer:
 - 1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
 - 2. Conduit entrance drawings, including floor penetrations.

3. Bus arrangement drawings.
4. Unit summary tables showing detailed equipment description and nameplate data for each compartment.
5. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply. Unmarked cut sheets will cause rejection of the submittal and its return for revision.
6. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between units and to remotely mounted devices. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
7. Master drawing index
8. Front view elevation
9. Floor plan
10. Top view
11. Single line
12. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.
13. Nameplate schedule
14. UL Listing of the completed assembly.
15. Component list with detailed component information, including original manufacturer's part number.
16. Conduit entry/exit locations
17. Assembly ratings including:
 - a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
18. Major component ratings including:
 - a. Voltage
 - b. Continuous current

c. Interrupting ratings

19. Descriptive bulletins

20. Product data sheets.

21. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.

22. Floor mat.

- a. The manufacturer of the specified equipment may not manufacturer or provide floor mats. However, the inclusion of the floor mats in this submittal is mandatory and shall be included in the submittal, or it will be considered incomplete and will be returned for revision and resubmittal.

23. Key interlock scheme drawing and sequence of operations.

24. Busway connection and amperage rating.

25. Instruction and renewal parts books.

26. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

M. Factory Tests. Submittals shall be made for factory tests specified herein.

N. Field Test Reports. Submittals shall be made for field tests specified herein.

O. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:

- a. Manufacturer's contact address and telephone number for parts and service.
- b. Instruction books and/or leaflets
- c. Recommended renewal parts list
- d. Record Documents for the information required by the Submittals paragraph above.

P. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.4 REFERENCE CODES AND STANDARDS

A. The low voltage motor control centers and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA Standard ICS 2 – 2000 Industrial Control and Systems
 2. UL 845 – Electric Motor Control Centers
 3. NEMA Standard SG-3 – Low Voltage Power Circuit Breakers
 4. NFPA 70 – National Electrical Code (NEC)
 5. NFPA 70E – Standard for Electrical Safety in the Workplace
 6. UL 991 - Tests for Safety-Related Controls Employing Solid-State Devices
- B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

- A. The manufacturer of the equipment provided shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- B. The manufacturer of the assembly provided shall be the manufacturer of the major components within the assembly. All assemblies provided shall be manufactured by the same manufacturer. Equipment that is manufactured by a third party and “brand labeled” will not be acceptable.
- C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.
- D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.
- E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.
- B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.
- C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

- D. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.
- E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, until such time that the site is ready for permanent installation of the equipment with no change in Contract Price or Schedule.
- F. Space heaters provided in equipment shall be provided with temporary electrical power to operate during jobsite storage and after equipment is installed in permanent location. Space heater operation shall be continuous until equipment is powered and placed in service.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warranty, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
 - 1. Schneider Electric/Square D
 - 2. ABB/GE
 - 3. Eaton
 - 4. Allen Bradley/ Rockwell Automations
 - 5. No Equal
- B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

- A. The service voltage, overall short circuit withstand and interrupting rating of the equipment and devices shall be as shown on the Drawings. Main and feeder circuit

protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.

- B. The continuous current rating of the main horizontal bus shall be as shown on the Drawings. Vertical busses shall be sized for the structure load and shall have a minimum rating of 300 amperes.
- C. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40°C ambient temperature.
- D. For additional ratings and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Control units shall be arranged as shown on the Drawings.
3. Provide a factory-installed dedicated Point of Utilization Device (SPD) specified in Section 16195, Power Metering and Protective Relays when the equipment contains a programmable logic controller (PLC) or a uninterruptible power supply (UPS) or Protective Relay devices, or is otherwise indicated on the drawings.
4. Nameplates
 - a. External
 - 1) Furnish nameplates for each device as specified herein and as indicated on the Drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inch, or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.

b. Internal

- 1) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special

- 1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

5. Control Devices and Indicators

- a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30-millimeter, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
- b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
 - 1) Red for ON, Valve OPEN, and Breaker CLOSED.
 - 2) Green for OFF, Valve CLOSED and Breaker OPEN.
 - 3) Amber for FAIL.
 - 4) Blue for READY
 - 5) White for POWER ON.
- c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
- d. Pushbuttons, shall be as follows:
 - 1) Red for STOP, Valve OPEN, Breaker OPEN and mushroom Red for EMERGENCY STOP.
 - 2) Green for START, Valve CLOSE and Breaker CLOSE.
 - 3) Black for RESET.

- e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
- f. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.

B. Voltage and Current Transformers

1. Voltage and Instrument Transformers

- a. Voltage transformers shall be draw out type, with current-limiting fuses and with BIL rating equal to the switchgear. Transformers shall be as shown on the Drawings.
- b. For rigidity during fault conditions all connections to roll-out potential transformer trays and control power transformer trays shall be rigid bus bars insulated to full voltage rating of switchgear assembly.
- c. All instrument transformers shall be metering accuracy type and vacuum cast using polyurethane resin.
- d. Transformers shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the Switchgear. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
- e. Secondary conductors shall be #14 AWG, extra flexible, stranded, copper control wire, Type MTW, rated 600 volts, except for specific circuits requiring larger wire. Crimp-type, uninsulated spade terminals shall be furnished on all wire ends, except non-insulated ring terminals are used to connect to fuse blocks, and instrument transformer studs. Secondary control wires shall be armored where they pass through primary compartments.

2. Current Transformers

- a. Current transformers (CTs) shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the CTs shall be coordinated with the circuit breakers' current rating. Their accuracy rating shall be equal to or higher than ANSI standard requirements.
- b. Multi-ratio CTs shall be provided unless specified otherwise.
- c. CT used with protective devices for fixed loads or to meter fixed loads (such as a single motor, transformer, or a generator) shall have a ratio which is no more than 150% of the rated full load current of the load.
- d. CTs on circuits for variable frequency drives (VFD) shall be rated for 150% of the rated full load input current to the VFD regardless of the size of the

motor controlled by the VFD.

- e. CTs used for protective devices shall have an accuracy rating equal to or higher than ANSI standard requirements.
- f. Current transformers used for metering shall be instrument accuracy. Provide separate CTs for meters. Do not series meters on the same CT circuit with protective relays.
- g. Provide a separate, independent set of CTs for differential protection, if specified.
- h. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections.
- i. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.
- j. Secondary conductors shall be #12 AWG, extra flexible, stranded, copper control wire, Type MTW, rated 600 volts, except for specific circuits requiring larger wire. Crimp-type, uninsulated spade terminals shall be furnished on all wire ends, except non-insulated ring terminals are used to connect to current transformer studs. Secondary control wires shall be armored where they pass through primary compartments.

3. Control Power Transformers

- a. Control power transformers (CPTs) shall be as shown on the Drawings. Transformer mechanical ratings shall equal the BIL and momentary rating of the switchgear. Transformers, when mounted in switchgear assemblies, shall be rated for the full voltage of the switchgear.
- b. All control power transformers shall have vacuum cast primary and secondary coils using epoxy resin. The quantity and ratings of the control power transformers shall be as shown on the drawings. Autotransformers are not acceptable. Transformers shall be mounted in draw out drawers contained in an enclosed auxiliary compartment. The voltage transformer primary connections shall utilize epoxy insulated bus bar. Rails shall be provided for each drawer to permit easy inspection, testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.
- c. CPTs shall be mounted in draw out drawers contained in an enclosed auxiliary compartment. Provide primary fuses in each ungrounded leg on the primary and secondary side. Secondary circuit breakers are permitted in each ungrounded leg. CPT primary connections shall utilize epoxy insulated bus bar. Rails shall be provided for each drawer to permit easy

inspection testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn. A mechanical interlock shall be provided to require the secondary breaker or fused disconnect to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

- d. Secondary conductors shall be No. 14 minimum, extra flexible copper control wire, stranded, Type MTW rated 600 volts, except for specific circuits requiring larger wire. Provide crimp-type, uninsulated spade terminals on all wire ends, except provide non-insulated ring terminals to connect to fuse blocks, and CPT studs. Secondary conductors shall be armored where they pass through primary compartments. All control wiring shall be UL listed with a VW-1 flame retardant rating.
- e. CPTs providing power to motor space heaters shall be sized to accommodate the full load of the motor space heater. Field verify the motor space heater rating on existing motors and shall coordinate with the motor manufacturer for new motors to provide sufficient capacity in the CPT to power the space heater and all other switchgear loads. CPT secondary conductors shall be increased to accommodate the full load output current of the CPT if its full load current exceeds the capacity of the #14 AWG conductors specified herein.
- f. Adhesive type conductor supports are unacceptable. Provide spot welded cable support studs or other support means from which nylon cable ties and conductors are supported.

C. Enclosures

1. Structures shall be NEMA Type 1A unless noted otherwise on the Drawings.
2. Motor control centers shall consist of a series of metal enclosed, free standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally 90 inches high, 20 inches wide and 20 inches deep unless otherwise shown on the Drawings. Vertical sections shall be mounted on steel channel sills. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full width of each shipping split. Top of each section shall have removable plates with lifting angle. MCCs shall be constructed to allow field installation of additional sections to each end and shall be provided with full depth cover plates (rodent barriers) at each end of the motor control center channel sills.
3. Provide continuous top and bottom horizontal wireways extending the full width of the lineup, isolated from the horizontal bus. Provide a four-inch wide, full height, vertical wire way in each section, equipped with a hinged door and cable supports. Vertical wire way shall be isolated from the bus and device compartments. Wireways or other metal member's openings shall have rolled edges or protective grommets.
4. All cables shall enter and exit underground from the bottom of the structure, unless otherwise shown on the Drawings.

5. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.
6. Motor control centers shall be designed for mounting against the wall or back-to-back with another MCC. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.
7. Each vertical section shall be divided into no more than six compartments which shall contain a feeder breaker, combination motor control unit, or other control assemblies connected to a common vertical power bus.
8. Vertical sections shall contain horizontal wire ways at top and bottom of the structure. The design shall be such to permit a continuous wiring trough from end to end of the entire width of the motor control center. End vertical sections shall have cover plates, which can be easily removed to allow continuation of wire ways and horizontal bus extensions for future addition of vertical sections.
9. The vertical section shall also have a continuous vertical raceway extending the full height of the structure and shall intersect with the horizontal raceways. This wire way shall be provided with barriers which completely isolate the wire way from the bus compartments, the controller compartment, and the adjacent vertical units. The wire way shall have its own separate hinged door.
10. Combination motor control units (Size 5 and smaller), as well as other electrical assemblies, including feeder tap units (225 ampere and smaller), shall be provided with appropriately rated stab assemblies for draw out (plug-in) type construction.
11. Plug in provisions shall include a positive guide rail system and stab shrouds to insure alignment of stabs with the vertical bus. The stab shall be designed to increase bus contact pressure during a fault. The stab design shall assure a consistent low-resistance contact with the vertical bus, even after repeated insertions and removals. The unit shall be equipped with a lockout mechanism to lock the drawer in an extended or stabbed position for maintenance and testing. Each draw out compartment shall have a separate hinged removable door.
12. Each unit compartment shall be provided with an individual front hinged door. Motor control and feeder units shall be interlocked mechanically with a unit disconnect device to prevent unintentional opening of the door while unit is energized. An interlock between the unit disconnect and the structure shall prevent the removal or reinsertion of the unit when the unit is in the "ON" position. Means shall be provided for releasing the interlock for intentional access and/or application of power. Pad locking arrangements shall permit locking the disconnect device in the "OFF" position.

13. The MCC shall be furnished as a completely factory assembled unit where transportation facilities and installation requirements permit. Minimize shipping splits if required.
14. All painted steel work shall be treated with a primer coat and a finish coat, or bonderized and finished with a coat of baked enamel at the factory, such that no field painting will be required except for "touching up" of damaged areas. Color shall be manufacturer's standard.
15. Furnish documentation with the equipment as follows: Compartments containing panel boards shall have a card holder on the inside of the door with the branch circuits clearly identified. Compartments containing motor starters shall each have an overload heater section table posted inside the door. All control compartments shall have a pocket on the inside of the door with a copy of the appropriate schematic and wiring diagram.
16. Where the motor control center is shown outdoors the construction shall be NEMA 3R and shall be as follows:
 - a. The MCC shall be non-walk-in weatherproof construction of basic indoor equipment enclosed in a weatherproof enclosure. Gasket all covers, provide filters for ventilation louvers and a sloped roof.
 - b. The MCC shall be supported on a heavy gauge, welded steel channel base extending around all four sides, constructed to exclude rodents, vermin, and dust.
 - c. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pretreatment to inhibit rust.
 - d. Roof structure shall be watertight with a continuous drip edge channel on the front. Roof shall slope to the rear for water drainage. Holes for lifting eyes shall be blind tapped.
 - e. Provide tamper resistant, pad lockable, weathertight, gasketed cubicle doors and switch handle covers, with stainless steel hinge pins.
 - f. Each vertical section shall have heavy duty, 240 volts AC, space heaters, thermostat controlled, of sufficient capacity to prevent condensation with the equipment de-energized, while operating at half their rated voltage. Heaters shall be provided with perforated metal guards and a circuit breaker disconnect. 120-volt AC control power shall be provided from the MCC.

D. Construction

1. Provide individual compartments for each removable combination starter and feeder tap device unit. Each vertical section shall accommodate a maximum of six compartments. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall

connect to the vertical bus in each section with tin plated, self-aligning, pressure type copper plug connectors. Size 6 and larger starter units may be wired directly to the bus. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.

2. Provide individual, isolated compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, relaying and control devices. Main and bus tie circuit breakers shall be wired directly to the main horizontal bus. All bus connections shall be fully rated.
3. Provide the following features:
 - a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.
 - b. Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.
 - c. Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.
 - d. Mechanical split type terminal blocks for disconnecting external control wiring.
 - e. Auxiliary contact on unit disconnect to isolate control power when fed from an external source.
 - f. Disconnect operating handles and control devices.

E. Bus Systems

1. The bus support system shall be high dielectric strength, low moisture absorbing high impact material.
2. Bus bracing shall be minimum 65,000 amperes RMS symmetrical, and be equal to or exceed the value shown on the Drawings.
3. Busses shall have uniform cross-sectional area throughout their length. Tapered bus will not be acceptable.
4. All bolted bus mating surfaces and splicing material shall be the same plated material as the bus.
5. The main horizontal bus shall extend the entire length of the motor control center. The main bus bars shall be rated as shown on the Contract Drawings but shall not be less than 600 amperes.

6. Main horizontal bus: Tin plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup. All field assembled joints shall be taped after installation, equal to the factory bus taping.
7. Vertical section bus: Tin plated copper, full height, totally insulated and isolated by labyrinth design barrier of glass-reinforced polyester, or sandwich insulated/isolated busses, with shutters to cover stab openings when units are withdrawn. Provide fish tape barriers to isolate bottom wireways from lower ends of vertical bus. Bus shall be provided in each vertical draw out section.
8. Vertical busses used for a tie circuit breaker or tie feeder lugs shall be rated for a continuous capacity equivalent to the main horizontal bus rating.
9. Horizontal ground bus: Provide a 300A minimum, continuous tin-plated copper ground bus in each section equipped with lugs for termination of feeder and branch circuit ground conductors. Connect to ground bus in adjacent sections with splice plates. Provide ground bolted connectors for 2/0 AWG minimum wire at each end of the bus.

F. Wiring

1. Wiring: Stranded copper, minimum size #14 AWG, with 600 volt, 90°C, flame retardant, Type MTW thermoplastic insulation, NEMA Class II, Type B. Line side power wiring shall be sized for the full rating or frame size of the connected device. All conductors #1/0 AWG and larger shall be terminated with long barrel NEMA two-hole lugs.
2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA standards and the NEC. Foreign voltage control wiring shall be yellow.
3. All control wiring to draw out units shall be run through split type terminal blocks (draw out) which can be split to allow easy unit removal. Motor "T" leads shall bolt directly to starter or overloads and shall not utilize split type terminal blocks. Terminal blocks shall be of the fully shielded, tubular screw clamp type, resilient collar design to eliminate loose connections. Terminal blocks shall be nickel or tin plated and have exposed wire numbering corresponding to the connected wires. Terminals shall have a maximum of two wires per terminal.
4. All wiring shall be neatly bundled with ty-raps and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
5. Where "shipping splits" are required between the control compartments and the starter cubicles, interconnecting jumper wires shall be provided for field re-connection.
6. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations

are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

7. In general, all conduit entering or leaving a motor control center shall be stubbed up into the bottom horizontal wire way directly below the vertical section in which the conductors are to be terminated or shall enter the motor control center from the top. Conduits shall not enter the motor control center from the side unless approved in writing by the Owner/Engineer.
8. All field wiring and all field-installed internal wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.

G. Main Section

1. The MCC main sections shall include the main and tie breakers, metering and power feeder entrance to the MCC. Where a power feeder entrance is shown on the Drawings, the power feeder entrance section shall be provided. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings. Where main and tie breakers are shown to be key interlocked, interlocks shall be Kirk-Key type.
2. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel or approved equal.

H. Surge Protective Devices

1. Furnish where shown on the Drawings, or specified herein, a manufacturer provided and installed, Low Voltage Surge Protective Devices (SPD) (Type 2), as specified in Section 16196 of these Specifications. Connection to the MCC shall be with a surge rated disconnect, mounted integral to the MCC.

I. Main Circuit Protective Devices

1. Unless otherwise shown on the Drawings, single main or main-tie-main circuit breakers, with a frame rating of 1200 amperes or less, shall be molded case (MCCB), three-pole, 600-volt, fixed type, manually operated with stored energy closing mechanism. Trip device shall be solid state with adjustable long time, short time with short time i2t switch, adjustable instantaneous settings, and adjustable ground fault settings with i2t switch. A remote energy-reduction maintenance switch with local indication connected to the instantaneous setting shall be provided to reduce the setting to minimum to reduce arc flash during equipment maintenance
2. Insulated case and molded breakers shall have a UL 489 listing.

J. Interlocks

1. Electrical, mechanical and Kirk-Key interlocks shall be provided on breakers where shown on the Drawings.
 2. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel or approved equal.
- K. Control and Instrument Power Transformers.
1. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity. Provide a load calculation showing that the sizing of the control power transformer complies with this requirement.
 2. Control power transformers shall be 120-volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.
- L. Furnish lugs for incoming line feeders, sizes as shown on the Drawings. Allow adequate clearance for bending and terminating of cable size and type specified.

2.4 MOTOR CONTROLLERS

A. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and thermal overload heater element ratings matched to the motors and control equipment supplied, in compliance with the NEC and the manufacturer's heater selection tables. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.
2. Motor starters shall be as shown on the Drawings. All motor starters shall be combination units, full voltage non-reversing (FVNR), with adjustable instantaneous trip magnetic only circuit breakers, or motor circuit protectors (MCP), unless otherwise specified or shown on the Drawings. NEMA starter sizes and breaker trip ratings shall be as required for the horsepower indicated but shall be in no case less than NEMA Size 1. If the manufacturer of the equipment utilizing the motor, supplies a motor horsepower larger than that shown on the Drawings, supply a motor starter sufficient in size to control the motor supplied. International (IEC) starters shall not be acceptable.
3. Each motor starter shall have a 120-volt operating coil unless otherwise noted.
4. NEMA Size 5 and smaller shall be draw out design with stab-on connectors engaging the vertical buses. Larger units shall be of the fixed (bolt-in) design.
5. Overload relays shall be standard Class 20, ambient compensated, manually reset by pushbutton located on front of the compartment door. A normally closed contact shall be directly used in the start circuit and a normally open contact shall be wire to a terminal board for overload alarm.

6. Control power transformers shall be 120-volt grounded secondary. Primary shall be fused with slow blow fuses in each phase. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused. The transformer shall be oversized for auxiliary loads as indicated on drawings, but in no case be smaller than 100 VA.
7. Combination starters shall include a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic trip range in percent of rated continuous current and a trip test feature. MCP's shall be labeled in accordance with UL489.
8. Where indicated on the Control Schematic title, motor starter logic shall be contained in a PLC with Modbus TCP Ethernet Communications. The PLC shall not be affected by VFD frequency interference. The PLC shall be programmed by the manufacturer using the control schematics shown on the Drawings.

B. Multi-Speed and Reversing Starters

1. Multi speed and reversing starters shall include two motor rated contactors as described above, mechanically and electrically interlocked so that only one device may be energized at any time.

C. Reduced Voltage Starters

1. Reduced Voltage Auto-Transformer Type Starters (RVAT).

- a. Auto-transformer type with closed circuit transition. Auto transformers shall be dry type with 50%, 65% and 80% voltage taps and over temperature protection. Timing relays shall be electronic, adjustable. Relay settings shall be approximately 75% of relay range. Contactors shall be electrically and mechanically interlocked

2. Reduced Voltage Solid State Type Starters (SSRV).

- a. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, paralleling bypass and output contactors, and electronic overload relay enclosed in a single molded housing
- b. The SCR-based power section shall consist of six back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1500 volts PIV
- c. Units using triacs or SCR/diode combinations shall not be acceptable
- d. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dV/dT effects
- e. The logic board shall be accessible for testing, service and replacement.
- f. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformal coated to protect environmental concerns

- g. The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under one times motor current
- h. The paralleling run bypass contactor shall utilize an intelligent coil controller to limit contact bounce and optimize coil voltage during varying system conditions
- i. Starter shall be provided with electronic overload protection as standard and shall be based on inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads.
- j. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter.
- k. Starter shall have selectable overload class setting of 5, 10, 20 or 30.
- l. Starter shall be capable of either an electronic or mechanical reset after a fault
- m. Units using bimetal overload relays are not acceptable
- n. Over temperature protection (on heat sink) shall be provided.
- o. Starters shall provide protection against improper line-side phase rotation. Starter shall shut down if a line-side phase rotation other than A-B-C exists. Provision for disabling shall be provided.
- p. Starters shall provide protection against a phase loss or unbalance condition. Starter shall shut down if a 50% current differential between any two phases is encountered. Provision for disabling shall be provided.
- q. Starter shall provide protection against a motor stall condition as standard. Provision for disabling shall be provided.
- r. Starter shall provide protection against a motor jam condition as standard. Provision for disabling shall be provided.
- s. Starter shall be provided with a Form C normally open, normally closed contact that shall change state when a fault condition exists. Contacts shall be rated 60 VA (resistive load) and 20 VA (inductive load). In addition, an LED display on the device keypad shall indicate type of fault (Overtemperature, Phase Loss, Jam, Stall, Phase Reversal and Overload)
- t. The following control function adjustments on the device keypad are required:
 - 1) Selectable Torque Ramp Start or Current Limit Start
 - 2) Adjustable Kick Start Time: 0–2 seconds

- 3) Adjustable Kick Start Torque: 0–85%
 - 4) Adjustable Ramp Start Time: 0.5–180 seconds
 - 5) Adjustable Initial Starting Ramp Torque: 0–85%
 - 6) Adjustable Smooth Stop Ramp Time: 0–60 seconds.
- u. Maximum continuous operation shall be at 115% of continuous ampere rating
 - v. Pump Control Option.
 - 1) Provide control algorithm for pump start-up and shut down sequences. Control algorithm shall reduce the potential for water hammer in a centrifugal pump system. Upon a start command, the speed of the motor shall increase, under the control of the soft starter microprocessor, to achieve a gentle start. After the speed has reached its nominal value, the bypass contactors shall close, and the pump shall run at design speed. Upon a stop command, the bypass contactors shall open, and the motor speed decreased in a tapered slope, to gradually slow the flow until the motor is brought to a stop. The start and stop ramp times shall be adjustable for the application requirements. The pump control option shall be factory installed.
3. Wye delta starters shall be closed circuit transition for use with 6 or 12 lead motors.
- D. Combination Contactors
1. Combination contactors shall be a circuit breaker and contactor, 600 Volt, three-pole, 60 Hertz, magnetically operated. NEMA size shall be as required for the kilowatt ratings shown on the Drawings, but shall be not less than NEMA size 1.
 2. Contactors shall have a 120-volt operating coil and control power transformer. Furnish the control power transformer with extra capacity for the unit heater fan.
 3. Combination Contactors used for lighting control shall be as specified herein, magnetically operated, with the number of channels and poles as shown on the Drawings. Each contactor shall be controlled by an Astronomic Time Clock Tyco Model TC-100, or approved equal.
- E. Control Relays
1. Control relays shall be 300-volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP at 120 volts AC, operating temperature minus 10 to plus 55°C. Provide spare normally open and normally closed contacts. Relays

shall be Potter & Brumfield KRP Series or equal with neon coil indicator light. Timing relays shall be 300-volt, solid state type, with rotary switch to select the timing range. Pneumatic timing relays are unacceptable.

2.5 METERING AND PROTECTIVE RELAYS

- A. Where an elapsed time meter is specified or shown on the Drawings, a six digit, non-resettable elapsed time meter shall be installed on the face of each motor starter. Meter shall be as specified in Section 16195.

2.6 REMOTE MONITORING AND CONTROL INTERFACE

- A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as shown in wiring schematics and P&ID.
- B. Discrete control or status functions shall be form C relays with contacts rated at 120 volts AC. Analog signals shall be isolated from each other.
- C. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.
- D. The equipment manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.
- E. Refer to wiring schematics and P&ID for monitored parameters.
- F. Communication
 - 1. For remote monitoring, one of the following communication capabilities shall be provided:
 - a. One integral 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP protocols.
 - b. One media protocol converter, interfacing the provided equipment to a 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP.
 - 2. The protocol interface shall implement the following:
 - a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
 - b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
 - 3. The media protocol converter shall meet the following criteria:

- a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
- b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air gap meeting IEC 1000-4-2. Power requirements shall be 9-30 volts DC at 0.5 amperes minimum.
- c. The converter shall have LED status for serial, signals, power, and Ethernet.
- d. The converter housing shall be UL 1604, Class 1 Div. 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
- e. Converter shall be Digi One IAP, or approved equal.

2.7 ACCESSORIES

A. Provide the following accessories:

1. Provide a corrugated non-conducting floor mat and include the floor mat in the submittals for this section. The floor mat shall have the following features:
 - a. Compliance with ANSI/ASTM D-178-01 standards
 - b. Type II: Made of any elastomer or combination of elastomeric compounds with the following special properties:
 - 1) Ozone Resistant ASTM D178-01
 - 2) Flame Resistant ASTM D178-01
 - 3) Oil Resistant ASTM D471-97

Classification	Working Voltage	Proof Voltage	Withstand Voltage	Thickness
Class1	7500 V AC	10000 V AC	20000 V AC	3/16 INCH
Class2	17000 V AC	20000 V AC	30000 V AC	1/4 INCH
Class3	26500 V AC	30000 V AC	40000 V AC	3/8 INCH
Class4	36000 V AC	40000 V AC	50000 V AC	1/2 INCH

- c. Classification: 1

- d. Minimum 3/16-inch thick by three feet wide.
- e. Length: Extending the full length of the switchgear lineup and provided in one piece
- f. Made from insulating rubber
- g. Resistant to acid exposure, UV, oil spills, high and low temperatures
- h. Boasting hydrophobic and fire-retardant characteristics
- i. Anti-skid patterns on the top and bottom surfaces
- j. Durable and puncture resistant
- k. Easily washable with mild detergent
- l. Manufacturers:
 - 1) American Floor Mats
 - 2) DIMEX
 - 3) HIC Insulation Universal
 - 4) PAC (Production Automation Corporation)
 - 5) No equal

2.8 SPARE PARTS

- A. Provide the following spare parts:
 - 1. Three – Control fuses of type used.
 - 2. One dozen each of cover bolts, spring nuts and door fasteners.
 - 3. One quart or 12 aerosol cans of touch-up paint.
- B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.9 FACTORY TESTING

- A. The Motor Control Center shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.
- B. Prior to factory testing, the manufacturer shall check to see that all selections and settings required by the Power System Study Engineer have been performed.

- C. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.
- D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.
- E. The manufacturer shall provide three certified copies of factory test reports as specified in Paragraph 1.03F.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

- A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist in installation and start-up of the equipment specified under this Section for a period of not less than two working days, with not less than one working day per motor control center. The manufacturer's field engineer shall provide technical direction and assistance in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. Provide three copies of the manufacturer's field-testing report.

3.2 INSTALLER'S QUALIFICATIONS

- A. Provide an installer who shall be specialized in installing low voltage motor control centers with minimum five years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.3 EXAMINATION

- A. Examine installation area to assure there is enough clearance to install the equipment.
- B. Housekeeping pads shall be included for the motor control centers as detailed on the Drawings except for motor control centers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) shall match the existing installation.
- C. Check concrete pads and baseplates for uniformity and level surface.
- D. Verify that the equipment is ready to install.
- E. Verify field measurements are as instructed by manufacturer.

3.4 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations and Contract Drawings.
- B. Install required safety labels.

3.5 FIELD QUALITY CONTROL

- A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.
- B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.6 FIELD ADJUSTING

- A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.
- B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, in accordance with settings designated in a coordinated study of the system as required in Section 16105 Power System Study.. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment

3.7 FIELD TESTING

- A. Provide a manufacturer's field engineer who shall make all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.
- B. Megger and record phase to phase and phase to ground insulation resistance of each bus section. Megger, for one minute, at minimum voltage of 1000 volts DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer's maximum test voltages be exceeded.
- C. Complete the following test forms:
 - 1. Motor Control Center Test Report: Before energizing the motor control center, perform megohm meter tests. The measurements shall be made on all phase busing and the data checked for conformance with typical manufacturer's data. The tests shall adhere to manufacturer's testing recommendations for the proper testing methods and test voltage levels for each piece of equipment. Readings that fall below manufacturer's recommended values will not be acceptable. Provide any necessary remedial action before the busing is energized. A data sheet and test report shall be submitted to the Owner/Engineer for each MCC and shall be reviewed and approved prior to energization of the MCC. The test report shall include the following equipment information:
 - a. MCC (SB or PNL) Name and number:
 - b. MCC (SB or PNL) manufacturer
 - c. MCC (SB or PNL) Nameplate data:

- 1) Volts:
 - 2) Horizontal bus amps:
 - 3) Main breaker amps:
 - d. Insulation test (measured):
 - 1) Phase A-B:
 - 2) Phase B-C:
 - 3) Phase C-A:
 - 4) Phase A-G:
 - 5) Phase B-G:
 - 6) Phase C-G:
 - e. Equipment disconnected during test:
 - f. Date of test:
 - g. Tested by:
- D. Test reports showing unsatisfactory results may require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items as determined by the Owner/Engineer with no change in the Contract Price or Schedule allowed. Retesting, if required by the Owner/Engineer shall be done with no change in Contract Price or Schedule.
- E. The manufacturer's field engineer shall perform field measurements, of both the voltage and current harmonic distortion at the point of common coupling with operating conditions to determine compliance with the Specifications.

3.8 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

- A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION

- A. Provide a qualified factory-trained manufacturer's representative who shall personally inspect the equipment at the jobsite and shall certify in writing that the

equipment has been installed, adjusted, and tested, in accordance with the manufacturer's recommendations, including all settings designated in the Power System Study.

B. Provide three copies of the manufacturer's representative's certification.

3.11 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.

B. The training shall be for a period of not less than one eight-hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner's use.

END OF SECTION

SECTION 16660 GROUNDING AND BONDING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required to install a complete Grounding and Bonding System, in strict accordance with Article 250 of the National Electrical Code (NEC), and as shown on the Drawings and specified herein.
- B. The system shall include ground wires, ground rods, exothermic connections, mechanical connectors, structural steel connections, all as shown on the Drawings, and as specified herein, to provide a bonding to earth ground of all metallic materials likely to become energized.

1.2 RELATED WORK

- A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references and include such information or work as may be specified.
- B. Other Divisions
 - 1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of Division 1, Section 16000, the Contract Documents and as specified herein the following:
 - 1. The manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings.
 - 2. Cut sheets for each individual item shall be submitted.

3. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project.
 4. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.
- B. All shop drawing submittals and all O&M submittals shall be submitted Division 1. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.
- C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.
- D. Submit to the Owner/Engineer, shop drawings and product data, for the following:
1. Grounding electrodes and conductors
 2. Grounding conduit hubs.
 3. Waterpipe ground clamps.
 4. Buried grounding connections.
 5. Compression lugs.
 6. Exothermic bonding system.
 7. Soil resistivity measurements
 8. Grounding system resistance to earth measurements of the completed grounding systems at each separate structure where grounding wells are present, at each structure if no grounding wells are present, and at each pad mounted equipment location remote from main structures.
 9. Soil resistivity measurements for each structure having a counterpoise grounding system and for each structure having a lighting protection system specified or shown to be installed.

1.4 REFERENCE CODES AND STANDARDS

- A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
1. NFPA 70 – National Electrical Code (NEC)
 2. UL 467-2007 --Grounding and Bonding Equipment
 3. NFPA 70E – Standard for Electrical Safety in the Workplace

- B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

- A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

- A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.
- B. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

1.7 WARRANTY

- A. Provide warranties, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Conduit shall be provided as specified under Section 16110.
- B. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be #12 AWG unless otherwise indicated on the drawings.

2.2 CONDUCTORS

- A. Conductors shall be as specified under Section 16120.
- B. Equipment grounding conductors shall be insulated XHHW-2 conductors. Conductors shall be green where available from the wire manufacturers or marked with green tape as specified under 16120.
- C. Grounding electrode conductors shall be bare tinned copper where direct buried, or encased in concrete. Bare grounding electrode conductors or lightning

protection conductors where exposed to damage shall be installed in conduit. Grounding electrode conductors or lightning protection down lead conductors shown, specified or required to be installed in conduit per the NEC with no other conductors shall be bare tinned copper. Bare conductors installed in metallic conduits shall be bonded to the metallic conduit at both ends.

- D. Grounding electrode conductors routed between concealed grounding electrodes or interconnecting grounding electrode counterpoise loop conductors to exposed (IE "Pigtails") shall be bare copper.

2.3 GROUNDING ELECTRODES

- A. Ground rods shall be 3/4-inch by 10-foot copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 10 mils.
- B. Manufacturers for ground rods
 - 1. ERICO
 - 2. Copperweld
 - 3. Approved equal

2.4 CONNECTORS AND CONNECTIONS

- A. Waterpipe ground clamps, and other ground clamps where specified, shall be cast bronze.
- B. Provide the correct size for the pipe.
- C. Manufacturers
 - 1. Thomas & Betts Co. Cat. JPT
 - 2. Burndy
 - 3. O.Z. Gedney Co.
 - 4. Cooper Power Systems
 - 5. Erico
 - 6. Harger
 - 7. The contractor shall determine and provide the correct size for the pipe.
- D. All concealed grounding system or lightning protection system connections shall be by an exothermic weld process
 - 1. Manufacturers
 - a. T&B Furseweld SCR1

- b. Burndy Thermoweld
 - c. Cadweld
2. Exothermic welded connections shall be used in exposed locations as specified herein.
- E. Provide a Burndy Hyground Irreversible Compression System or equal in areas where the Owner's operations prevent the use of an exothermic welded connection. The use of a compression system ground connection is otherwise prohibited without written approval on a case-by-case basis from the Owner or Engineer. Permission shall be submitted through the RFI process. Compression connectors installed without permission shall be removed and replaced with exothermic weld connections with no change in the Contract Price or change in the Contract Schedule allowed.
- F. All grounding connections which would require exothermic welding in a Class 1 Division 1 Area as determined by NFPA 820, or the Engineer, or the NEC Authority Having Jurisdiction shall use a Burndy Hyground Irreversible Compression System, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Route exposed grounding electrode conductors in rigid aluminum conduits to protect the conductors from damage. The rigid conduits shall be aluminum or PVC-coated aluminum conduits as specified in 16110. Bond the protecting conduits to the grounding electrode conductors at both ends. Water pipe grounding connections shall not be painted. Painted connections shall be disassembled, replaced, and reconnected.
- B. Install wire type equipment grounding conductors in all raceways for the power, control and instrumentation systems. Grounding conductors shall be independent conductors and shall be separate from all shield drain wires.
- C. Conduits and other raceways shall contain a wire type equipment grounding conductor whether the raceway is metallic or not. Conduits, motors, cabinets, outlets, and other equipment shall be properly bonded in accordance with NEC requirements. Where ground wire is exposed to mechanical damage, install wire in rigid aluminum conduit.
- D. In NEC classified areas, connection of grounding electrode connections to structural steel columns shall be made with long barrel type one-hole heavy duty copper compression lugs, bolted through 1/2-inch maximum diameter holes drilled in the column web, with stainless steel hex head cap screws and nuts.
- E. In new construction, bond each building column to the grounding electrode counterpoise system whether or not specifically shown on the Drawings using grounding electrode conductors. Grounding electrode conductor connections to structural steel columns shall be made with exothermic welds.

- F. Metal conduits stubbed into a motor control center shall be terminated with insulated grounding bushings and connected to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250.122, except that a minimum #12 AWG shall be used.
- G. Liquid tight flexible metal conduit in sizes 1-1/2-inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.
- H. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized as shown with a minimum size in accordance with NEC Article 250.66.
- I. Provide a #1/0 AWG bare tinned grounding conductor the full length of each cable tray system, bond each section and tray fitting to the tray grounding conductor. Route the tray grounding conductor along the outside of the cable tray. Install no grounding clamps on the inside of the tray to avoid damage to tray conductors. Bond the tray grounding conductor to the power system counterpoise grounding electrode system at the end of the tray, or for tray systems installed in a loop configuration, bond in at least two locations at opposite sides of the tray loop. Bond every enclosure to which tray conductors are routed to the tray grounding conductor. Bond every conduit or raceway routing tray conductors away from or to the tray system to the cable tray and to the cable tray grounding conductor.
- J. All equipment enclosures, motor and transformer frames, conduits systems, cable tray, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.
- K. Seal exposed connections between different metals with no-oxide paint, Grade A or equal.
- L. Lay all underground grounding conductors' slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.
- M. Care shall be taken to ensure good ground continuity, between the conduit system and equipment frames and enclosures. Where necessary, bonding jumper conductors shall be provided.
- N. Ground all grounding type receptacles to the outlet boxes with a minimum, #12 AWG XHHW-2 stranded green conductor, connected to the ground terminal of the receptacle and bonded to the outlet box by means of a green colored grounding screw.

3.2 INSPECTION AND TESTING

- A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

- B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance earth resistivity. Measure the earth-to-ground resistance of each system having a counterpoise grounding system, or a lightning protection system installed. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.
- C. All test equipment shall be provided under this Section and approved by the Owner/Engineer.
- D. Resistance to ground testing shall be preceded by no precipitation for a minimum of five days. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.
- E. Testing shall be performed before energizing the electrical distribution system.
- F. A separate test shall be conducted for each building or system.
- G. Perform soil resistivity measurements prior to the installation of any grounding systems and submit the results to the Engineer.
- H. Perform ground resistance tests after underground installation and connections to building steel and electrical raceways and equipment are complete. Where measured values exceed this figure, install additional ground rods as required to reduce the resistance to the specified limit.
 - 1. Make tests at each ground test well using a "fall of potential" test method. Each ground test well shall not exceed a maximum resistance of 5 ohms.
 - 2. Make tests at each remotely pad mounted equipment location.
 - 3. Make tests at each structure where no ground wells are present.
- I. Submit the results of the ground-to-earth tests to the Owner and the Engineer.
- J. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION

APPENDIX – B

Scope of Work for Pump, Motor & Baseplate

BY

Jersey Equipment Company (JEC)

JERSEY EQUIPMENT COMPANY
510 ARCHER DR.
COPPELL, TEXAS 75019
(469) 358-2144

Town of Addison, Texas
Addison Surveyor Pump Station Improvements
High Service Pump #2
Advanced Engineered Pump

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- e. Cross sectional drawing
- e. Parts list
- f. Engineering data

IV Woods Sureflex Coupling

V TECO Westinghouse Motor

- a. Dimensions
- b. Motor Data
- c. Connection Diagram

VI Automatic Air Release Valve

Rayvoss 277-3Y-S3-3-00-C-H #100-1512 surge arrester in a NEMA 4 enclosure

(6) J style anchor bolt assemblies in 316 SS

Pump Manufacturer

**Advanced Engineered Pump
7800 Redsky Dr.
Cincinnati, Ohio 45249
(513) 530-5111**

Motor Manufacturer

**TECO Westinghouse Motors
5100 N. I-35
Round Rock, Texas 78681
(512) 244-5512**

**Authorized Distributor for Advanced Engineered Pump
and TECO Westinghouse Motors**

**Jersey Equipment Co.
510 Archer Dr.
Coppell, Texas 75019
(469) 358-2144**

Authorized Service Facility for Advanced Engineered Pump

**Control Specialist
P.O. Box 1479
Decatur, Texas 76234
(940) 626-1415**

Authorized Service Facility for TECO Westinghouse Motors

**Brandon & Clark Inc.
2475 E. Long Ave.
Ft. Worth, Texas 76106
(817) 838-5593**

Scope of Supply

One Complete Pumping Unit, High Service Pump #2

Pump : Advance Engineered Pump 12x10x17 8000 Series SC80 horizontal split case pump rated 3000 GPM @ 175' TDH @ 1800 rpm. 80% efficiency. Cast iron casing. Bronze impeller with bronze impeller wear rings. Bronze casing wear rings. SAE 1045 shaft with bronze shaft sleeves. Graphite asbestos packed stuffing box. $\frac{3}{4}$ " automatic air release valve.

Baseplate : Stealth Industry fab steel baseplate.
83.250" long X 24.00" wide X 0.500" thick.

Coupling : Woods EPDM #12 Sure-Flex Plus coupling.

Motor : TECO Westinghouse 200 hp, 1800 rpm, 460 volts, inverter duty in a TEFC enclosure. Motor to have Class F insulation, NEMA Design B, NEMA KVA Code Letter G with a minimum 95.4% efficiency.

Factory test : Non-witness factory performance test.

Paint : A-C Blue standard machinery enamel coating.

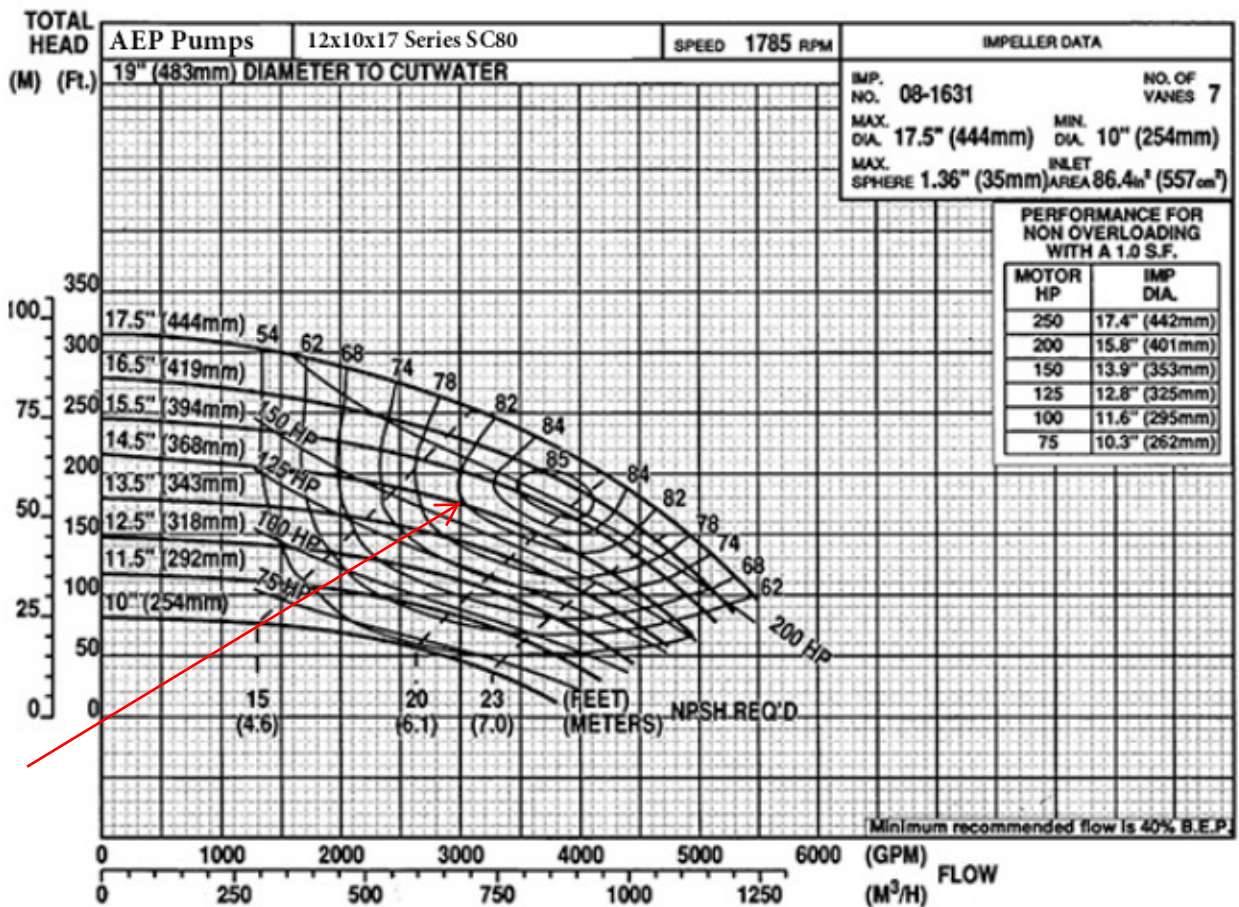
Field Quality Control :

1. We have Brandon & Clark Inc. technicians scheduled to do an alignment of the pump and motor using their calibrated laser alignment instrument. Alignment procedures will be per H.I. Standards.
2. The motor will be bumped to confirm that rotation is correct.
3. Once others have confirmed that all suction and discharge valves are fully open, we will energize the motor and pump into the system. It will be the Town of Addison to document where the pump is operating on the pump's performance curve using their pressure gauges and flowmeters.
4. Brandon & Clark will then run a vibration analysis on the pump and motor. A report in an electronic format will follow.
5. Brandon & Clark will then perform a motor winding insulation test which will follow to Baker AWA motor windings. A report supplied in an electronic format.
6. During the pump operation, pump bearings will be monitored for temperature.
7. Packing glands will be adjusted to allow the proper leakage.
8. Electricians to provide running amp data.


Optional - Rayvoss 277-3Y-S3-3-00-C-H #100-1512 surge arrester in a NEMA 4 enclosure.

Optional – (6) J style anchor bolt assemblies in 316 SS

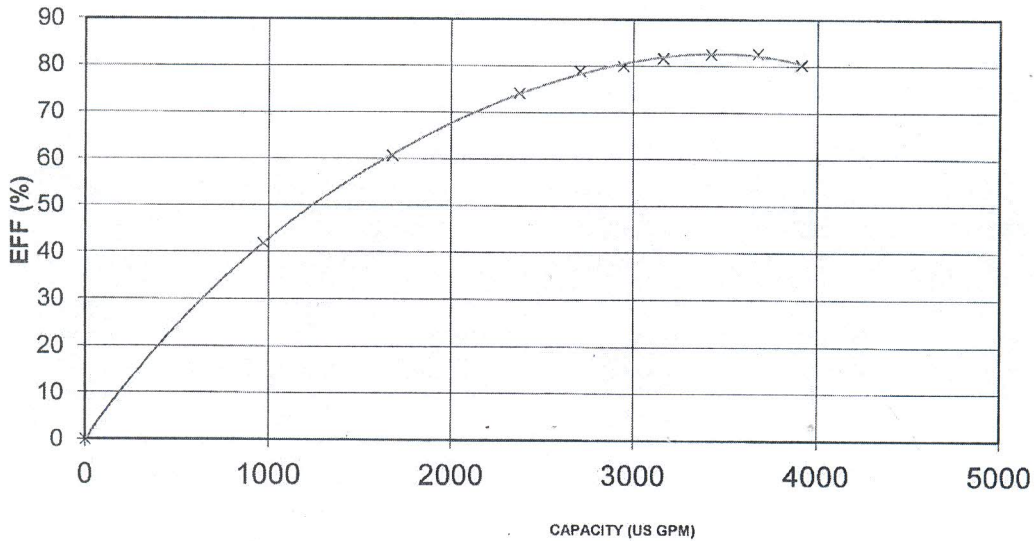
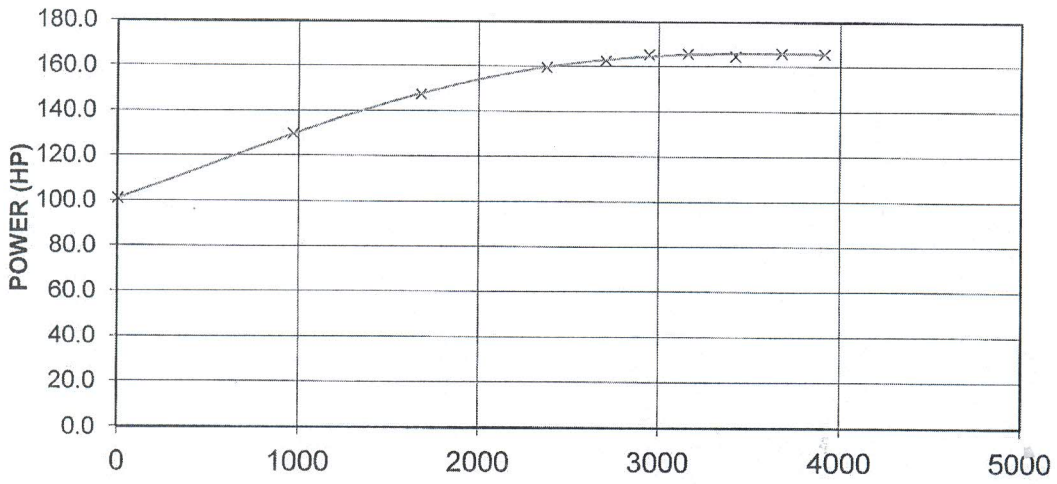
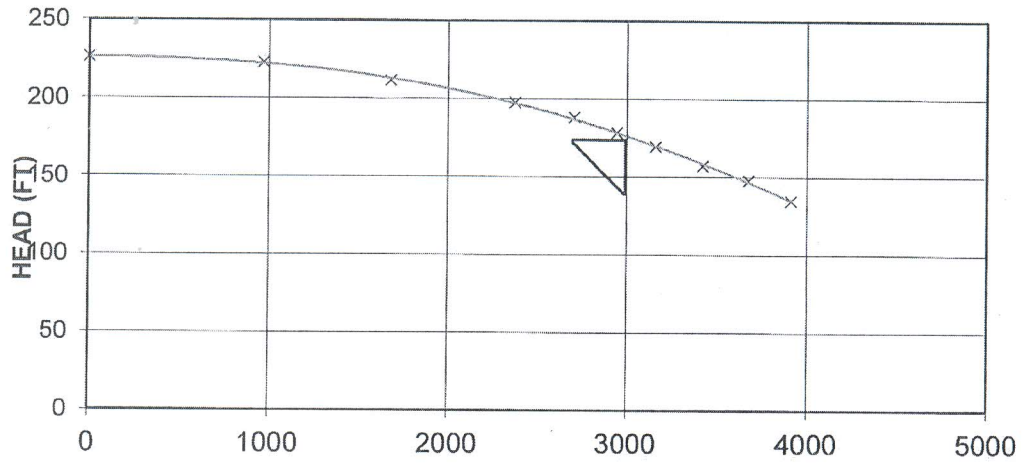
**3000 GPM @ 175' TDH 80%
guaranteed efficiency**



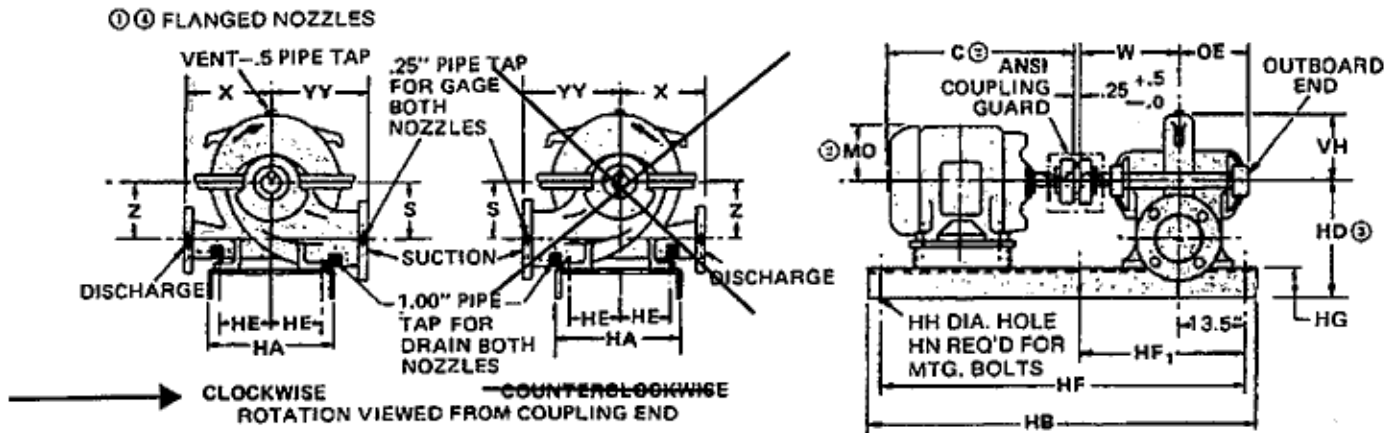
Anticipated performance based on HSP #1 factory test in February 2019 Per H.I. Standards using affinity laws

Pump Size & Type 8100S 12 x 10 x 17				Stages	Customer	Customer Item No. P 8818 / 18				Customer Order No. 18-24935				Pump Test 9314							
		Field Rating (Viscous Product)		Test Rating (Water)		AE PUMPS Actual Deviation %		Acceptance Tol %		Test Motor 75KW 4P						Imp Test Dia (mm)					
Dif. Head		175.00 ft		176.59 FT		0.91		5% -5 %		Gear Box						375					
Power		HP		164.93 HP		0.00		N/A													
Capacity		3000.0 US gpm		2992.5 US gpm		Remarks:															
Efficiency		%		81.03 %																	
Speed		1770 RPM		1480 RPM																	
d*		1.00		1.00																	
Viscosity		0.00 cs		Water																	
Stages																					
				Gauge to Gauge Elev: 1.1 m				Eye Area:				Tested By: KMK				Test Date: 07/02/2019					
		Suction		Discharge		Hv	Differential Head	Capacity FLOW METER	Power Calculation				Pump Input Power	Pump Power Output	Pump Eff	Temp	Corrected to: Dif. 'l Head	Constant Speed 1770 RPM	Constant Temp 18 °C	Imp Diameter 375 mm	
		mm Hg Manom.		kPa Gauge					Power Factor: 1.00		Motor Input										Motor Output
Speed	Test Value		Test Value					Watt Meter 1	Watt Meter 2	Input	Output	Power	Output	%	°C	ft	US gpm	HP	HP		
RPM	mm Hg	m	kPa	m	m	m	m^3/hr			kW	kW	kW	kW								
1	1486	100	1.36	480	48.91	0.00	48.65	48.0	0.0	48.00	44.63	44.63	0.00	0.0	18	226.33	0.00	101.05	101.05		
2	1481	67	0.91	465	47.38	0.03	47.60	60.7	0.0	60.70	56.77	56.77	23.83	42.0	19	222.92	968.84	129.86	129.86		
3	1480	45	0.61	438	44.63	0.08	45.20	68.8	0.0	68.80	64.37	64.37	39.10	60.7	19	211.97	1675.54	147.55	147.55		
4	1478	20	0.27	403	41.07	0.16	42.06	74.2	0.0	74.20	69.40	69.40	51.48	74.2	19	197.75	2374.25	159.72	159.72		
5	1477	0	0.00	380	38.72	0.21	40.03	75.5	0.0	75.50	70.61	70.61	55.76	79.0	19	188.49	2703.20	162.84	162.84		
6	1479	0	0.00	360	36.68	0.25	38.03	77.1	0.0	77.10	72.10	72.10	57.73	80.1	19	178.59	2942.08	165.60	165.60		
7	1480	-15	-0.20	340	34.65	0.29	36.24	77.4	0.0	77.40	72.38	72.38	59.15	81.7	19	169.93	3161.39	165.90	165.90		
8	1481	-30	-0.41	312	31.79	0.34	33.64	77.0	0.0	77.00	72.01	72.01	59.48	82.6	19	157.53	3422.53	164.72	164.72		
9	1478	-50	-0.68	288	29.35	0.39	31.51	77.2	0.0	77.20	72.20	72.20	59.75	82.8	19	148.18	3677.45	166.15	166.15		
10	1485	-70	-0.95	260	26.49	0.44	28.99	78.2	0.0	78.20	73.13	73.13	58.75	80.3	19	135.02	3912.18	165.92	165.92		
Witnessed at Lilianton on 07/02/2019 by _____ of _____										Approved by SAMCO Test Engineer 											

HIQ PERFORMANCE CURVE



Customer AE PUMPS Order no. 18-24935 Item no. P 8818 / 18		IMPELLER DIA. 375 CURVE No. 9314	Pump Size & Type 8100S 12 x 10 x 17 1770 RPM
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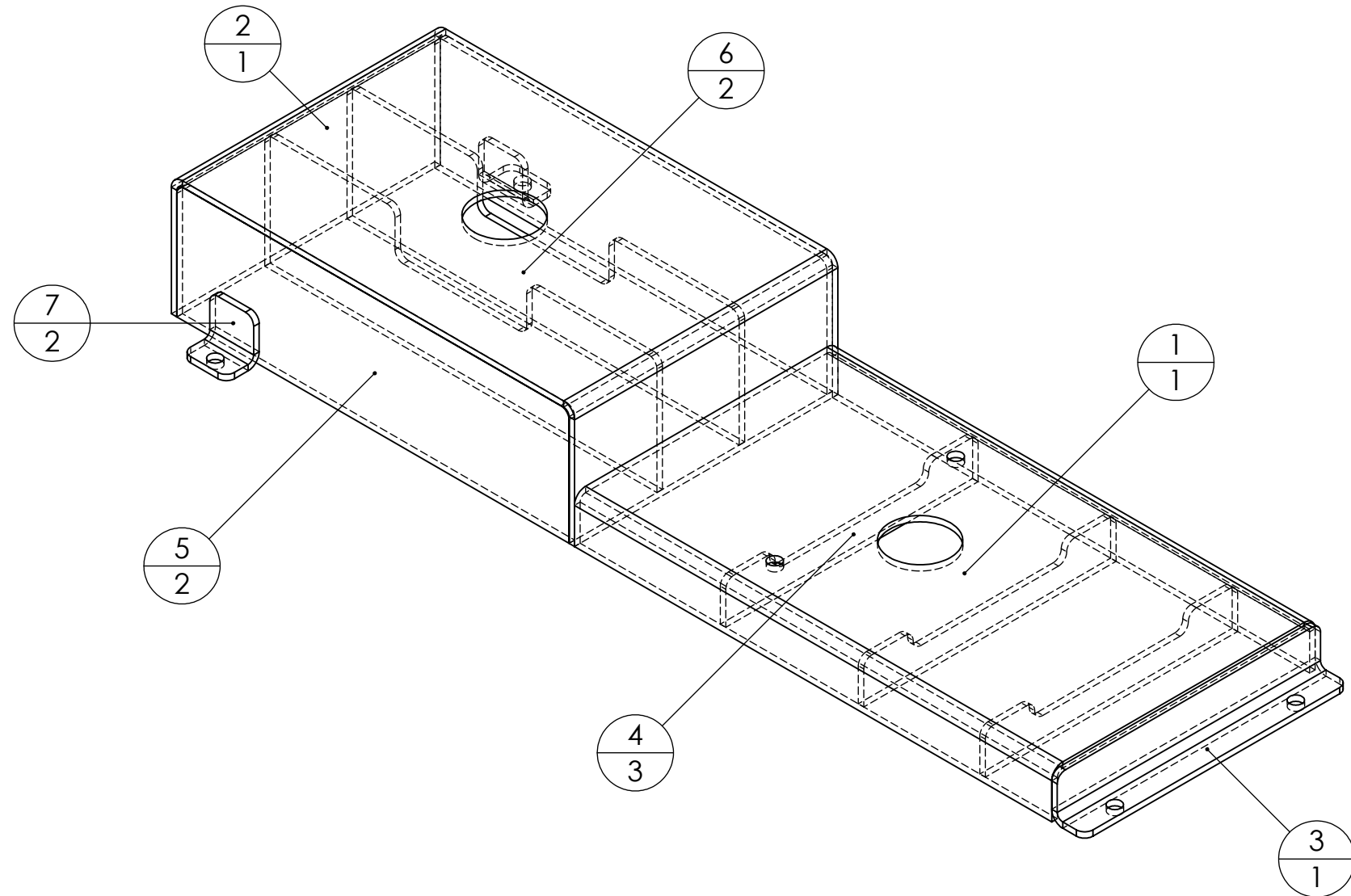
- HA 24"
- HB 83.25"
- YY 20"
- X 18"
- S 11"
- Z 11"
- C 49.90"
- W 22.5"
- OE 18.5"

For other baseplate dimensions, see following baseplate drawing.

NOT FOR CONSTRUCTION, INSTALLATION OR APPLICATION PURPOSES UNLESS CERTIFIED

Certified For:										
CO #		ID #				SO #				
PUMP DATA	Size & Type	Model	Curve No		GPM	Head	Packing	M/S	Rotation	Flanges
	12X10X17	8000 SC80	A-7854-3A		3000	175'	YES	NO	CW	125PSI
MOTOR DATA	HP	RPM	Phase	Hertz		Volts	Frame Size	Enclosure		
	200	1770	3	XX		60	460	447	TEFC	
Sign: _____ Date _____										

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
1	AB-1		.500 Steel	1
2	AB-2 Revision		.500 Steel	1
3	AB-3		.500 Steel	1
4	AB-4		.500 Steel	3
5	AB-5 Revision		.500 Steel	2
6	AB-6 Revision		.500 Steel	2
7	AB-7		.500 Steel	2



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ANGULAR: MACH ±		COMMENTS:	
BEND ±			
TWO PLACE DECIMAL ±			
THREE PLACE DECIMAL ±			
MATERIAL			
FINISH			
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TITLE:

SIZE DWG. NO. REV

SCALE: 1:20 WEIGHT: 1 OF 4

Addison Base Revision

4

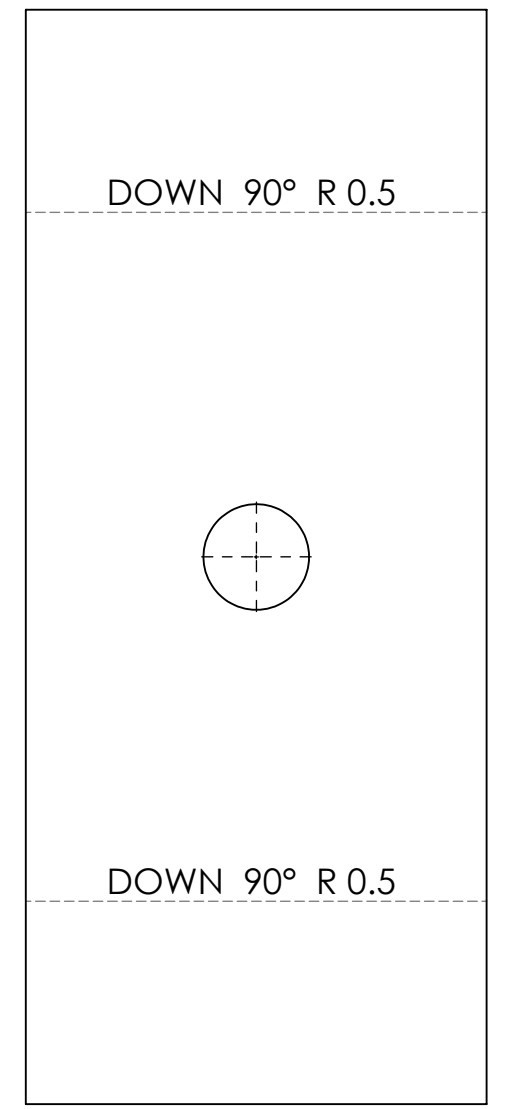
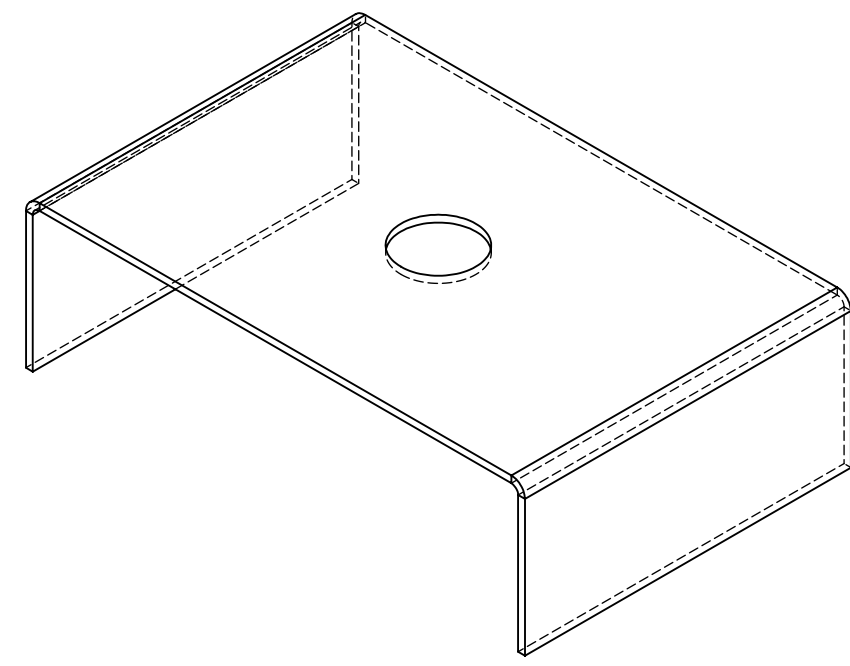
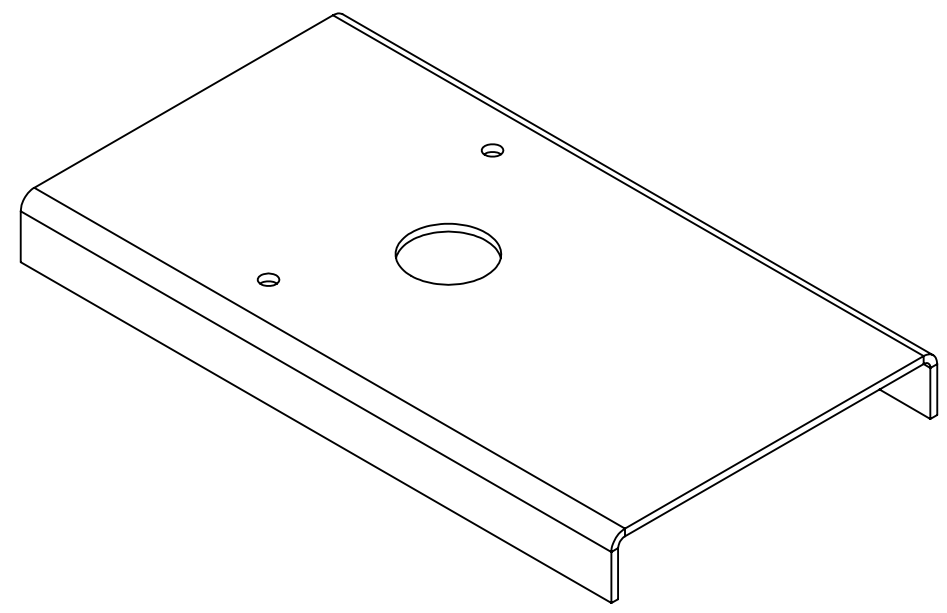
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2

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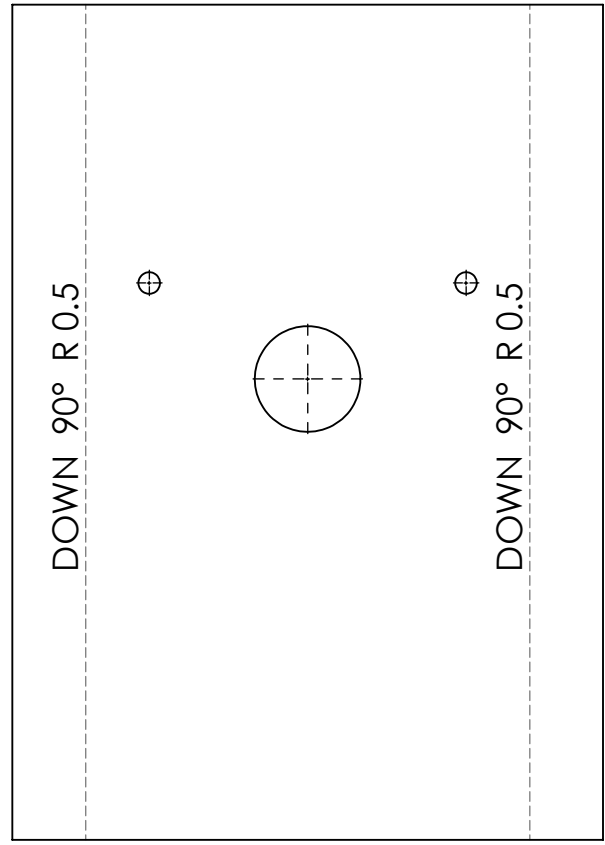
AB- 1

AB- 2 Revision



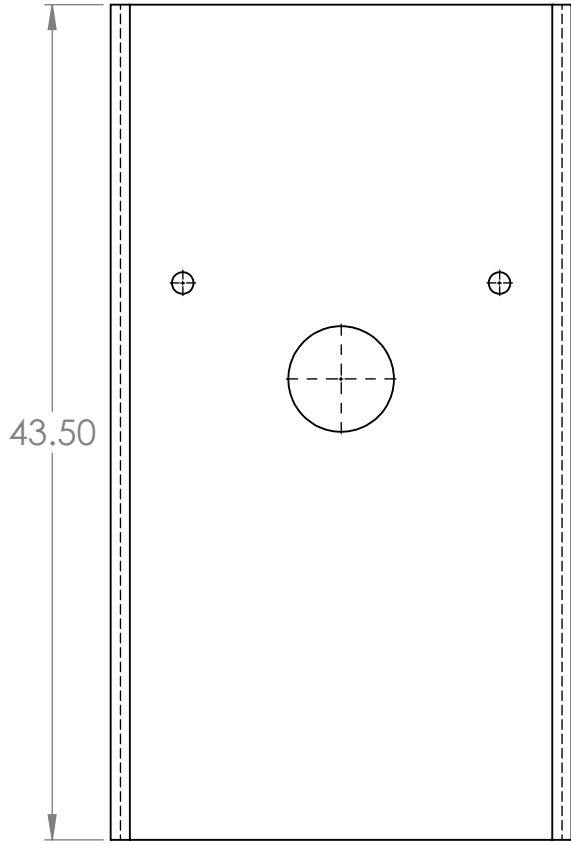
DOWN 90° R 0.5

DOWN 90° R 0.5

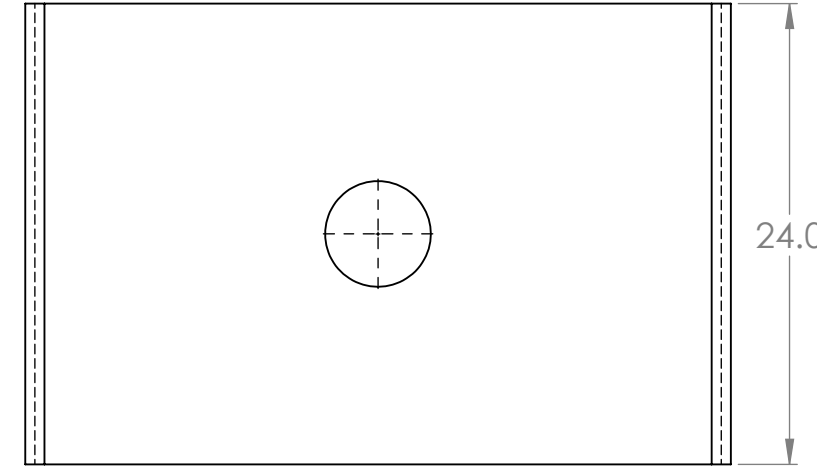


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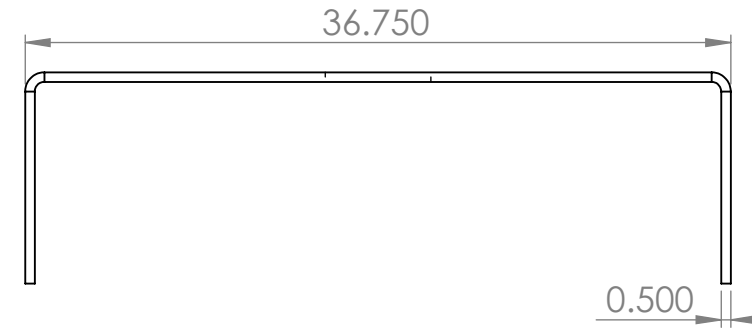
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43.50

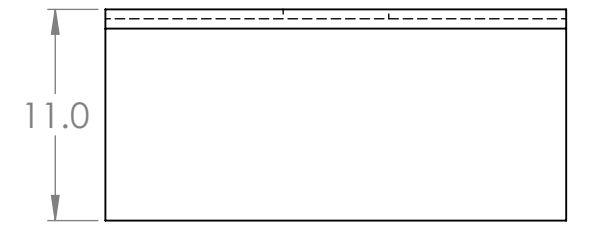


24.0

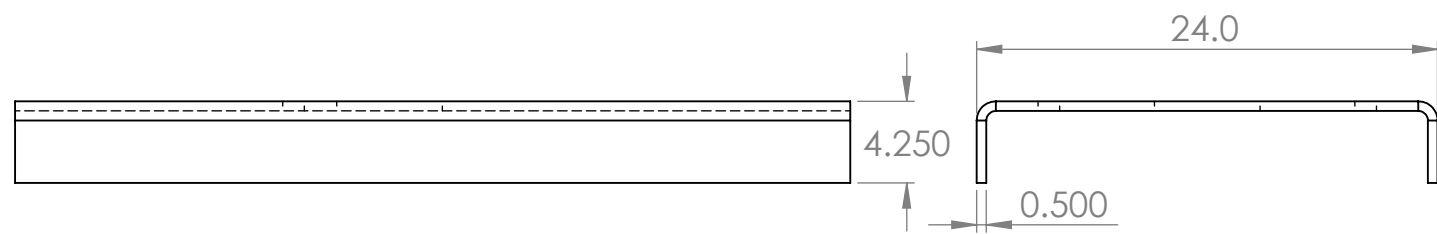


36.750

0.500



11.0



24.0

4.250

0.500

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TITLE:		
SIZE	DWG. NO.	REV
SCALE: 1:10 WEIGHT:		2 OF 4

Addison Base Revision

4

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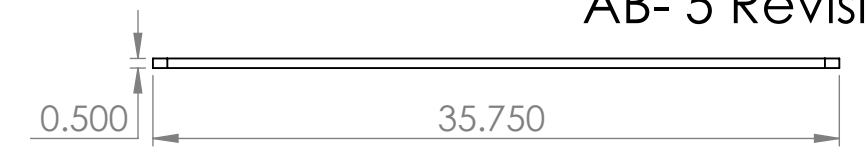
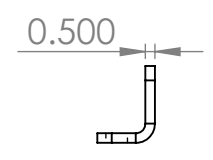
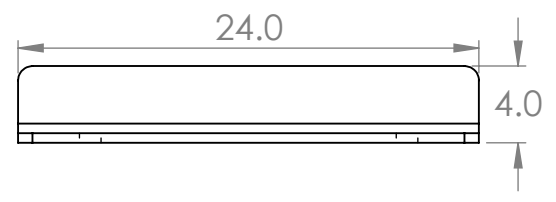
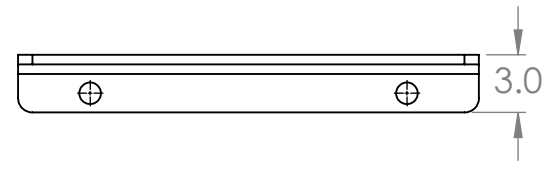
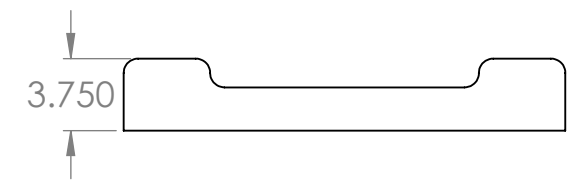
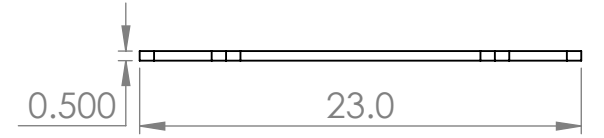
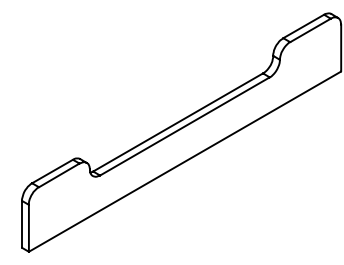
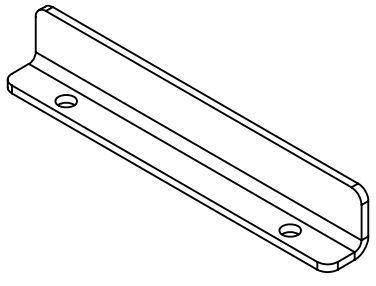
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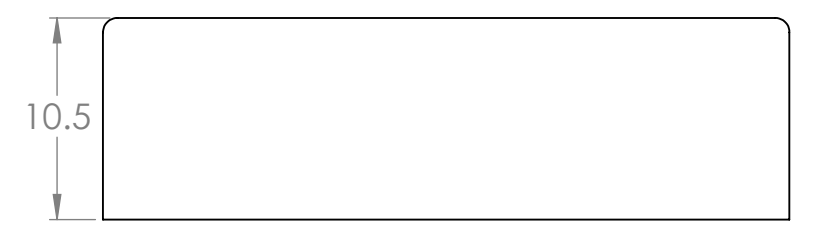
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AB- 3

AB- 4

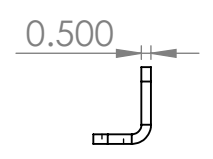
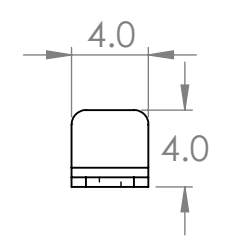
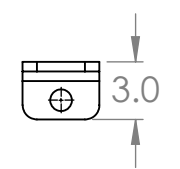
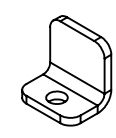
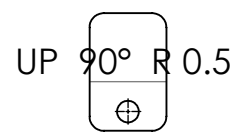
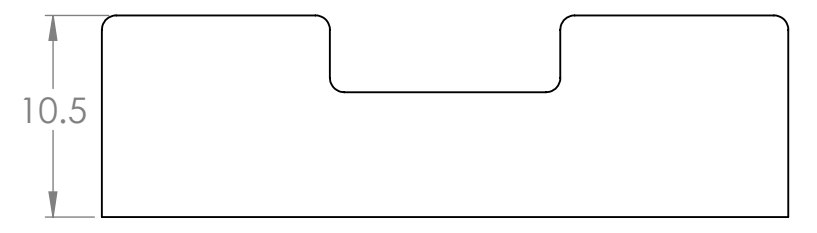
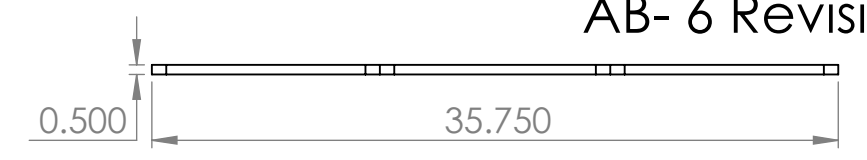


AB- 5 Revision



AB- 7

AB- 6 Revision



B

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1

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BEND ±

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TITLE:		
SIZE	DWG. NO.	REV
SCALE: 1:10 WEIGHT:		3 OF 4

Addison Base Revision

4

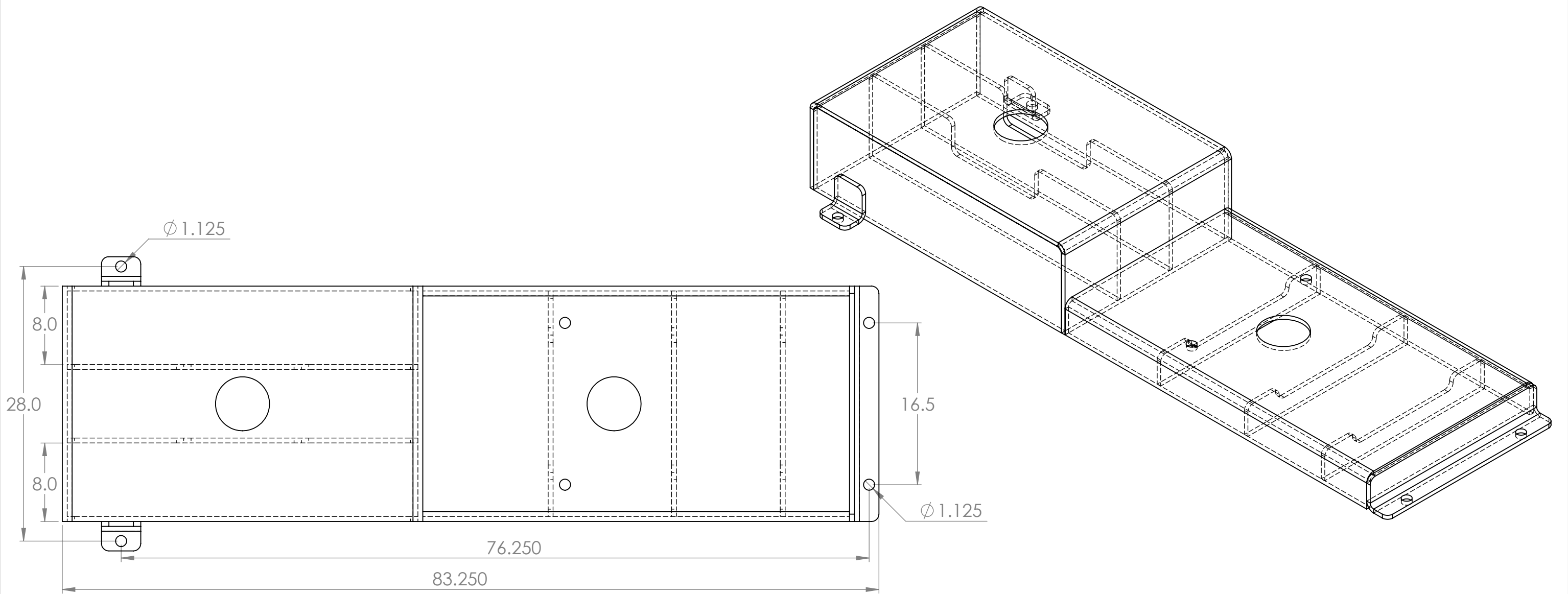
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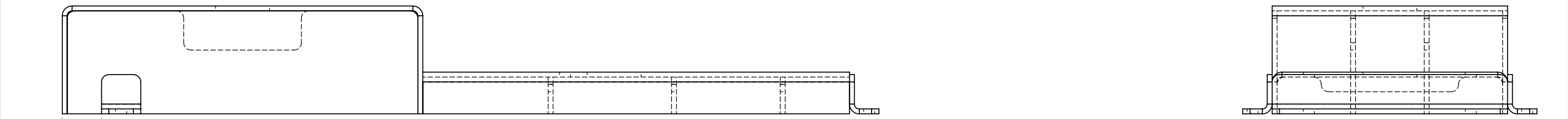
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SCALE: 1:20 WEIGHT:		4 OF 4

Addison Base Revision

4

3

2

1

CATALOG NO.	PART NAME	MATERIAL OPTIONS	
		Cast Iron, Bronze Fitted	Special
1-014-9	Gland Packing	Bronze (ASTM B584-932)	
1-924-9	Packing	Graphited Asbestos	
2-001-0	Casing Assembly	③ Cast Iron (ASTM A48 Class 35A)	
2-123-5	Gasket Casing Joint (Suction)	Paper (Vellumoid 505)	
2-123-6	Gasket Casing Joint (Discharge)	Paper (Vellumoid 505)	
2-910-9	Pipe Plug (Casing)	Steel	
3-003-9	Casing Rings	Bronze (ASTM B584-932)	
3-007-0	Shaft	④ Steel (SAE 1045)	
3-009-9	Shaft Sleeve	Bronze (ASTM B584-932)	
3-015-9	Shaft Sleeve Nut	Bronze (ASTM B584-932)	
3-025-3	Bearing Housing	Cast Iron (ASTM A48 Class 25A)	
3-025-4	Bearing Housing	Cast Iron (ASTM A48 Class 25A)	
3-026-3	Bearing (Inboard) Ball	⑤ Steel	
3-026-4	Bearing (Outboard) Ball	⑤ Steel	
3-073-9	Stuffing Box	Cast Iron (ASTM A48 Class 25A)	
3-136-9	Deflector	Rubber	
3-177-9	Oil Seal (Bearing)	Rubber	
3-902-9	Screw, Locking (Set Screw)	Steel	
3-904-9	Cap Screw (Bearing Housing)	Steel, Grade 2	
3-904-9	Cap Screw (Gland)	Steel, Grade 2	
3-910-9	Pipe Plug (Stuffing Box)	Steel	
3-911-1	Key (Impeller)	Steel	
3-911-2	Key (Coupling)	Steel	
3-914-1	"O" Ring (Stuffing Box)	Rubber (Buna "N")	
3-914-2	"O" Ring (Casing Rings)	Rubber (Buna "N")	
3-915-4	Retaining Ring (Bearing)	Steel	
3-938-1	End Cap	Steel	
3-943-9	Spirol Pin (Stuffing Box) ①	304 SS	
3-943-9	Spirol Pin (Casing Ring) ①	304 SS	
4-002-0	Impeller	Bronze (ASTM B584-836)	

ENG. DATA

Key No.	55	56	56.1	57	57.1	58	59	60	61
Pump Size	12x10x17	12x10x17	12x10x17	12x10x17	12x10x17	12x10x17	12x10x17	12x10x17	12x10x17

CASING DATA (All Dimensions In Inches)

125# FF Std	Max. Suction Pressure	75	75	75	75	75	75	75	75
④ ASA Flanges	Max. Working Pressure	175	175	175	175	175	175	175	175
⑥ NOMINAL 175 PSI Working Press.	Max. Hydrostatic Test Pressure	262	262	262	262	262	262	262	262
	Casing Material	Cast I	Cast I	Cast I	Cast I	Cast I	Cast I	Cast I	Cast I
⑤		200	200	200	200	200	200	200	200
① NOMINAL 280# Working Press.	Max. Working Pressure	280	280	280	280	280	280	280	280
③	Max. Hydrostatic Test Pressure	420	420	420	420	420	420	420	420
	Casing Material	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I
⑤ 250# FF	Max. Suction Pressure	300	300	300	300	300	300	300	300
② NOMINAL 400# Working Press.	Max. Working Pressure	400	400	400	400	400	400	400	400
③	Max. Hydrostatic Test Pressure	600	600	600	600	600	600	600	600
④	Casing Material	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I	Ductile I
	Casing Wall Thickness	.44	.44	.44	.60	.60	.44	.44	.60

STUFF BOX DATA (All Dimensions In Inches)

Packing Dimensions	Bore	3.7	3.75	3.75	3.75	3.75	3.75	3.75	3.75
	Depth	3.62	3.62	3.62	3.62	3.62	3.62	3.62	3.62
	Sleeve O.D.	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
	Packing Size/No Rings W/O S. Cage	6/50	6/50	6/50	6/50	6/50	6/50	6/50	6/50
	Packing Size/No Rings W S. Cage	5/50	5/50	5/50	5/50	5/50	5/50	5/50	5/50
	Seal Cage Width	.94	.94	.94	.94	.94	.94	.94	.94
Mech. Seal On Shaft Dimensions	Bore	3.125	3.125	3.125	3.125	3.125	3.125	3.125	3.125
	Depth	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
	Mech. Seal Size Type 1 or 21 or Balanced Type	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Mech. Seal On Sleeves Dimensions	Bore	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	Depth	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12
	Mech. Seal Size Type 1 or 21 or Balanced Type	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75

IMPELLER DESIGN DATA (All Dimensions In Inches)

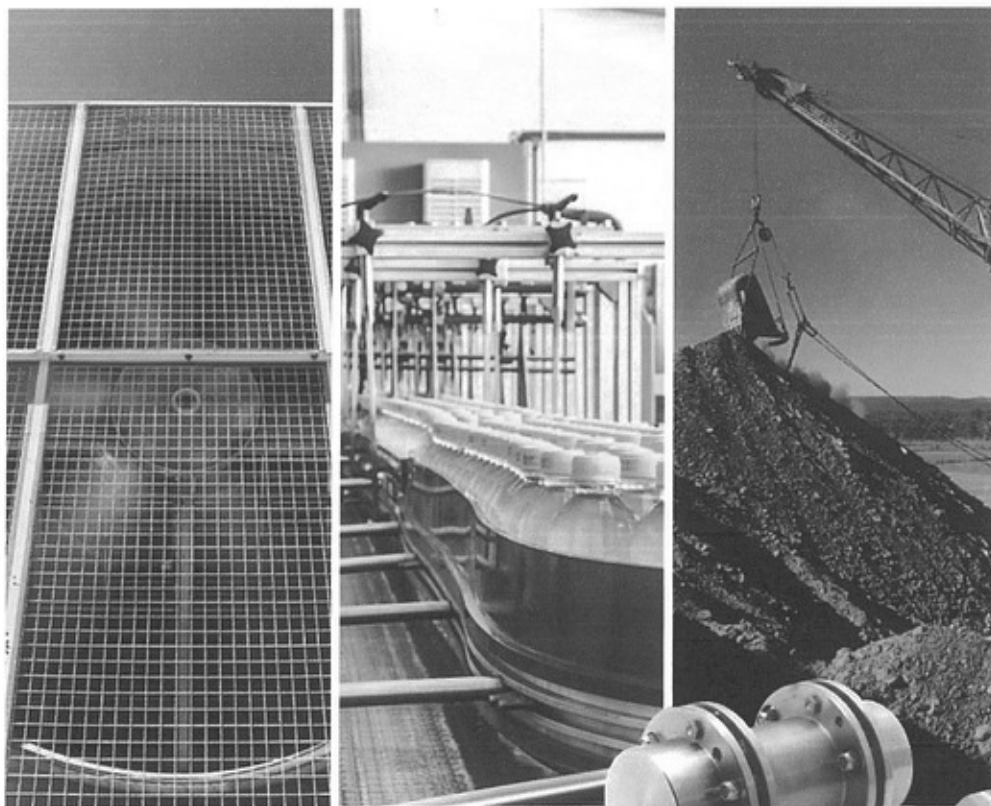
No. of Vanes	7	6	6	7	5	6	6	7
Inlet Area (Sq. In.)	10.2	82.9	57.4	57.5	65.4	86.0	77.2	86.4
Inlet Velocity per 100 GPM (Ft./Sec.)	.69	.51	.56	.56	.49	.37	.42	.37
Maximum Diam.	17.7	12.8	12.8	17.3	12.8	12.8	17.5	17.5
Minimum Diam.	10.0	8.0	8.0	10.0	12.0	9.3	8.7	10.0
Maximum Sphere	.98	1.4	1.4	1.16	1.16	1.54	1.12	1.38
WR ² for Max. Dia. (Lbs.-Ft. ²)	17.0	9.8	11.2	20.7	2.0	11.7	11.7	22.3
⑧ Wear Ring Clearance — Diam. 175# & 280# W.P.	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012	.010-.012
⑧ Wear Ring Clearance — Diam. 400# W.P.	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024	.020-.024

SHAFT AND BEARING DATA (All Dimensions In Inches)

Under Sleeve		2.374	2.374	2.374	2.374	2.374	2.374	2.374	2.374
		2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
		2.125	2.125	2.125	2.125	2.125	2.125	2.125	2.125
At Coupling		1.625	1.625	1.625	1.625	1.625	1.625	1.625	1.625
Thru Impeller with Packing — Min.		2.437	2.437	2.437	2.437	2.437	2.437	2.437	2.437
		2.439	2.439	2.439	2.439	2.439	2.439	2.439	2.439
Shaft Span	Bearing to Bearing C	29.90	29.90	29.90	29.90	29.90	32.90	29.90	29.90
Ball Bearings	Inboard	6309	6309	6309	6309	6309	6309	6309	6309
	Outboard	5308	5308	5308	5308	5308	5308	5308	5308
Frame Designation — Packing		F20-E1	F20-E1	F20-E1	F20-E1	F20-E1	F20-E1	F20-E1	F20-E1
		F20-E2	F20-E2	F20-E2	F20-E2	F20-E2	F20-E2	F20-E2	F20-E2
		F20-E3	F20-E3	F20-E3	F20-E3	F20-E3	F20-E3	F20-E3	F20-E3

- With 250# FF flanges and 280# PSIG working pressure refer to pump as M3x2x11S
- With 250# FF flanges and 400# PSIG working pressure refer to pump as H3x2x11S
- Note: For pumps with 400 PSI working pressure, wear ring clearances are doubled. Derate pump efficiencies by 2 percentage points.
- Flange dimensions are in accordance with ANSI A21.10, AWWA C110 & ANSI B16.1 class 125.
- Flange dimensions are in accordance with ANSI B16.1 class 250 except flanges are flat faced.
- The hydrostatic test will be in accordance with the latest edition of the Hydraulic Institute Standards, test will be maintained for a minimum of 5 minutes.
- Type 1 and 21 seals have the same working lengths.
- For bronze impellers and casing rings. For diametral clearances for other materials, consult factory.
- Impeller is a light press fit on shaft.

Flexible Couplings



TB Wood's®
Altra Industrial Motion

TB Wood's

TB Wood's is an industry leading designer and manufacturer of mechanical power transmission equipment for industrial control. Our mechanical product lines include: clutch and brake, synchronous and belted variable speed drives; grid, disc, jaw, gear coupling and elastomeric coupling products; sheaves and bushings. Registered trademarks include Sure-Flex Plus®, Dura-Flex®, G-Flex®, and Sure-Grip®.

TB Wood's was founded in 1857 and began as a foundry producing wood burning stoves. Our company's tradition of product innovation started early. TB Wood's entered the power transmission industry at the turn of the century with the introduction of flat belted drives and line shafting.

VISIT US ON THE WEB AT
TBWOODS.COM

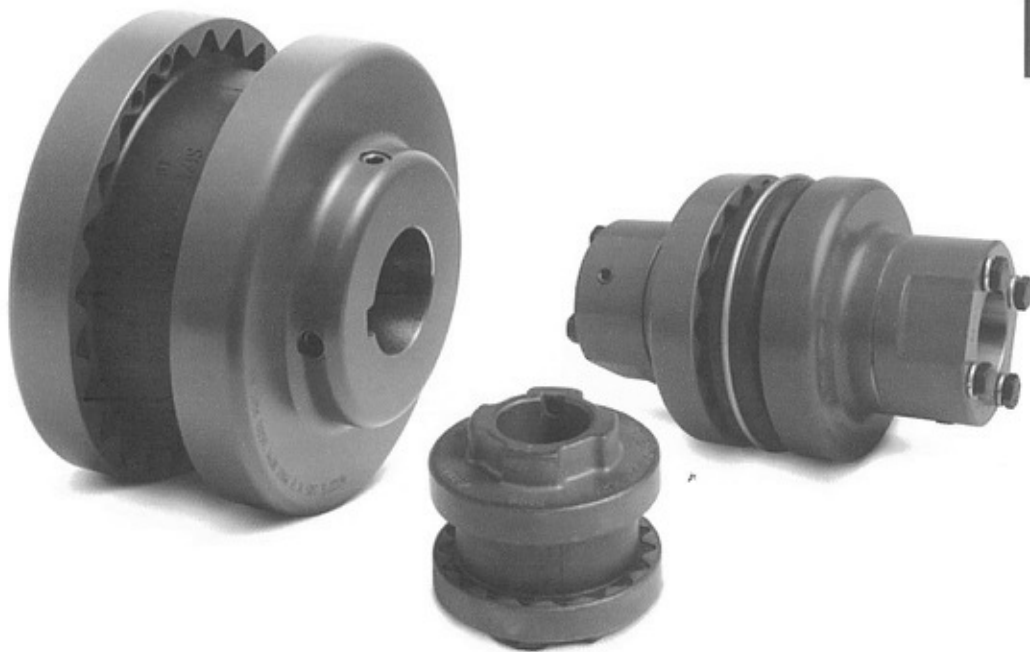


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		Typical Applications	3
		Coupling Application Types	4
		Coupling Selection Process	5
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F7	Rigid Couplings	AVS Selection	2-5

Sure-Flex Plus® Elastomeric Couplings

F1



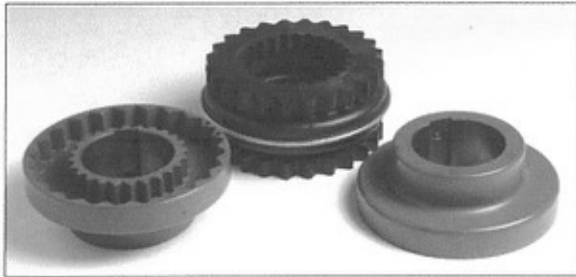
- **30% Higher Rating**
- **Quick, Easy Installation**
- **Clean, Quiet Performance**
- **No Lubrication, No Maintenance**

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Sure-Flex Plus® Table of Contents

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Sleeve Dimensions	5
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Sure-Flex Plus couplings are a TB Wood's original!



New! Sure-Flex® PLUS+

For over 50 years, TB Wood's has led the coupling industry with the original TB Wood's Sure-Flex design. And we haven't stopped innovating: this industry favorite just got even better. Our new Sure-Flex Plus EPDM and Neoprene sleeves are best-in-class for coupling performance and value. Here's why:

High Torque Rating

- **30% Increased Torque Rating**

Sure-Flex Plus sleeves provide longer service life in demanding applications, reducing required maintenance and associated replacement cost.

Longer Life

- **Sure-Flex Plus Lasts Over 3X Longer than the Competition**

Extensive testing shows our sleeves outlast the imitators. More uptime means less costly downtime.

Better Value

- **Save Money Using a Smaller Coupling**

Over 50% of common applications can now use a smaller coupling, lowering the cost of both coupling purchase and sleeve replacement.

Interchangeable

- **Retrofits to Existing Flanges**

No need to replace the full coupling – the Sure-Flex Plus sleeve design is 100% compatible with the current industry standard created by TB Wood's over 50 years ago.

Sure-Flex Plus couplings utilize EPDM, Neoprene, Hytrel™ and Urethane flexible elastomer sleeves to transmit torque and accommodate shaft misalignment. Sure-Flex Plus couplings have exceptional torsional flexibility, with the 4-way flexing action absorbing virtually all types of shock, vibration, misalignment and end float. Sure-Flex Plus couplings are an excellent choice when low cost, high flexibility, low vibration and easy installation are important.

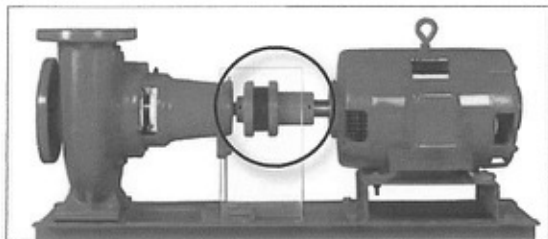
Easy, Quick Installation

Sure-Flex Plus can be installed quickly and easily, thanks to its simple design with no bolts, gaskets, covers or seals. Alignment can be checked on the precision-machined flanges using only a straightedge and calipers. No special tools are needed for installation, alignment or removal.



Features

- Up to 72,480 in.lbs.; 8.20 kNm
- Quick and easy installation
- Spacer, bushed hub, and clamping hub designs in stock
- Flexible design accommodates misalignment and protects equipment
- 7° to 21° torsional wind up
- Needs no lubrication, no maintenance



No Lubrication, Trouble-Free Operation

The teeth of the sleeve lock into the teeth of the flanges without clamps or screws, tightening under torque to provide smooth transmission of power. Couplings are not affected by abrasives, dirt or moisture, eliminating the need for lubrication or maintenance and providing clean, dependable, quiet performance.

Applications

Sure-Flex Plus couplings can be found hard at work in many industries. These couplings are ideal for a wide variety of applications including:

- Pumps
- Fans/Blowers
- Compressors
- Mixers
- Electric Motors
- Conveyors



Sure-Flex Plus 4-Way flexing action absorbs all types of shock, vibration and misalignment



Torsional

Sure-Flex Plus coupling sleeves have an exceptional ability to absorb torsional shock and dampen torsional vibrations. The EPDM and Neoprene sleeves wind up approximately 21° torsionally at their rated torque. Hytrel sleeves will wind up about 7°.



Angular

The unique design of the Sure-Flex Plus coupling's teeth allows for the absorption of angular misalignment without wear. Refer to page F1-18 for misalignment limits. Angular alignment can be achieved using only a scale and calipers.



Parallel

Parallel misalignment is absorbed without wear or appreciable energy loss. The lateral flexibility of the coupling sleeve minimizes radial bearing loads normally associated with parallel misalignment. This feature also allows for easier installation by the use of components bored for slip fits without fretting corrosion occurring at the shaft. Refer to page F1-18 for parallel misalignment limits. Only a straight-edge and feeler gage are required for parallel alignment.



Axial

Sure-Flex Plus couplings may be used in applications with limited axial shaft movements. The axial compressibility of the EPDM and Neoprene sleeves allows for shaft end-float without the absolute transfer of thrust loads.

Sure-Flex Plus SELECTION GUIDE

Use the Coupling Selector Program on www.TBWoods.com/Select

Or follow these steps:

Sure-Flex Plus couplings are selected as component parts.

1. Determine SLEEVE material and type.
Refer to pages F1-4 & 5
2. Determine coupling SIZE.
Refer to pages F1-6, 7, & 8
3. Determine FLANGES to be used.
Refer to pages F1-9 thru 16

Specify coupling components.

- Example #1 - Close coupled
Size 6, Type S flange w 1-3/8 bore
Size 6, Type S flange w 1" bore
Size 6, Split EPDM sleeve
- Example #2 - 5" Between shaft spacer
Size 9, Type SC flange for #11 hub
Size 9, Type SC flange for #9 hub
Size 11 Hub w 2-3/8 bore
Size 9 Short hub w 1-1/8 bore
Size 9 Solid Hytrel sleeve

PROD. NUMBER	PROD. DESCRIPTION
6S138	6Sx1-3/8
6S1	6Sx1
6JS	6JES
9SC5011	9SC50-11
9SC50	9SC50
11SCH238	11SCH x 2-3/8
9SCHS118	9SCHS x 1-1/8
9H	9H

Sure-Flex Plus® Sleeve

Selection

Sure-Flex Plus Sleeves are available in four materials and various shape configurations.

New! Sure-Flex Plus EPDM and Neoprene sleeves have a 30% higher torque capacity.

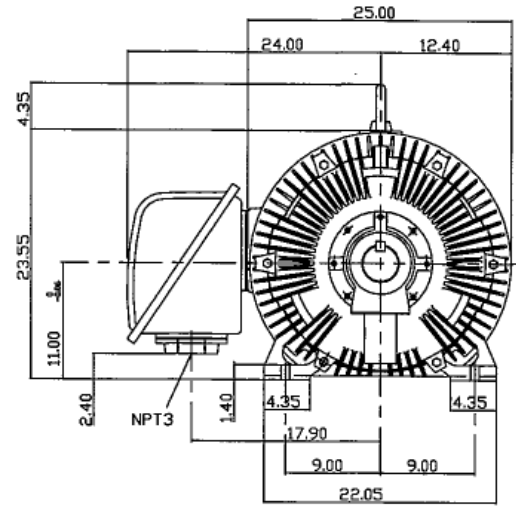
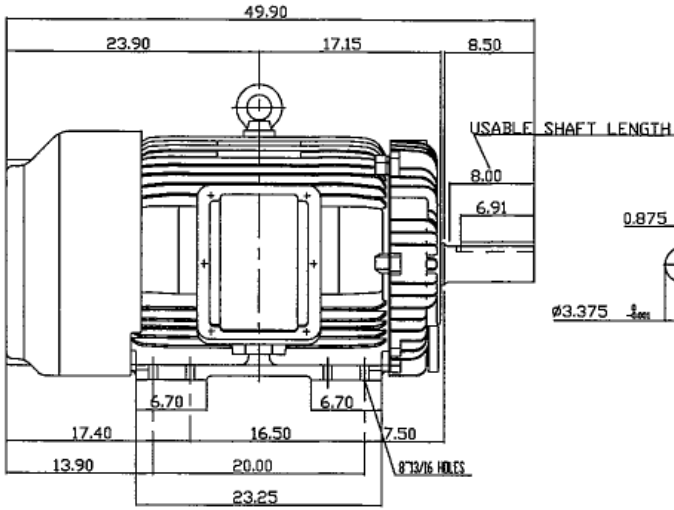
	EPDM	Neoprene	Hytrel	Urethane
CONSTRUCTIONS AVAILABLE				
1 pc, E/N w/ring	E	N	H	U
2 pc, E/N w/ring	E	N	H	U
TYPICAL USE	General Purpose	Oil Resist Non-flame	General Purpose	Stiffness
REL. RATING	1X	1X	3X	3X
WIND-UP ANGULAR MISALIGN	21°	21°	7°	3°
	1°	1°	1/4°	1/4°
TEMPERATURE				
maximum	+275°F/+135°C	+200°F/+93°C	+250°F/+121°C	+200°F/93°C
minimum	-30°F/-34°C	-0°F/18°C	-65°F/-54°C	-80°F/-62°C

SURE-FLEX PLUS SLEEVES

Part No.	Product Description	Part No.	Product Description	Part No.	Product Description
3J	3JE EPDM	4	4E EPDM	6H	6H Hytrel
4J	4JE EPDM	5	5E EPDM	7H	7H Hytrel
5J	5JE EPDM	6	6E EPDM	8H	8H Hytrel
6J	6JE EPDM	7	7E EPDM	9H	9H Hytrel
7J	7JE EPDM	8	8E EPDM	10H	10H Hytrel
8J	8JE EPDM	9	9E EPDM	11H	11H Hytrel
9J	9JE EPDM	10	10E EPDM	12H	12H Hytrel
10J	10JE EPDM	11	11E EPDM	6HS	6HS Split Hytrel
3JS	3JES EPDM Split	12	12E EPDM	7HS	7HS Split Hytrel
4JS	4JES EPDM Split	14	14E EPDM	8HS	8HS Split Hytrel
5JS	5JES EPDM Split	16	16E EPDM	9HS	9HS Split Hytrel
6JS	6JES EPDM Split	4N	4N Neoprene	10HS	10HS Split Hytrel
7JS	7JES EPDM Split	5N	5N Neoprene	11HS	11HS Split Hytrel
8JS	8JES EPDM Split	6N	6N Neoprene	12HS	12HS Split Hytrel
9JS	9JES EPDM Split	7N	7N Neoprene	13HS	13HS Split Hytrel
10JS	10JES EPDM Split	8N	8N Neoprene	14HS	14HS Split Hytrel
3JN	3JN Neoprene	9N	9N Neoprene	10U	10U Urethane
4JN	4JN Neoprene	10N	10N Neoprene	11U	11U Urethane
5JN	5JN Neoprene	11N	11N Neoprene	12U	12U Urethane
6JN	6JN Neoprene	12N	12N Neoprene		
7JN	7JN Neoprene	13N	13N Neoprene		
8JN	8JN Neoprene	14N	14N Neoprene		
3JNS	3JNS Neoprene Split				
4JNS	4JNS Neoprene Split				
5JNS	5JNS Neoprene Split				
6JNS	6JNS Neoprene Split				
7JNS	7JNS Neoprene Split				
8JNS	8JNS Neoprene Split				

TYPE	OUTPUT		POLE	TIME RATING	VOLTAGE V	Hz	SYN.SPEED R.P.M
	HP.	KW.					
AEHH8N	200	149.2	4	CONT.	460	60	1800

TOTALLY ENCLOSED FAN-COOLED TYPE, SQUIRREL-CAGE ROTOR



NOTE:

1. DIMENSIONS IN INCH
2. FRAME NO. 447T
3. F CLASS INSULATION, S.F.115
4. FOR DIRECT FLEXIBLE COUPLING
5. ENCLOSURE: IP54
6. BEARING SIZE: DRIVE END: 6320
NON-DRIVE END: 6316
7. APPROX. WEIGHT: 2450 LBS

TW-56C

DWN.	N.QIN	JAN 13 2005
CHKD.	H.HUANG	JAN 13 2005
APPD.	C.WANG	JAN 13 2005

DATE 20050617
CATALOG # EP2004

OUTLINE DIMENSIONS
3-PHASE INDUCTION MOTOR

TECO Westinghouse

DWG NO. REV: 00
3A040Y597

TECO Westinghouse

ISSUED 8/15/2014	PERFORMANCE DATA 3-PHASE INDUCTION MOTOR	ENCLOSURE TEFC
TYPE AEHH8N		CATALOG# EP2004

NAMEPLATE INFORMATION

OUTPUT		POLE	FRAME SIZE	VOLTAGE	HZ	RATED AMBIENT	INS. CLASS	NEMA DESIGN	TIME RATING	SERVICE FACTOR
HP	KW									
200	149.2	4	447T	460	60	40°C	F	B	CONT.	1.15

VARIABLE FREQUENCY DRIVE SERVICE

VARIABLE TORQUE				OHMS/PHASE EQUIVALENT WYE CIRCUIT (AT RATED OPERATING TEMPERATURE 25°C)				
HZ	HP	RPM	TORQUE (lb-ft)	R1	R2	X1	X2	X _m
3~60	0.025~200	90~1800	1.458~588	0.0248	0.0232	0.219	0.442	10.3

CONSTANT TORQUE				CONSTANT HORSEPOWER			
HZ	HP	RPM	TORQUE (lb-ft)	HZ	HP	RPM	TORQUE (lb-ft)
6~60	20~200	180~1800	588	60~90	200	1800-2700	588~392

TYPICAL PERFORMANCE

FULL LOAD RPM	EFFICIENCY				POWER FACTOR			SOUND PRESSURE LEVEL @ 3 FT Db(A)
	FULL LOAD		3/4 LOAD	1/2 LOAD	FULL LOAD	3/4 LOAD	1/2 LOAD	
	MIN.%	NOM.%	%	%	%	%	%	
1786	95.4	96.2	95.8	95	87	83.5	78.5	81

CURRENTS					NEMA KVA CODE LETTER	SAFE STALL TIME IN SECONDS		
NO LOAD		FULL LOAD		LOCKED ROTOR		COLD	HOT	
AT 460 VOLT		AT 460 VOLT		AT 460 VOLT				
46.4		224.00		1450		G	19	13

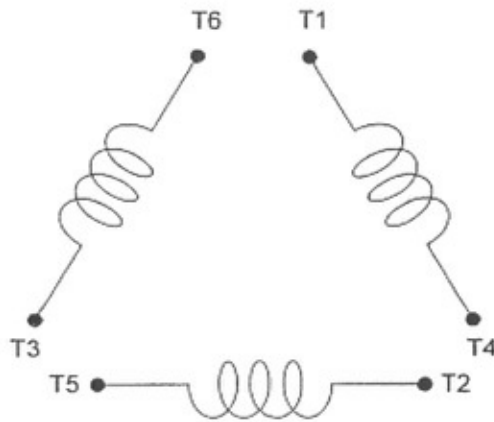
TORQUE				INERTIA			ACCEL TIME (DOL)		ALLOWABLE STARTS PER HOUR	
FULL LOAD (lb-ft)	LOCKED ROTOR %FLT	PULL UP %FLT	BREAK DOWN %FLT	ROTOR WR ² (lb-ft ²)	NEMA LOAD WK ² (lb-ft ²)	MAX ALLOWABLE WK ² (lb-ft ²)	NEMA LOAD WK ² Sec	MAX ALLOWABLE WK ² Sec	COLD	HOT
588.00	120	95	210	73.5	831	1662	5.52	10.59	2	1

APPROVED:	M. PRATER	DRAWING NO.	31057EP2004	REVISION:	1
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DATE:
November 10, 2005

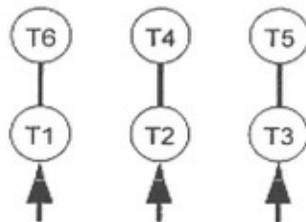
CONNECTION DIAGRAM

CATALOG NO.:
EP2004



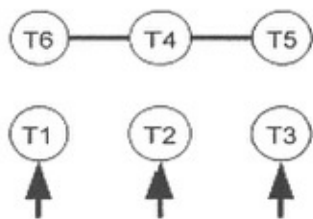
SCHEMATIC - Δ / Y CONNECTION

ACROSS THE LINE CONNECTION

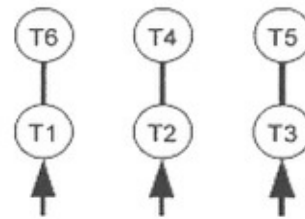


460 VOLT CONNECTION

WYE START-DELTA RUN CONNECTION



**LINE
460 VOLT START**



**LINE
460 VOLT RUN**

TECO  **Westinghouse**

DWG NO.
DAC-1545-3

3/4" automatic air release valve



Type 2 - Surge Protective Device (SPD)

Installation Instructions

Please read the following before installing your Rayvoss Transient Voltage Surge Suppression System

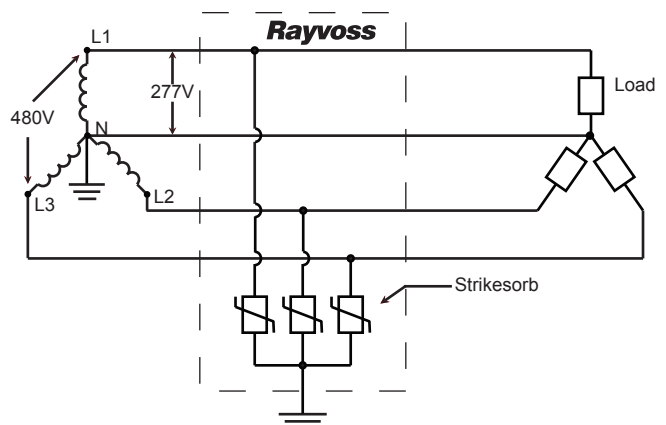
- Verify the system voltage and configuration on the label is appropriate for the application.
- Risk of Electric Shock – Installation and maintenance should be performed by qualified personnel only
- Disconnect from energized circuits before installing or servicing.
- Installation should conform to all applicable national and local codes.
- This product has a NEMA 4 rating. To maintain this rating, appropriately rated fittings must be used for installation.
- The maximum size conductor allowed in this product is #6 AWG.
- This unit should be installed behind a maximum 50A rated fused disconnect or circuit breaker when installed In-Line. For Parallel installations the unit may be installed behind larger overcurrent protective devices per Article 240.21 of the 2008 NEC.
- The enclosure door must be closed and secured prior to applying power to the unit.
- If glands are fitted, follow manufacturer’s instructions and use only dielectric seal silicon for weatherization.

Product Specifications

Nominal Voltage	277V/480V Three Phase WYE
Maximum Continuous Operating Voltage (MCOV) (L-G)	350V
Nominal Discharge Current I (8/20µs) per UL 1449 3rd Edition (L-G).....	20kA
Voltage Protection Rating (VPR), in-line, per UL 1449 3rd Edition (L-G)	1200V
Voltage Protection Rating (VPR), in-line, per UL 1449 3rd Edition (L-L).....	2500V
Maximum Surge Current I _{max} (8/20µs) NEMA LS-1 (L-G)	140kA
Maximum Lightning Current I _{imp} (10/350µs) IEC 61643-11 (L-G).....	12.5kA
Let Through Voltage Level for surge current 10kA (8/20µs) (L-G)	895V
Long Duration Surge Performance 500A square waveform 2ms IEEE C62.11.....	250 hits
Response Time	< 1ns
Operating Temperature.....	-40...+85°C
Environmental Protection	NEMA 4 - IP65
Enclosure Dimensions.....	10" x 8" x 6.5"
Enclosure Type.....	Powder Coated Steel

General Interconnection Diagram

Suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 350V maximum, when protected by a RK5 Class fuse, or a circuit breaker rated at 50A or less.



For additional information:

Raycap Inc.
www.raycap.com
Toll Free: 800.890.2569

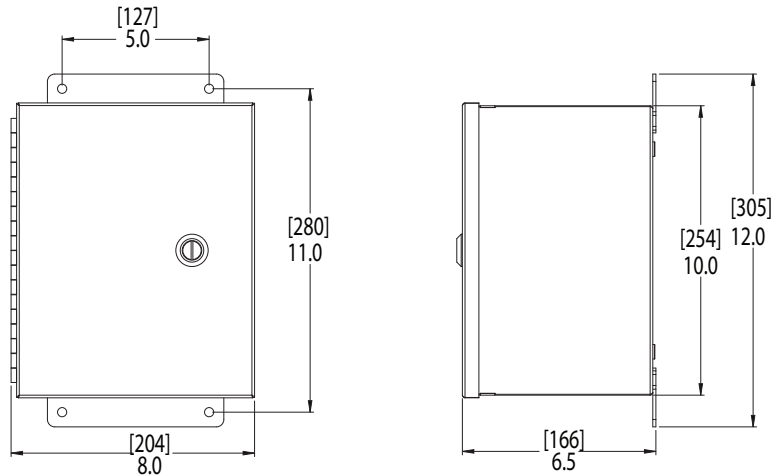


Type 2 - Surge Protective Device (SPD)

Mounting

This product should be mounted on a solid, flat surface capable of supporting 15 pounds. The mounting hole locations are shown in the diagram to the right.

Warning: Do not use the mounting lugs to establish the safety and protection grounds.

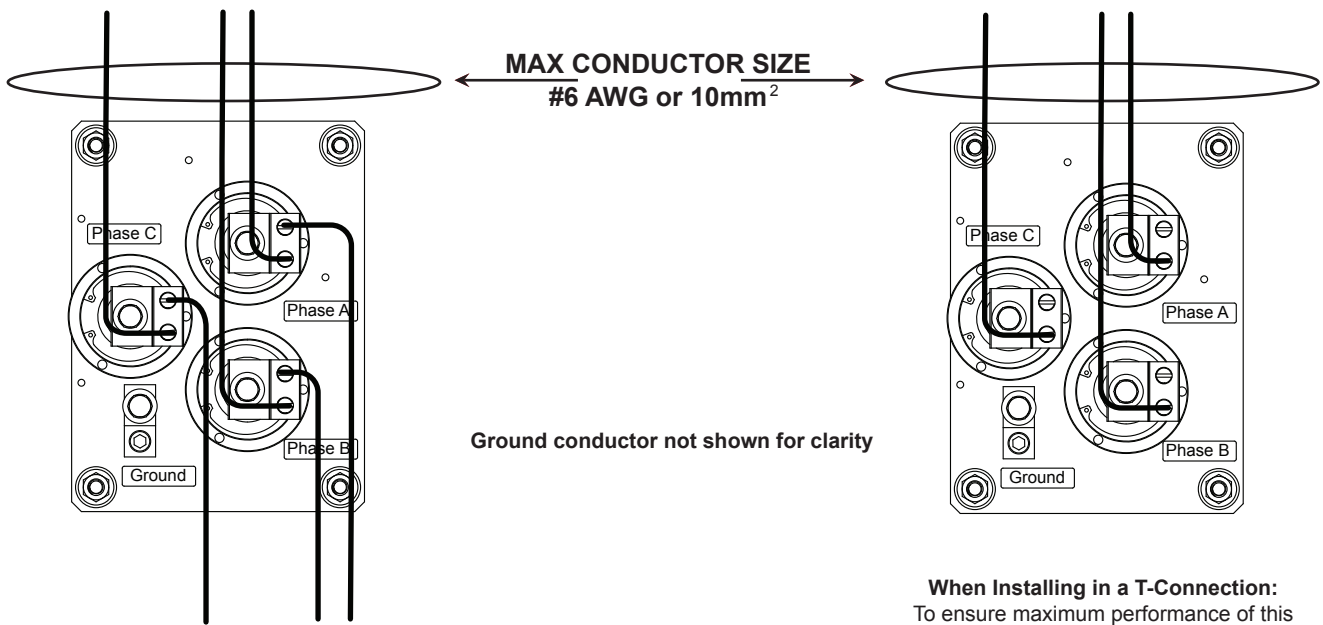


Connection Methods

This product may be installed in-line or in parallel. The two diagrams below show the different methods.

In-Line Connection

Parallel Connection (T-Connection)



When Installing in a T-Connection:
To ensure maximum performance of this product, the installation should use the largest gauge, shortest, and straightest conductors

Grounding

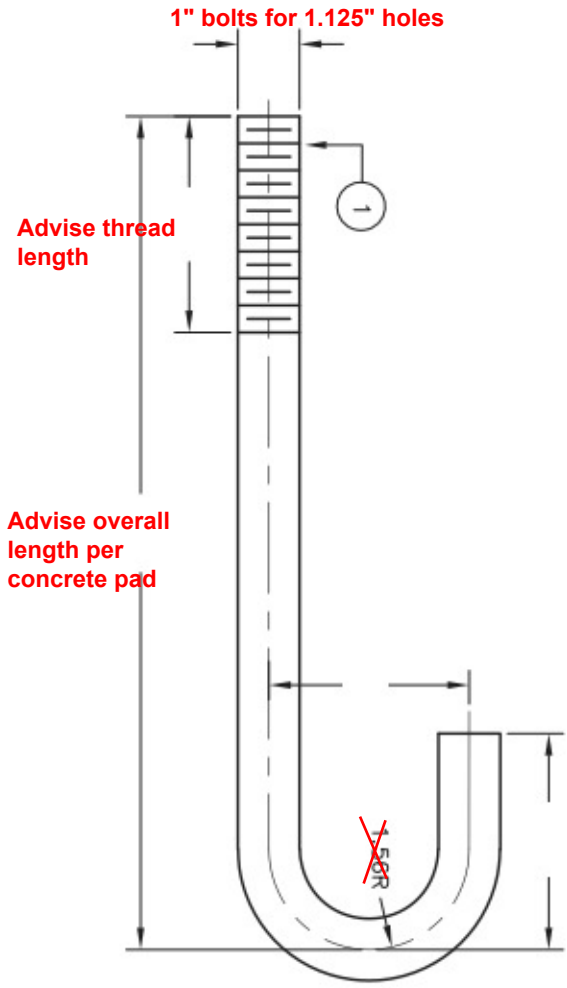
The ground connection should be made to the ground terminal mounted inside the Rayvoss unit. The connection should be made using a short, straight cable to the power ground or to the main ground bar at the installation location.

For additional information:

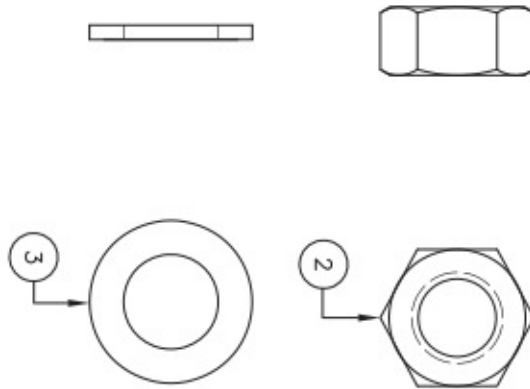
Raycap Inc.
www.raycap.com
Toll Free: 800.890.2569



ITEM NO.	RECD	PART NAME	DESCRIPTION	MATERIAL
3	1	PLAIN WASHER	PLAIN WASHER	316SS
2	1	HEX NUT	HEX-NUT CL 2B	316SS
1	1	1/2" BOLT		316SS



anchor bolt assemblies in 316 SS



Windham Manufacturing
 8520 Forney Rd.
 Dallas, Texas 75227

APPENDIX – C

Scope of Work for Instrumentation & Controls (I&C)

BY

Prime Controls

Prime Controls will install the Instrumentation and control work associated with the referenced Surveyor Pump Station Improvements project as described hereafter.

Scope of Work includes associated products and services specified to be provided in the following bid specifications:

SPECIFICATION	DESCRIPTION
Drawing I3, E8	Communication Architecture

The offering is complete with the exception of those items specifically excluded within the “Exclusions” section of this proposal.

A. CONTROL PANELS AND MAJOR PRODUCTS

Material shall be furnished per plans and specifications. Major products and control panels to be furnished by Prime Controls include the following:

ITEM	QTY	DESCRIPTION	REFERENCE
1.	LOT	CAT 6 Cable	DRWG – I3
2.	1	Network Switch <i>(To be located in existing RTU.)</i>	DRWG – E8

B. SERVICES

Services to be provided by Prime Controls include the following major items:

ITEM	SERVICE
1.	System Responsibility per Specifications
2.	Submittals per Specifications
3.	PLC/HMI/SCADA System Software Development and Programming for soft I/O indicated on drawing I3 only (MCC\PQM provided by others). <i>All existing field instrumentation indicated on DWG - I3 is assumed to be existing and functional. All existing instrumentation control wiring assumed to be present and will be terminated in existing PLC cabinet.</i>
4.	For Items Supplied by Prime Controls: <ul style="list-style-type: none"> a. Installation of Instrumentation, including Stands and Brackets (See Exclusions) b. Installation of Process Tubing Connection Sets c. Final Electrical Terminations to Control Panels and Field Instrumentation Final Coax Terminations for RF Devices
5.	Final Fiber Optic Cable Testing, Certification and Terminations
6.	Check-Out and Start-Up Services
7.	Factory and Site Acceptance Testing per Specifications
8.	Training Services per Specifications
9.	Operations and Maintenance Documentation per Specifications
10.	Warranty Services per Specifications

C. PROPOSAL EXCLUSIONS

The following items are not included in our pricing and shall be the responsibility of others:

ITEM	EXCLUSION
1.	Furnishing and installation of all electrical conduit, raceway, duct banks, wire, etc. required to connect instruments and associated panels.
2.	Furnishing and installation of all electrical power and specialty panels/products including switchgear, MCCs, distribution panels, AFD's/VFD's, disconnects, heat tracing, power monitor devices, etc.
3.	Physical installation of all required Fiber Optic cable (connectors and fiber optic accessories to be provided by Prime Controls).
4.	Furnishing and installation of any Miscellaneous Control Panels which are not specifically listed in Section A, above such as LCPs, VCP, local control stations, etc.
5.	Physical installation of all Control Panels and related Enclosures.
6.	Mechanical installation of all in-line devices (flow meters, valves, etc.).
7.	Furnishing and installation of mechanical piping saddles/mating flanges/process taps and isolating valves required to connect field instrumentation.
8.	Disposal of removed or demolished material. Such material will be turned over to the owner for salvage or disposal.
9.	Installation of Radio Towers including concrete footings/pads, etc.
10.	Concrete housekeeping/equipment pads.
11.	All "Civil" work including building and vessel modifications, asphalt demolition, patching, concrete foundations, piers, etc.
12.	<i>Terminations to new MCC provided by others. Prime Controls responsible for terminations in PLC cabinet only.</i>

D. PROPOSAL CLARIFICATIONS

ITEM	CLARIFICATION
1.	No Addenda are acknowledged.
2.	Pricing does not include Sales Taxes or Bonding costs.
3.	Pricing shall be valid for 60 days only from proposal date.
4.	If this quote includes control panel enclosures, pricing is based on the enclosure manufacturer's standard paint/finish unless a special paint/finish is required by the relevant bid specification.
5.	Pricing is valid for this offer only; for a single order for the Base Bid Amount (considering Contract Options and awarded Alternates, if any).
6.	Pricing is based on the assumption that, once Prime Controls receives an order or Notice to Proceed, the project will proceed without interruption. Should any interruptions occur due to Force Majeure, Prime Controls reserves the right to adjust pricing accordingly.

