

**CONTRACT DOCUMENTS
AND
SPECIFICATIONS
FOR
PROJECT NO. ES 2022-05, NORTHSIDE
AERATION JOCKEY BLOWER ADDITION**

ATTENDANCE AT PRE-BID CONFERENCE IS MANDATORY

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Tulsa CITY OF
A New Kind of Energy..

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VOLUME II – SPECIFICATIONS

TULSA METROPOLITAN UTILITY AUTHORITY
TMUA PROJECT NO. ES 2022-05
NORTHSIDE AERATION JOCKEY BLOWER ADDTION

TECHNICAL SPECIFICATIONS

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TETRA TECH, INC. (Certificate of Authorization No. 2388, Expires 6-30-2025)
As to all CIVIL ENGINEERING



Alexandria Belle Kindrick

Alexandria Kindrick, P.E.

09/19/2024

Date

TETRA TECH, INC. (Certificate of Authorization No. 2388, Expires 6-30-2025)
As to all STRUCTURAL ENGINEERING

Paul Perrin

Paul Perrin, P.E.

19 September 2024

Date

TETRA TECH, INC. (Certificate of Authorization No. 2388, Expires 6-30-2025)
As to all ELECTRICAL ENGINEERING



A handwritten signature in black ink, appearing to read "William Paison".

William Paison, P.E.

9/18/24

Date

PART 1: GENERAL REQUIREMENTS

1.01 GENERAL/SPECIAL/SUPPLEMENTAL CONDITIONS:

- A. The General Conditions (previous section) shall govern and control all work to which they apply; however, since these SPECIFICATIONS are of a general nature, they may refer to work not found in this project, in which case such non-applicable stipulations will have no meaning in this Contract. In case of conflict between the General Conditions and the Special Conditions, the Special Conditions shall govern. In case of conflict with either the General or Special Conditions by Supplemental Conditions of a funding agency such as EPA, FmHA, EDA or HUD, the Supplemental Conditions will govern.

1.02 DEFINITIONS: Whenever the words defined below, or pronouns used in their stead occur hereinafter, they shall have the meanings given as follows:

- A. "OWNER" and "City" shall mean Tulsa Utility Authority or its designated Agent.
- B. "ENGINEER" shall mean Tetra Tech, Inc., who has been employed by the Owner for this work, or his duly authorized agent.
- C. "INSPECTOR" shall mean the engineering or technical inspector or inspectors duly authorized by the Engineer or Owner, limited to the particular duties entrusted to him or them.
- D. "CONTRACTOR" shall mean the person, persons, partnership, company, firm or corporation entering into this contract for the performance of the work, or the agent appointed to act for such party.
- E. "SPECIFICATIONS" shall mean, collectively, all of the terms and stipulations contained in the written portion of information furnished.
- F. "DRAWINGS" shall mean, collectively, all of the drawings pertaining to the contract and made a part thereof, and also such supplementary drawings as the Engineer may issue from time to time in order to clarify the drawings, or for the purpose of showing authorized changes in the work, or for showing details which are not shown thereon.
- G. The term "Grade" used in these Specifications is understood to refer to and indicate the established elevations of the paving, flow line of sewers and other appurtenances as shown on the drawings.
- H. Whenever in these CONTRACT DOCUMENTS the words "as ordered", "as directed", "as permitted", "as allowed", or words or phrases of like import are used, it shall be understood that the order, direction, requirements, permission, or allowance of the Owner and Engineer is intended.
- I. Similarly, the words "approved", "reasonable", "suitable", "acceptable", "properly", "satisfactory", or words of like effect and import, unless otherwise particularly specified herein, shall mean approved, reasonable, suitable, acceptable, proper, or satisfactory in the judgment of the Owner and Engineer.

- J. Whenever the term "or equal" is used in the drawings and/or specifications it shall refer to a material which will adequately perform the same function, in the opinion of the Engineer upon review of sufficient material provided by Contractor, as the material specified or shown on the drawings.

1.03 SCOPE OF WORK:

- A. The work to be covered under these contracts in accordance with the drawings listed herein and in these specifications consists of the furnishing of all materials, equipment, tools, labor, transportation and services necessary to complete the construction as outlined herein and as shown on the drawings. The complete installation shall not lack any part which can be reasonably implied as necessary to its proper functioning or any subsidiary which is customarily furnished.

1.04 EXAMINATION OF SITE OF WORK:

- A. It is the obligation of the bidder to examine carefully the site of the proposed work; to ascertain for himself all the facts concerning conditions therein, including all physical characteristics above, on and below the surface of the ground; to investigate the subsurface conditions and to determine for his information the character and proportionate quantities of soils, rock and other subsurface material which may be encountered in the work; to inform himself by independent research of the difficulties to be encountered and judge for himself the accessibility of the work and all other circumstances affecting the cost of doing the work or the time required for its completion; and the bidder agrees to this obligation in signing the proposal. When provided, the soils boring and testing report is attached to these specifications for the Contractor's information and is not a part of the contract. No guarantee is made as to their accuracy or completeness. The Owner assumes no responsibility whatsoever with respect to ascertaining for the bidder such facts covering physical characteristics at the site of the work. The bidder agrees that, if awarded the contract, he will make no claim for, and will have no right to, additional payment or extension of time for completion of the work or any other concession because of any failure on his part to fully acquaint himself with all conditions relating to the work. The bidder shall rely exclusively upon his own estimate, investigation and evaluation of site conditions.

1.05 SITE CONDITIONS:

- A. Where connection to existing lines are shown on the drawings, the work may be required to be done at night or at a time which will least interfere with the operation of the existing facility. No night time work allowed. Work between 8:00 a.m. – 5:00 p.m., Monday through Friday, only.
- B. The tie to existing lines will be coordinated with Engineer and with personnel of the existing line's Owner and will be done at a time to least inconvenience their operation.
- C. Where possible the existing utility lines (water, gas, etc.) have been noted on the drawings. There may be additional buried lines that are not shown and if such is encountered, said lines will be left in service. If said lines are broken by the Contractor, they shall be repaired as soon as possible.
- D. The work along or across streets shall be done in accordance with the permit from City of Tulsa. The right-of-way shall be maintained in a satisfactory manner at all times.

1.06 NOT USED:

1.07 SUBMITTALS:

- A. Work Plan and equipment list to be furnished under this contract shall be submitted to the Engineer for review. This datum shall include drawings and operation; anchorages and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment. Data submitted shall include drawings showing essential details of any changes proposed by Contractor and all required structural layout.
- B. Copies of each drawing and necessary data with statement of approval by the Contractor, shall be submitted to the Engineer. Drawing or data sheet shall be clearly marked with the name of the project, the Engineer's name, Contractor's name and references to applicable specification paragraphs and drawing sheets.
- C. The Engineer's review of drawings and data submitted by the Contractor will cover only general conformity to the drawings and specifications, external connections and dimensions which affect the layout. The Engineer's review of drawings returned marked NO EXCEPTIONS NOTED or EXCEPTIONS NOTED does not indicate a thorough review of all dimensions, quantities and details of the material, equipment, device or items shown and does not relieve the Contractor from any responsibility for errors, omissions, or deviations from the contract requirements.
- D. All drawings and data, after final processing by the Engineer, shall become a part of the CONTRACT DOCUMENTS and the work shown or described thereby shall be performed in conformance therewith unless otherwise authorized by the Owner or the Engineer.
- E. Progress Reports. A progress report shall be furnished to Engineer with each Application for Payment. If the work falls behind schedule, Contractor shall submit additional progress reports at such intervals as Engineer may request. Each progress report shall include sufficient narrative to describe current and anticipated delaying factors, their effect on the progress schedule, and proposed corrective actions. Any work reported complete, but which is not readily apparent to Engineer, must be substantiated with satisfactory evidence. Each progress report shall also include three prints of the accepted graphic schedule marked to indicate actual progress.
- F. Construction Photographs. Contractor shall be responsible for the production of construction photographs as provided herein. Engineer shall designate the subject of each photograph. A minimum of twenty photographs of the entire site, or pertinent features thereof, shall be taken before the commencement of work at the site and promptly submitted to Engineer. The same views shall be re-photographed upon completion of all construction activities and submitted with Contractor's application for final payment. Ten additional photographs shall be made each month throughout the progress of the work at such times as requested by Engineer, and submitted with Contractor's application for progress payment.
- G. Safety Work Plan. The Contractor shall submit and maintain on-site a comprehensive Safety Work Plan that includes safety procedures and demonstrates full compliance with OSHA and other applicable safety regulations. The Plan shall not rely on Owner to provide staff or resources for Regulatory Compliance. This

plan will not be reviewed by the Engineer for conformance with regulations. The Engineer will maintain a copy for review by the Owner and Regulatory Agencies.

1.08 SURVEYS:

- A. The Owner will, where necessary, provide survey of property including reference points, property corners and bench marks. If necessary, the Contractor shall transfer these reference points and bench marks to permanent locations where they will not be disturbed. If disturbed, the Contractor shall re-install them to Owner's satisfaction, at Contractor's cost.

1.09 PERMITS AND REGULATIONS:

- A. The Contractor shall secure and pay for all construction permits required to carry out the work unless otherwise specified and shall produce same upon demand of the Owner. The Contractor shall give all notices and pay all fees and shall, before starting work, ascertain whether the drawings and specifications are at variance with any codes or regulations applying at the site. The Contractor shall obtain completion survey, certificate of completion or occupancy if required by local regulations.
- B. All features of design and construction shall comply with the local building regulations and/or other lawful or public regulations which apply at the site. If any features of construction as shown on the Owner's plan, do not conform to the regulations, the Contractor shall notify the Owner of such discrepancy, and shall base his quotation and work on features of construction which do conform to the regulations.
- C. If the Contractor performs any work contrary to such laws, ordinances, rules and regulations and without such notice to the Owner, he shall bear all costs arising therefrom.

1.10 INSPECTION:

- A. The Contractor will provide access to the work site and facilities for representatives of the Environmental Protection Agency, Oklahoma Department of Environmental Quality, and other agencies, as well as, Owner and Engineer, as required whenever the work is in progress.

1.11 SATURDAY, SUNDAY, HOLIDAY AND NIGHT WORK:

- A. No work shall be done between the hours of 5:00 p.m. and 8:00 a.m., nor on Saturday, Sunday or legal holidays without the written approval or permission of the Owner in each case.
- B. In the event the Contractor requests to work additional hours and for any reason cancels without giving reasonable notice, he shall be responsible for all costs incurred as a result of any Representative being present when the Contractor failed to work.
- C. At the Contractor's option, should weather conditions prevent the Contractor or any sub-unit of his forces from working on a regular work-day and the Engineer and applicable Resident Project Representative are promptly notified, any unworked hours may be transferred to a later time in the current week in order to achieve a 45-hour work week for those forces without additional Resident Project Representative(s) costs. Such hours shall not be carried beyond the current work

week and no credit will be given for weeks when the total worked is less than 40 hours per week.

- D. The Engineer shall be the sole authority as to when Representatives are required and as to the number of Representatives required for the Contractor's overtime activities for any given day. These determinations shall be based upon the Contractor's written request for overtime work including the description of the work to be performed and approved. Said requests shall be submitted not later than 36 hours in advance of the initiation of the work, except in the case of an emergency.
- E. The Owner shall periodically deduct the cost for all overtime hours from the Contractor's Payment Requests based on the actual cost of providing the Resident Project Representative(s). If the amount due to the Contractor in any pay period is not sufficient to cover the cost, the Contractor shall reimburse the Owner in the amount necessary.

1.12. PROTECTION OF PROPERTY:

- A. The protection of City, State and Government monuments, street signs and other Owner's property is of prime importance, and if the same be damaged, destroyed or removed, they shall be repaired, replaced or paid for by the Contractor. Disturbance to this property must first be approved by the agency which controls it.
- B. No valves or other control on any utility main or building service line shall be operated for any purpose by the Contractor, unless shown in plans.
- C. At places where the Contractor's operations are adjacent to the plant of railway, telegraph, telephone, electric and gas companies, or water, sanitary sewers and storm sewers, damage to which might result in expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.
- D. The Contractor shall not remove any water or sanitary sewer lines except as directed by the Engineer or as required by the Drawings and specifications and shall adequately brace and protect them from any damage during construction. Any existing water main or sewer main or lateral damage caused by the Contractor's operations will be repaired by the Contractor. The repairs will be made at the Contractor's expense.
- E. The location of utility service lines serving individual properties may or may not be shown on the Drawings, but the Contractor shall assume that such service lines exist whether or not they are shown on the Drawings, and it shall be the responsibility of the Contractor to make any necessary changes in the line and/or grade of such services, or to secure the necessary changes therein to be made by the particular utility company involved or other Owner thereof, or by an agent or individual Contractor approved by such utility company or other Owner. Contractor shall pay the cost of all such revisions whether performed by Contractor, the utility company or other Owner, or an approved Contractor. In the event of interruption of a utility service as a result of accidental breakage, Contractor shall promptly notify the Engineer and the Owner of the utility, and shall repair or cause the same to be repaired, in the same manner as necessary changes above are provided for, the Contractor shall do all things necessary to see that the restoration of services are done as promptly as may be reasonably done. All sanitary sewer service lines damaged shall be replaced with cast iron pipe regardless of type or kind damaged.

- F. In the event the Contractor in any way fails to comply with the requirements of protecting, repairing and restoring of any utility or utility service, the Owner may, upon forty-eight (48) hours written notice proceed to protect, repair, rebuild or otherwise restore such utility or utility service as may be deemed necessary, and the cost thereof will be deducted from any money due or which may become due the Contractor pursuant to the terms of his contract.

1.13 CONTRACTOR'S SUPERINTENDENT:

- A. The Contractor shall keep a competent Superintendent and any necessary assistants at the site throughout the progress of the work. All directions given to said Superintendent shall be as binding as if given to the Contractor. Upon request, such directions will be confirmed, in writing, to the Contractor.
- B. The Contractor's Superintendent and/or any of his assistants shall be promptly replaced in the event he or they shall prove to be incompetent and/or unsatisfactory to the Engineer.

1.14 ASSISTANCE BY ENGINEER:

- A. It is distinctly understood and agreed that such assistance as the Engineer may render to the Contractor in connection with the interpretation of drawings and Specifications shall not relieve the Contractor from any responsibility for the work. Any work which proves faulty shall be made right by the Contractor without delay. The failure of the Engineer, or his Inspectors to call the Contractor's attention to faulty work or work done which is not in accordance with drawings and Specifications shall not prevent the Owner from insisting that the Contractor make all work right.

1.15 INCIDENTAL WORK:

- A. Work called for on the drawings and/or Specifications and are not set forth in the Bid Schedule as pay items, shall be considered as incidental work and will not be paid for directly, but shall be included in the price bid for the various pay items.

1.16 TERMINATION OF CONTRACT:

- A. If the Contractor shall be adjudged bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should persistently or repeatedly refuse, or should fail, except in cases for which extension of time is provided, to supply enough properly skilled workmen, equipment or proper materials, or if he should fail to make prompt payment to subcontractor or for material or labor, or persistently disregard laws, ordinances or the instructions of the Engineer, or otherwise be guilty of a substantial violation of any provision of the Contract, then the Owner upon the certificate of the Engineer that sufficient cause exists to justify such action, may without prejudice to any other right or remedy and after giving the Contractor seven days written notice, terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances thereon and finish the work by whatever method the Owner may deem expedient. In such case, the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the Contract Price shall exceed the expense of finishing the work, including compensation for additional managerial and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor shall pay the difference to the

Owner as herein provided, and the damage incurred through the Contractor's default shall be certified by the Engineer.

- B. In the event of termination of Contract before completion of the work, due to abandonment of the project or discontinuance thereof, the Contractor will be paid in proportion to the work completed and in progress as per scope of work described in the drawings and Specifications and in accordance with the unit price schedule.

1.17 ACCEPTANCE AND FINAL PAYMENT:

- A. Upon receipt of written notice from the Contractor that the work is ready for final inspection and acceptance, the Engineer shall promptly make such inspection and when he finds the work acceptable under the Contract and the Contract fully performed, he shall promptly issue a final certificate over his own signature, stating that the work provided for in this Contract has been completed and is accepted by him under the terms and conditions thereof, and the entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor, as approved by the Owner, at the office of the Owner within 30 days after the date of said final certificate.
- B. If, after receipt of written notice from Contractor requesting final inspection and the performance of said final inspection by Engineer, additional inspections are necessary in order for Engineer to issue a final certificate; the Owner shall withhold the cost associated with said additional inspections from the final payment due the Contractor.
- C. Before issuance of final certificate, the Contractor shall submit evidence satisfactory to the Engineer that all payrolls, material bills, equipment rentals, and all other indebtedness connected with the work have been paid.

1.18 PLACING WORK IN SERVICE:

- A. If desired by the Owner, upon approval by ODEQ and EPA, portions of the work may be placed in service when completed and the Contractor shall give prior access to the work for this purpose, but such use and operation shall not constitute an acceptance of the work.

1.19. SCHEDULES:

- A. The Contractor shall prepare within 10 days of NOTICE TO PROCEED a tentative project schedule. The schedule shall clearly identify the critical path, set forth in detail work tasks, procedures, start dates and complete dates for all tasks. Contractor shall update Detail Schedule for review with Owner and Engineer on a monthly basis. If at any time, in the opinion of the Engineer, proper progress is not being maintained, such changes shall be made in the schedule of operations which will satisfy the Engineer that the work will be completed within the period stated in the proposal, or extension thereof made as herein provided. In the event the Contractor does not maintain the work schedule approved by the Engineer, a sum equal to the liquidated damages for the number of days Contractor is behind schedule may be retained by the City out of the Engineer's estimates of the amount due the Contractor from time to time to guarantee the City against loss by reason of the failure of the Contractor to complete the work or any part thereof in the time provided herein. The amount of damages finally determined to be due may be withheld from any sums finally determined to be due Contractor hereunder, or otherwise.

- B. Contractor is to prepare a list of proposed subcontractors including material suppliers; submit to Engineer for approval before subcontracts are awarded. No subcontractor is to be employed on work unless approved by Owner and Engineer

1.20 INSURANCE:

- A. Every employer of labor directly employed on the project shall provide insurance on the following kinds and limits throughout the life time of the work:

Public Liability Insurance:

Bodily Injury	\$ 100,000.00 Minimum, Each Person
Property Damage	\$ 100,000.00 Minimum, Each Person
B.I. and P.D. Combined	\$1,000,000.00 Minimum, Each Occurrence
Property Damage Insurance	\$ 200,000.00 Minimum
Workmen's Compensation Insurance	Statutory Limit
Builder's Risk Insurance	Insurable Portion of Project

Automotive Liability:

Bodily Injury	\$ 100,000.00 Minimum, Each Person
Property Damage	\$ 100,000.00 Minimum, Each Accident
B.I. and P.D. Combined	\$1,000,000.00 Minimum, Each Accident

1.21 SAFETY STANDARDS AND ACCIDENT PREVENTION:

- A. With respect to all work performed under this Contract the Contractor shall:
1. Comply with the safety standards provisions of applicable laws, building and construction codes and the "Manual of Accident Prevention in Construction" published by the Associated General Contractors of America, the requirements of the Occupational Safety and Health Act of 1970 (Public Law 91-596), and the requirements of Title 29 of the Code of Federal Regulations, Section 1910 or 1926 as applicable.
 2. Exercise every precaution at all times for the prevention of accidents and the protection of persons (including employees) and property.
 3. Trench Excavation and Safety System: All work under this item shall be in accordance with the current edition of the OSHA Standard for Excavation and Trench Safety Systems, 29 CFR 1926 Subpart P.
 4. The Contractor shall notify all utility companies and owners in accordance with the OSHA requirements given in 29 CFR 1926.651 (b) (2) for the purpose of locating utilities and underground installations.
 5. Where the trench or excavation endangers the stability of a building, wall, street, highway, utilities, or other installation, the Contractor shall provide support systems such as shoring, bracing, or underpinning to ensure the stability of such structure or utility. The Contractor may elect to remove and replace or relocate such structures or utilities with the written approval of the utility owner, the Engineer, and the Owner.
 6. Payment for the work required by this item shall be included in the lump sum price bid. With each periodic payment request, Contractor shall submit a certification that the Contractor has complied with the provisions of the OSHA standards.

- B. The Contractor shall familiarize himself with all Owner provided safety plans to ensure that its activities do not alter or jeopardize the safety of the work space for Owner employees.
- C. The Contractor shall submit a Safety Work Plan per 1.07 I of this Section.

1.22 WAGE RATES:

- A. The Contractor shall comply with all the current requirements of the Oklahoma State Dept. of Labor and abide by their interpretations for this Contract. If applicable, a wage determination will be included in these documents or added by Addendum prior to the date set for procuring Bids. If applicable, a Federal wage determination will be included in these documents or added by Addendum and the higher rate from either the Federal or State wage determination shall be used for each job classification.

1.23 WORKMEN:

- A. The Contractor shall employ foreman and skilled laborers where necessary, and if any person employed on the work shall refuse or neglect to obey orders of the Engineer or Inspector when such orders are in keeping with the provisions of these Specifications or shall appear to the Engineer or his Inspector to be incompetent, disorderly or unfaithful, he shall, upon order of the Engineer, be at once discharged and not again employed upon any part of the work. It shall be the responsibility of the superintendent representing the Contractor to transmit all necessary orders and instructions. If requested by the Engineer the Contractor shall submit, in written form, qualifications including work experience of any workman used on the project.

1.24 NUMBER OF WORKING DRAWINGS AND SPECIFICATIONS:

- A. The Engineer will furnish to the Contractor not more than four sets of blueprints and Specifications for construction. The Contractor may procure additional copies of blueprints and Specifications for construction at cost of reproduction. Such costs are reimbursable by the Engineer.

1.25 PRECONSTRUCTION CONFERENCE:

- A. Prior to the commencement of work at the site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by:
 - 1. Contractor and its superintendent.
 - 2. Principal subcontractors.
 - 3. Representatives of principal suppliers and manufacturers as appropriate.
 - 4. Engineer and its Resident Project Representative.
 - 5. Representatives of Owner.
 - 6. Government representatives as appropriate.
 - 7. Others as requested by Contractor, Owner, or Engineer.
- B. Unless previously submitted to Engineer, Contractor shall bring to the conference a preliminary schedule for each of the following:
 - 1. Progress.
 - 2. Procurement.

3. Values for progress payment purposes.
 4. Shop Drawings and other submittals.
- C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include:
1. Contractor's preliminary schedules.
 2. Transmittal, review, and distribution of Contractor's submittals.
 3. Processing applications for payment.
 4. Maintaining record documents
 5. Critical work sequencing.
 6. Field decisions and change orders.
 7. Use of premises, office and storage areas, security, housekeeping, and Owner's needs.
 8. Major equipment deliveries and priorities.
 9. Contractor's assignments for safety and first aid.
- D. Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

1.26 DETERMINATION AND EXTENSION OF CONTRACT TIME:

- A. The Contract time consist of the number of calendar days stated in the Contract for the completion of the work beginning on the effective date of the work order or the date the Contractor begins work, whichever is earlier, including all Sundays, holidays, and non-work days. All calendar days elapsing between effective dates of any orders of the Engineer to suspend work and to resume work for suspensions, not the fault of the Contractor shall be excluded.
- B. The occurrence of unusually severe weather during the life of the Contract will be considered a basis for extending contract time when work is not already suspended for other reasons. Unusually severe weather shall mean weather which at the time of year it occurs is unusual for the place in which it occurs.

1.27 SUBSTANTIAL AND FINAL COMPLETION:

- A. All work including site restoration shall be finished within the time called out on the Bid Form for final completion.

END OF SECTION

PART 1: GENERAL REQUIREMENTS:

1.01 SCOPE:

- A. These Equipment Stipulations apply, in general, to all equipment. They supplement the detailed equipment Specifications but in case of conflict, the detailed equipment Specifications shall govern.

1.02 COORDINATION:

- A. The Contractor shall assume full responsibility for coordination of the entire project, including verification that all structures, piping and equipment components are compatible. The Contractor shall start up each equipment system and shall make all necessary adjustments so that each system is placed in proper operating condition.

1.03 ADAPTATION OF EQUIPMENT:

- A. Equipment shall be readily adaptable for installation and operation in the structures shown on the drawings. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the Owner. Equipment which requires alteration of the structures will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.04 PATENT ROYALTIES:

- A. All royalties and fees for patents covering materials, articles, apparatus, devices, or equipment (as distinguished from processes) shall be included in prices quoted by equipment suppliers.

1.05 EQUIPMENT GUARANTEE:

- A. The Contractor shall guarantee all equipment against (a) faulty or inadequate design, (b) improper assembly or erection, (c) defective workmanship or materials, and (d) leakage, breakage or other failure. The Contractor shall guarantee the equipment, materials, and workmanship furnished under this contract to be as specified and to be free from defects for a period of one year after the date of final payment. In addition, the equipment furnished by the Contractor shall be guaranteed to be free from defects in design.
- B. Upon notification, the Contractor shall promptly make all adjustments, repairs or replacements which, in the opinion of the Engineer or Owner, arose out of defects and became necessary during the guarantee period.

- C. The cost of all materials, parts, labor, transportation, supervision, special tools and supplies required for replacement or repair of parts and for correction of defects shall be paid by the Contractor or by the Surety.
- D. This guarantee shall be extended one year from date of all repairs and replacements furnished under the original guarantee for each such repair or replacement.
- E. If within ten days after the Owner has notified the Contractor of a defect, failure, or abnormality in the work, the Contractor has not started to make the necessary repairs or adjustments, the Owner is hereby authorized to make the repairs or adjustments or to order the work to be done by a third party, the cost of the work to be paid by the Contractor.
- F. In the event of an emergency where, in the judgment of the Owner, delay would cause serious loss or damage, repair or adjustments may be made by the Owner, or a third party chosen by the Owner, without advance notice to the Contractor, and the cost of the work shall be paid by the Contractor, or by the Surety.

1.06 WORKMANSHIP AND MATERIALS:

- A. All equipment shall be designed, fabricated and assembled in accordance with the best modern engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
- B. Materials shall be suitable for service conditions. Iron castings shall be tough, close-grained gray iron free from any flaws or excessive shrinkage and shall conform to ASTM A48.
- C. Except where otherwise specified, structural and miscellaneous fabricated steel used in items of equipment shall conform to the Standards of the American Institute of Steel Construction. All structural members shall be considered as subject to shock or vibratory loads.

1.07 LUBRICATION:

- A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.
- B. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to acceptance of equipment by the Owner.

1.08 SAFETY GUARDS:

- A. All belt or chain drives, fan blades, couplings and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 US gage or heavier galvanized sheet steel of ½-inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

1.09 ANCHOR BOLTS:

- A. Equipment suppliers shall furnish suitable bolts for each item of equipment. Two nuts shall be furnished for each bolt.

1.10 SPECIAL TOOLS AND ACCESSORIES:

- A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

1.11 PROTECTION:

- A. All equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. All equipment shall be protected from exposure to the elements and shall be kept thoroughly dry at all times. Motors, electrical equipment and other equipment having anti-friction or sleeve bearings shall be stored in watertight warehouses which are maintained at a temperature of at least 60°F.
- B. Painted surfaces shall be protected against impact, abrasion, discoloration and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of the Engineer.
- C. Electrical equipment, controls, and insulation shall be protected against moisture or water damage. All space heaters provided in the equipment shall be kept connected and operating at all times until equipment is placed in service.

1.12 SALVAGE AND DISPOSAL OF EQUIPMENT:

- A. Owner has right to salvage all existing material, equipment or parts thereof or any surplus product, material, equipment or parts thereof purchased through the project. The Contractor shall deliver equipment that the Owner claims to an Owner designated location within the project. Unclaimed equipment shall become property of the Contractor and removed from the Owner's property as approved by the Engineer.

END OF SECTION

PART 1: GENERAL

1.01 DESCRIPTION:

- A. This section includes general use of the City of Tulsa project site, including limits of construction, access to site, material storage and staging area as well as State or City rights-of-way and utility easements.

1.02 CONSTRUCTION AREA:

- A. The CONTRACTOR will confine work to the limits of construction shown on the Drawings. Trespassing on abutting lands or other land in the area is not allowed.
- B. CONTRACTOR will have limited use of the construction sites for material storage; CONTRACTOR material storage and staging area shall be approved by the City of Tulsa. The CONTRACTOR will be required to remove the materials once construction is completed and restore the area with established grass cover.
- C. CONTRACTOR's work shall not interfere with Owner's operation and use of its Facilities. Demolition, stored equipment, and other nuisances shall not interfere with facility operations and the CONTRACTOR shall safeguard personnel by maintaining reasonable warnings. At Owner's request, roadways temporarily blocked by CONTRACTOR shall be cleaned and cleared to assist Owner's operations or to restore access for property owners.
- D. At no time shall the site be left unattended by the CONTRACTOR without existing, temporary or permanent fencing, gates and locks in place.

1.03 PROTECTION OF WORK AND PROPERTY:

- A. CONTRACTOR shall be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage.
- B. CONTRACTOR shall assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by the CONTRACTOR, it shall be restored by the CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.
- C. Perform daily clean-up of dirt, debris, scrap materials, and other disposable items. Keep streets, driveways, and sidewalks clean of dirt, debris and scrap materials. Do not leave building, roads, streets or other construction areas unclean overnight.

D. UNDERGROUND STRUCTURES:

1. Underground structures are defined to include, but not be limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical conduits, tunnels, vaults and other existing subsurface work located within or adjacent to the Contract limits.
2. All underground structures known to Engineer except water, sewer, electric, and telephone service connections are shown on the Drawings. This information is shown for the assistance of CONTRACTOR in accordance with the best information available, but is not guaranteed to be correct or complete.
3. CONTRACTOR shall explore ahead of his trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If the CONTRACTOR damages an underground structure, he shall restore it to original condition at his expense.
4. Necessary changes in the location of the Work may be made by Engineer, to avoid unanticipated underground structures.
5. If permanent relocation of an underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, Engineer will direct CONTRACTOR in writing to perform the Work, which shall be paid for under an agreed Change Order.

E. Surface Structures are defined as all existing buildings, structures and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, houses, trailer homes, fences, tanks, walls, bridges, roads, dams, channels, open drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

F. PROTECTION OF UNDERGROUND AND SURFACE STRUCTURES:

1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the work of sustaining and supporting such structure, CONTRACTOR shall satisfy the Engineer that the methods and procedures to be used have been approved by the party owning the same.
2. CONTRACTOR shall assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits to the Work. CONTRACTOR shall be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. CONTRACTOR shall repair immediately all damage caused by his work, to the satisfaction of the Owner of the damaged structure.

G. All other existing surface facilities, including, but not limited to, guard rails, posts, fences, gates, guard cables, signs, light poles, poles, markers, and curbs which are temporarily removed to facilitate installation of the Work shall be replaced and restored to their original condition at CONTRACTOR's expense.

H. **PROTECTION OF INSTALLED PRODUCTS:**

1. Provide protection of installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed and prior to completion of Work.
2. Control traffic to prevent damage to equipment, materials, and surfaces.
3. Provide coverings to protect equipment and materials from damage. Cover projections, wall corners, jambs, sills, and exposed sides of openings in areas used for traffic and for passage of materials in subsequent work.

1.04 **NOTIFICATION TO ADJACENT OCCUPANTS:**

- A. Notify individual occupants in areas to be affected by the Work of the proposed construction and time schedule. Notification shall be not less than 72 hours or more than 2 weeks prior to work being performed within 200 feet of the homes or businesses.
- B. Include in notification names and telephone numbers of two company representatives for resident contact, who will be available on 24-hour call. Include precautions that will be taken to protect private property and identify potential access or utility inconvenience or disruption.
- C. Submit proposed notification to Engineer for approval.

1.05 **SURFACE MAINTENANCE AND RESTORATION:**

- A. CONTRACTOR shall maintain a clean and tidy site at all times. Contractor shall keep site clean of rocks, tree branches, and debris during the entire contract period. CONTRACTOR shall be responsible for mowing the grass around the staging and work areas.
- B. Restore site to condition existing before construction to satisfaction of Engineer.

PART 2: PRODUCTS NOT USED

PART 3: EXECUTION NOT USED

END OF SECTION

DIVISION 01 - GENERAL REQUIREMENTS
SECTION 01 10 00
PROJECT RECORD DOCUMENTS

PART 1: GENERAL REQUIREMENTS:

1.01 GENERAL:

- A. The Contractor shall be responsible for accumulation and maintenance of a complete set of Project Record Documents and upon completion and acceptance of the project shall submit these documents to the Engineer, as the Owner's representative, for a permanent record.
- B. The Project Record Documents shall consist of:
 - 1. One complete set of drawings, with revisions.
 - 2. One complete Project Manual with all addenda, field bulletins and Change Orders.
 - 3. One complete set of all field test data.
 - 4. One complete set of approved shop drawings, product data brochures and samples.
 - 5. Three complete sets of Manufacturer's Operation and Maintenance Manuals.
 - 6. Three complete sets of warranties.

1.02 MAINTENANCE OF RECORD DOCUMENTS:

- A. The Contractor shall maintain, on the site, one complete set of Contract Documents, other than those used for construction, throughout the life of the job.
 - 1. This set of documents shall be marked "Record Set" and shall be maintained up-to-date at all times and available to the Engineer for inspection.
 - 2. The only notations or other markings to be made on this set are notations of field variations made from the work shown on the drawings for purposes of "Record Drawings" revisions when the project is complete. Failure to record revisions by each Contractor shall be considered a breach of contract.
 - 3. This set of Documents will be turned over to the Engineer for preparation of "Record Drawings" prior to approval of final application for payment.

1.03 OPERATION AND MAINTENANCE MANUAL:

- A. Three complete sets of manufacturer's operating and maintenance instructions (O&M Manual) for the project shall be prepared by the Contractor for the Owner's continual use.
 - 1. To be bound in 3-ring binder(s), 8-1/2" x 11" in size, labeled "Northside Aeration Jockey Blower Addition Project" Operation and Maintenance Manual" on the Ring Binder Cover and Spine.

2. To include a Table of Contents, separation sheets between items, and tabbed indexes of each item for quick reference use.
 3. To contain manufacturer's printed data, record forms, diagrams, parts lists, maintenance procedures, start-up procedures, operating procedures, service requirements and schedules, and names, addresses and phone numbers of subcontractor, manufacturer and local service agent.
 4. To contain all written warranties and guarantees. Warranties shall be identified in the Table of Contents for quick reference use.
- B. Each manual shall consist of a complete hard copy plus a complete digital copy located in a jacket pocket of the three ring binder(s). Where more than 1 binder is required the binders shall be labeled "Book 1 of [number of binders]".
- C. Manuals shall be submitted to the Engineer for review and approval for completeness for the Owner as stated above. Approved manuals are required for project closeout. Final payment may be withheld until all such information is received.

END OF SECTION

PART 1: GENERAL REQUIREMENTS:

1.01 GENERAL:

- A. Contractor shall provide for everything required to complete the improvements outlined on the Drawings and in the Specifications and render the improvements operable subject to the specific exclusions which note otherwise.
- B. The completed work shall meet all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area where the construction is located. Failure to point out items that do not meet such requirements does not relieve the Contractor or his subcontractors of the responsibility for meeting them.

1.02 INCIDENTAL ITEMS:

- A. There are numerous incidental items of work that are required to complete the Project. While these items may not be specifically mentioned or illustrated by the Contract Documents and there may be no specific pay items listed for them, the Contractor will be required to perform those incidental tasks that can be anticipated through inspection of the Contract Documents, inspection of the construction areas, and experience in this class of construction.
- B. Items considered incidental work shall not be measured for payment or paid for as such unless specified as unit price by items on the Bid Form. These items and their costs shall be included in the unit prices for the pay items unless bid separately. Incidental items include but are not limited to the following:
 - a. Notifications
 - b. Material royalties
 - c. Construction Entrances
 - d. Field measurements and verifications
 - e. Site security
 - f. Labeling
 - g. Providing specified submittals
 - h. Supervision and management
 - i. Insurance
 - j. Licenses
 - k. Workman's compensation
 - l. General overhead, applicable taxes and profits
 - m. Safety devices
 - n. Confined space entry
 - o. Attendance at meetings as directed by Owner
 - p. All other items required to complete the project, for which pay items are not provided, will not be measured nor paid for as such, but their cost shall be included in the price for other items of work

1.03 PAY ITEMS AND PAY ITEM NOTES:

- A. Item 1 – Demolition (Pipe, supports, electrical, and blower removal), Complete
Shall be bid as EACH (EA). This item shall include payment for all labor, bonds, insurance, construction equipment, temporary supports, and labor to perform all electrical, structural, and equipment demolition as specified or otherwise required to build the Work. Payment shall be at the Contract EACH (EA) price.
- B. Item 2 – Concrete Pad, Complete
Shall be bid by the contractor as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with any formwork, rebar, setting, finishing, tools, materials, and labor necessary to build the Work. Payment shall be at the Contract EACH (EA) price.
- C. Item 3 – Steel Supports, Complete
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with all connections, material certifications, and labor necessary to build the Work. Payment shall be at the Contract EACH (EA) price.
- D. Item 4 – NX700D-C080 High Speed Turbo Blower and Accessories, Complete
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with standard equipment package, submittals, tests, QA/QC, installation and operation training, and product certifications provided by Manufacturer. Payment shall be at the Contract EACH (EA) price.
- E. Items 5 – 24" Stainless Steel Pipe
Shall be bid as LINEAR FOOT (LF) Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per LINEAR FOOT (LF).
- F. Items 6 – 24" Stainless Steel 90° Bend
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).
- G. Item 7 – 30"x24" Reducer
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).
- H. Item 8 – 14" Butterfly Valve with Chainwheel
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).
- I. Item 9 – 14" Long Radius Elbow
Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).
- J. Item 10 – 14" Stainless Steel Pipe

Shall be bid as LINEAR FOOT (LF). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per LINEAR FOOT (LF).

K. Item 11 – 20"x20"x14" Tee

Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).

L. Item 12 – 20" Blind Flange

Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).

M. Item 13 – Switchgear Starter Rebuild

Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).

N. Item 14 – 4" Rigid Metal Conduit

Shall be bid as LINEAR FOOT (LF). Incidental items include any applicable listed in paragraph 1.02.B along with labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per LINEAR FOOT (LF).

O. Item 15 – 1" Rigid Metal Conduit

Shall be bid as LINEAR FOOT (LF). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per LINEAR FOOT (LF).

P. Item 16 – 5 Kv Rated Wire - #1 90 degree C

Shall be bid as HUNDRED LINEAR FEET (CLF). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per HUNDRED LINEAR FEET (CLF).

Q. Item 17 – Twisted Shielded Pair Wire - 2/C#18SH

Shall be bid as HUNDRED LINEAR FEET (CLF). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per HUNDRED LINEAR FEET (CLF).

R. Item 18 – Fiber

Shall be bid as HUNDRED LINEAR FEET (CLF). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per HUNDRED LINEAR FEET (CLF).

S. Item 19 – SCADA Programming, Complete

Shall be bid as EACH (EA). Incidental items include any applicable listed in paragraph 1.02.B along with qualified labor, materials, tools, and testing necessary to build the Work. Payment shall be at the Contract Price per EACH (EA).

T. Item 20 – Mobilization

Shall be bid as EACH (EA). Incidental items shall include Contractor mobilization and demobilization costs including bonds, insurance, move in and move out of personnel and equipment, project signs and any other costs for mobilization to and demobilization from the site. Payment shall be at the Contract EACH (EA) price.

U. Item 21 – Owner's Allowance

Shall be bid as ALLOW. An allowance has been provided in the contract to various mechanical, electrical, or structural work.

- a. The allowance shall be used for the cost of materials, labor, installation, and overhead, and profit not identified in the Construction Documents/Plans, and not included in the base bid EACH.
- b. The allowance shall be used only at the discretion of the Authority.
- c. The Contractor shall provide, to the Authority Representative, a written request for the use of the allowance, with a schedule of values, and associated backup information.
- d. Contractor shall proceed with work included in the allowance only after receiving a written order, from the Authority Representative, authorizing such work. Proceeding with work in the allowance without a written order from the Authority Representative will be at the Contractor's cost.

END OF SECTION

PART 1: GENERAL

1.01 DESCRIPTION:

A. WORK INCLUDED:

1. Wherever possible throughout the Contract Documents, the minimum acceptable quality of workmanship and materials has been defined by manufacturer's name and catalog number, reference to recognized industry and government standards, or description of required attributes and performance.
2. To ensure that the specified products are furnished and installed in accordance with design intent, procedures have been established for advance submittal of design data and for their review by the Engineer.
3. Make all submittals required by the Contract Documents, and revise and resubmit as necessary to establish compliance with the specified requirements.

B. RELATED WORK DESCRIBED ELSEWHERE: Individual requirements for submittals are described in pertinent other Sections of these Specifications.

1.02 QUALITY ASSURANCE:

A. COORDINATION OF SUBMITTALS: Prior to each submittal, carefully review and coordinate all aspects of each item being submitted and verify that each item and the submittal for it conforms in all respects with the requirements of the Contract Documents. By affixing the Contractor's signature to each submittal, certify that this coordination has been performed.

B. CERTIFICATES OF COMPLIANCE:

1. When requested, certify that materials used in the work comply with specified provisions thereof. Certification shall not be construed as relieving the Contractor from furnishing satisfactory materials if, after tests are performed on selected samples, the material is found to not meet specified requirements.
2. Show on each certification the name and location of the work, name and address of Contractor, quantity and date or dates of shipment or delivery to which the certificate applies, and name of the manufacturing or fabricating company. Certification shall be in the form of letter or company standard forms containing all required data. Certificates shall be signed by an officer of the manufacturing or fabricating company.
3. In addition to the above information, all laboratory test reports submitted with Certificates of compliance shall show the date or dates of testing, the specified requirements for which testing was performed, and results of the test or tests.

1.03 SUBMITTALS:

- A. SUBMITTAL SCHEDULE: Within 35 days after award of Contract, and before any items are submitted for approval, submit to the Engineer two copies of the schedule described in Article 2.01 of this Section.
- B. CERTIFICATES OF COMPLIANCE: Upon completion of the work, and as a condition of its acceptance, submit to the Engineer all Certificates of Compliance.
- C. PROCEDURES: Make submittals in strict accordance with the provisions of this Section.

PART 2: PRODUCTS

2.01 SUBMITTAL SCHEDULE:

- A. GENERAL: Compile a complete and comprehensive schedule of all submittals anticipated to be made during progress of the work. Include a list of each type of item for which Contractor's drawings, Shop Drawings, Certificates of Compliance, material samples, guarantees, Operations and Maintenance manuals or other types of submittals are required. Upon approval by the Engineer this schedule will become part of the Contract and the Contractor will be required to adhere to the schedule except when specifically otherwise permitted.
- B. COORDINATION: Coordinate the schedule with all necessary subcontractors and materials suppliers to ensure their understanding of the importance of adhering to the approved schedule and their ability to so adhere. Coordinate as required to ensure the grouping of submittals as described in this Section.
- C. REVISIONS: Revise and update the schedule monthly as necessary to reflect conditions and sequences. Promptly submit revised schedules to the Engineer for review and comment.

2.02 SHOP DRAWINGS AND COORDINATION DRAWINGS:

- A. SHOP DRAWINGS:
 - 1. Scale and measurements: Make all Shop Drawings accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the work.
 - 2. Type of prints required: Submit all Shop Drawings in the form of blueprints.

2.03 MANUFACTURERS' LITERATURE:

- A. GENERAL: Where contents of submitted literature from manufacturers include data not pertinent to the submittal, clearly indicate which portion of the contents is being submitted for review.
- B. NUMBER OF COPIES REQUIRED: Submittals may be digitally submitted to Engineer. Approved submittals can be finalized by submitting the required number of hard copies which is two copies to be retained by the Engineer plus any additional copies required by the Contractor.

2.04 SAMPLES:

- A. ACCURACY OF SAMPLES: Samples shall be of the precise article proposed to be furnished. Samples shall have stickers or tags which bear identification of the project, the subcontractor, the vendor or manufacturer, the product color name or number, model, style or series, and the size and thickness of components.
- B. NUMBER OF SAMPLES REQUIRED: Unless otherwise specified, submit all Samples in the quantity which is required to be returned plus one which will be retained by the Engineer.
- C. REUSE OF SAMPLES: In situations specifically so approved by the Engineer, the Engineer's retained Sample may be used in the construction as one of the installed items.
- D. MATCH EXISTING MATERIALS: Brick or other materials that are to match existing materials shall require a "test panel" to be erected adjacent to the existing material to allow the Owner to approve the match in size, color, and texture.

2.05 COLORS AND PATTERNS:

- A. Unless the precise color and pattern is specifically described in the Contract Documents, and whenever a choice of color or pattern is available in a specified product, submit accurate color and pattern charts to the Engineer for review and selection.

2.06 SUBSTITUTIONS:

- A. APPROVAL REQUIRED:
 - 1. The Contract is based on the standards of quality established in the Contract Documents.
 - 2. All products proposed for use, including those specified by required attributes and performance, shall require approval by the Engineer before being incorporated into the work.
 - 3. Do not substitute materials, equipment, or methods unless such substitution has been specifically approved for this work by the Engineer.
- B. "OR EQUAL":
 - 1. Where the phrase "or equal" or "approved or equal" occurs in the Contract Documents, do not assume that materials, equipment, or methods will be approved as equal unless the item has been specifically approved for this work by the Engineer.
 - 2. The decision of the Engineer shall be final.

PART 3: EXECUTION

3.01 IDENTIFICATION OF SUBMITTALS:

- A. GENERAL: Bind submittals with cover label that identifies project, division of work, subcontractor, and vendor/manufacturer. Consecutively number all submittals.

Accompany each submittal with a letter of transmittal containing all pertinent information required for identification and checking of submittals.

- B. INTERNAL IDENTIFICATION: On at least the first page of each copy of each submittal, and elsewhere as required for positive identification, clearly indicate the submittal number in which the item was included.
- C. RESUBMITTALS: When material is resubmitted for any reason, transmit under a new letter of transmittal and with a new submittal number.

3.02 COORDINATION OF SUBMITTALS:

- A. GENERAL: Prior to submittal for approval, use all means necessary to fully coordinate all material including, but not necessarily limited to:
 - 1. Determine and verify all interface conditions, catalog numbers, and similar data.
 - 2. Coordinate with other trades as required.
 - 3. Clearly indicate all deviations from requirements of the Contract Documents.
- B. GROUPING OF SUBMITTALS: Unless otherwise specified, make all submittals in groups containing all associated items to ensure that information is available for checking each item when it is received. Partial submittals may be rejected as not complying with the provisions of the Contract Documents and the Contractor shall be strictly liable for all delays so occasioned.

3.03 TIMING OF SUBMITTALS:

- A. GENERAL: Make all submittals far enough in advance of scheduled dates for installation to provide all time required for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing delivery.
- B. ENGINEER'S REVIEW TIME: In scheduling, allow at least 21 calendar days for review by the Engineer following his receipt of the submittal.
- C. DELAYS: Delays caused by tardiness in receipt of submittals will not be an acceptable basis for extension of the Contract completion date.

3.04 PACKAGING OF SUBMITTALS:

- A. GENERAL: Contractor shall package the submittal for engineer's review in rational groups to facilitate and expedite the review. All submittals related to a common element and tasks shall be grouped together and submitted for review.
- B. Engineer reserves the right to reject submittal if they are not submitted in groups as indicated above.

3.05 ENGINEER'S REVIEW:

- A. CONTRACTOR'S APPROVAL: Prior to submission to the Engineer, all submittals shall have been reviewed and approved by the Contractor.

- B. GENERAL: Review by the Engineer shall not be construed as a complete check, but only that the general method of construction and detailing is satisfactory. Review shall not relieve the Contractor from responsibility for errors which may exist.
- C. AUTHORITY TO PROCEED: The notations "Reviewed, no exceptions noted" or "Reviewed, exceptions noted" authorize the Contractor to proceed with fabrication, purchase, or both, of the items so noted, subject to the revisions, if any, required by the Engineer's review comments.
- D. REVISIONS: Make all revisions required by the Engineer. If the Contractor considers any required revision to be a change, he shall so notify the Engineer as provided for under "Changes" in the General Considerations. Show each drawing revision by number, date, and subject in a revision block on the drawing. Make only those revisions directed or approved by the Engineer.
- E. REVISIONS AFTER APPROVAL: When a submittal has been reviewed by the Engineer, resubmittal for substitution of materials or equipment will not be considered unless accompanied by an acceptable explanation as to why the substitution is necessary.

END OF SECTION

PART 1: GENERAL REQUIREMENTS:

1.01 GENERAL:

- A. The Contractor shall be responsible for maintaining a clean, tidy, safe job condition at all times in compliance with OSHA standards.
- B. Contractor shall store his materials in a safe orderly manner that will not encumber access or the work, and allow routine maintenance cleaning to continue unimpeded.
- C. Paint, cleaners and other volatile materials shall be stored in a clean safe, ventilated area to avoid safety hazards.
- D. At the completion of his work, Contractor shall remove from the premises all equipment, construction aids, excess materials, debris, and other items used by him but not incorporated in the work and leave the entire premises "broom clean" to the best of his or her individual ability.

1.02 RELATED WORK:

- A. SECTION 01 00 20 SUBSECTION 1.12A – Salvage and Disposal of Equipment

1.03 MEASUREMENT AND PAYMENT:

- A: Payment shall be as per the Bid Schedule.

END OF SECTION

DIVISION 01 - GENERAL REQUIREMENTS
SECTION 01 51 00
TEMPORARY SERVICES AND FACILITIES

PART 1: GENERAL

- 1.01 **GENERAL:** The Contractor shall be responsible for the provision of all temporary services and facilities required during construction to make the job clean, efficient and safe for workers and others involved with the project.
- A. These items shall include, but not necessarily be limited to:
- Temporary utilities
 - Temporary Air and Process Piping
 - Temporary barricades, covers and barriers

PART 2: TEMPORARY PROVISIONS

- 2.01 **UTILITIES:** The Contractor shall provide all temporary services during construction such as water, electricity, etc. Contractor shall provide a construction project telephone, direct line, listed in the name of the Contractor and the project.
- 2.02 **AIR AND PROCESS PIPING:** The Contractor shall provide valves, equipment and all appurtenances necessary to facilitate routine operation during blower replacement .
- 2.03 **FIELD OFFICE:** The Contractor shall provide temporary field office ("job shack") on the site in a location easily accessible to the work. Field office shall contain not less than:
- A. Construction project telephone.
 - B. Plan table containing record Contract Documents for use by Engineer and Inspectors.
 - C. Lock storage for small supply items such as hardware, hand tools, office and toilet supplies, etc.
 - D. Lights, heater and air conditioning for all-weather occupancy.

END OF SECTION

DIVISION 01 - GENERAL REQUIREMENTS
SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Examination.
- B. Preparation.
- C. Field engineering.
- D. Execution.
- E. Cutting and patching.
- F. Protecting installed construction.
- G. Starting of systems.
- H. Demonstration and instruction.
- I. Testing, adjusting, and balancing.
- J. Closeout procedures.
- K. Project record documents.
- L. Operation and maintenance data.
- M. Manual for materials and finishes.
- N. Manual for equipment and systems.
- O. Spare parts and maintenance products.
- P. Product warranties and product bonds.
- Q. Maintenance service.
- R. Final cleaning.

1.2 EXAMINATION

- A. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Examine and verify specific conditions described in individual Specification Sections.
- C. Verify that utility services are available with correct characteristics and in correct locations.

1.3 PREPARATION

- A. Clean surfaces prior to applying next material or substance according to manufacturer's instructions.
- B. Seal cracks or openings of surfaces prior to applying next material or substance.
- C. Apply manufacturer-required or -recommended substrate primer, sealer, or conditioner prior to applying new material or substance in contact or bond.

1.4 EXECUTION

- A. Equipment will not be put in service until the Manufacturer Start Up is completed, Manufacturer Training on O&M is completed, and Final O&M's are provided to the City of Tulsa to ensure proper maintenance.
- B. Comply with manufacturer's installation instructions, performing each step in sequence. Maintain one set of manufacturer's installation instructions at Project Site during installation and until completion of construction.
- C. When manufacturer's installation instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Verify that field measurements are as indicated on approved Shop Drawings or as instructed by manufacturer.
- E. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
 - 1. Secure Work true to line and level and within specified tolerances, or if not specified, industry-recognized tolerances.
 - 2. Physically separate products in place and provide electrical insulation or protective coatings to prevent galvanic action or corrosion between dissimilar metals.
 - 3. Exposed Joints: Provide uniform joint width and arrange to obtain best visual effect. Refer questionable visual effect choices to Engineer for final decision.
- F. Allow for expansion of materials and building movement.
- G. Mounting Heights: Where not indicated, mount individual units of Work at industry-recognized standard mounting heights for particular application indicated.
 - 1. Refer questionable mounting height choices to Architect/Engineer for final decision.
 - 2. Elements Identified as Handicap Accessible: Comply with applicable codes and regulations.
- H. Adjust operating products and equipment to ensure smooth and unhindered operation.
- I. Clean and perform maintenance on installed Work as frequently as necessary through remainder of construction period. Lubricate operable components as recommended by manufacturer.

1.5 CUTTING AND PATCHING

- A. Employ skilled and experienced Installers to perform cutting and patching.
- B. Submit written request in advance of cutting or altering elements affecting the following:
 - 1. Structural integrity of element.
 - 2. Efficiency, maintenance, or safety of element.
 - 3. Visual qualities of sight-exposed elements.

4. Work of Owner or separate Contractor.

- C. Execute cutting, fitting, and patching to complete Work and to provide openings in elements of Work for penetrations of mechanical and electrical Work.
- D. Execute Work by methods to avoid damage to other Work and to provide proper surfaces to receive patching and finishing.
- E. Cut masonry and concrete materials using masonry saw or core drill.
- F. Restore Work with new products according to requirements of Contract Documents.
- G. Fit Work tight to pipes, sleeves, ducts, conduits, and other penetrations through surfaces.
- H. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- I. At penetrations of fire-rated walls, partitions, ceiling, or floor construction, completely seal voids with fire-rated material to full thickness of penetrated element.
- J. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for assembly, refinish entire unit.
- K. Identify the hazardous substances or conditions exposed during the Work to Architect/Engineer for decision or remedy.

1.6 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual Specification Sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate Work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Use durable sheet materials to protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.

1.7 STARTING OF SYSTEMS

- A. Coordinate schedule for startup of various equipment and systems.
- B. Notify Engineer seven days prior to startup of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- D. Verify that tests, meter readings, and electrical characteristics agree with those required by equipment or system manufacturer.

- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute startup under supervision of manufacturer's representative according to manufacturer's instructions.
- G. When specified in individual Specification Sections, require manufacturer to provide authorized representative who will be present at Site to inspect, check, and approve equipment or system installation prior to startup and will supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 013300 - Submittal Procedures stating that equipment or system has been properly installed and is functioning correctly.

1.8 DEMONSTRATION AND INSTRUCTION

- A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of Substantial Completion.
- B. Use operation and maintenance manuals as basis for instruction. Review contents of manual in detail to explain all aspects of operation and maintenance.
- C. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at an agreed time, at equipment location.
- D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- E. Allot the required instruction time for each item of equipment and system as specified in individual Specification Sections.

1.9 CLOSEOUT PROCEDURES

- A. Prerequisites to Substantial Completion: Complete following items before requesting Certification of Substantial Completion, either for entire Work or for portions of Work:
 - 1. Retain maintenance manuals, Project record documents, digital images of construction photographs, and other similar final record data in compliance with this Section.
 - 2. Complete facility startup, testing, adjusting, balancing of systems and equipment, demonstrations, and instructions to Owner's operating and maintenance personnel as specified in compliance with this Section.
 - 3. Conduct inspection to establish basis for request that Work is substantially complete. Create comprehensive list (initial punch list) indicating items to be completed or corrected, value of incomplete or nonconforming Work, reason for being incomplete, and date of anticipated completion for each item. Include copy of list with request for Certificate of Substantial Completion.
 - 4. Discontinue or change over and remove temporary facilities and services from Project Site, along with construction tools, mockups, and similar elements.

5. Perform final cleaning according to this Section.

B. Substantial Completion Inspection:

1. When Work is substantially complete, submit to Engineer:

- a. Written certificate that Work, or designated portion, is substantially complete.
- b. List of items to be completed or corrected (initial punch list).

2. Within seven days after receipt of request for Substantial Completion, Engineer will make inspection to determine whether Work or designated portion is substantially complete.

3. Should Engineer determine that Work is not substantially complete:

- a. Engineer will promptly notify Contractor in writing, stating reasons for its opinion.
- b. Contractor shall remedy deficiencies in Work and send second written request for Substantial Completion to Engineer.
- c. Engineer will reinspect Work.
- d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer's inspection.

4. When Engineer finds that Work is substantially complete, Engineer will:

- a. Prepare Certificate of Substantial Completion, accompanied by Contractor's list of items to be completed or corrected as verified and amended by Engineer and Owner (final punch list).
- b. Submit Certificate to Owner and Contractor for their written acceptance of responsibilities assigned to them in Certificate.

5. After Work is substantially complete, Contractor shall:

- a. Allow Owner occupancy of Project under provisions stated in Certificate of Substantial Completion.
- b. Complete Work listed for completion or correction within time period stipulated.

C. Prerequisites for Final Completion: Complete following items before requesting final acceptance and final payment.

1. When Work is considered to be complete, submit written certification that:

- a. Contract Documents have been reviewed.
- b. Work has been examined for compliance with Contract Documents.
- c. Work has been completed according to Contract Documents.
- d. Work is completed and ready for final inspection.

2. Submittals: Submit following:

- a. Final punch list indicating all items have been completed or corrected.

- b. Specified warranties, workmanship/maintenance bonds, maintenance agreements, and other similar documents.
 - c. Accounting statement for final changes to Contract Sum.
 - 3. Perform final cleaning for Contractor-soiled areas according to this Section.
- D. Final Completion Inspection:
 - 1. Within seven days after receipt of request for final inspection, Engineer will make inspection to determine whether Work or designated portion is complete.
 - 2. Should Engineer consider Work to be incomplete or defective:
 - a. Engineer will promptly notify Contractor in writing, listing incomplete or defective Work.
 - b. Contractor shall remedy stated deficiencies and send second written request to Engineer that Work is complete.
 - c. Engineer will reinspect Work.
 - d. Redo and Inspection of Deficient Work: Repeated until Work passes Engineer's inspection.

1.10 PROJECT RECORD DOCUMENTS

- A. Maintain on Site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, product data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record, at each product Section, description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates used.
 - 3. Changes made by Addenda, bulletin, Change Order, and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction as follows:
 - 1. Include Contract modifications such as Addenda, supplementary instructions, change directives, field orders, minor changes in the Work, and change orders.

2. Include locations of concealed elements of the Work.
3. Identify depth of buried utility lines and provide dimensions showing distances from permanent facility components that are parallel to utilities.
4. Dimension ends, corners, and junctions of buried utilities to permanent facility components using triangulation.
5. Identify and locate existing buried or concealed items encountered during Project.
6. Measured depths of foundations in relation to finish main floor datum.
7. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
8. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
9. Field changes of dimension and detail.
10. Verification of dimensions built according to original Drawings.
11. Details not on original Drawings.

G. Submit marked-up paper copy documents to Architect/Engineer before Substantial Completion.

H. Submit PDF electronic files of marked-up documents to Architect/Engineer before Substantial Completion.

1.11 OPERATION AND MAINTENANCE DATA

A. See Section 01 78 23.

1.12 MANUAL FOR MATERIALS AND FINISHES

A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect/Engineer will review draft and return one copy with comments.

B. For equipment or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes before Substantial Completion. Completed volumes, with Engineer comments, will be returned after Substantial Completion. Revise content of document sets as required prior to final submission.

D. Submit two sets of revised final volumes within 10 days after final inspection.

E. Submit in PDF composite electronic indexed file of final volumes within 10 days after final inspection.

F. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations.

G. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

- H. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Include recommendations for inspections, maintenance, and repair.
- I. Additional Requirements: As specified in individual product Specification Sections.
- J. Include listing in table of contents for design data, with tabbed fly sheet and space for insertion of data.

1.13 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit one copy of completed volumes before Substantial Completion. Completed volumes, with Architect/Engineer comments, will be returned after Substantial Completion. Revise content of document sets as required prior to final submission.
- D. Submit two sets of revised final volumes within ten days after final inspection.
- E. Submit in PDF composite electronic indexed file of final volumes within ten days after final inspection.
- F. Equipment and Systems: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- G. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications.
- H. Include color-coded wiring diagrams as installed.
- I. Operating Procedures: Include startup, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and special operating instructions.
- J. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- K. Include servicing and lubrication schedule and list of lubricants required.
- L. Include manufacturer's printed operation and maintenance instructions.
- M. Include sequence of operation by controls manufacturer.

- N. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- O. Include control diagrams by controls manufacturer as installed.
- P. Include Contractor's coordination drawings indicating installed color-coded piping diagrams.
- Q. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- R. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- S. Include test and balancing reports as specified in Section 014000 - Quality Requirements.
- T. Additional Requirements: As specified in individual product Specification Sections.
- U. Include listing in table of contents for design data with tabbed dividers and space for insertion of data.

1.14 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Furnish spare parts, maintenance, and extra products in quantities specified in individual Specification Sections.

1.15 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible Subcontractors, suppliers, and manufacturers within ten days after completion of applicable item of Work.
- B. Execute and assemble transferable warranty documents and bonds from Subcontractors, suppliers, and manufacturers.
- C. Verify documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Include table of contents and assemble in three D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time of Submittals:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.

2. Make other submittals within ten days after date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.16 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in Specification Sections during warranty period.
- B. Examine system components at frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.
- D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of Owner.

1.17 FINAL CLEANING

- A. Execute final cleaning prior to final Project assessment.
 1. Employ experienced personnel or professional cleaning firm.
- B. Clean surfaces exposed to view; remove temporary labels, stains, and foreign substances; polish transparent and glossy surfaces.
- C. Clean equipment and fixtures to sanitary condition with appropriate cleaning materials.
- D. Clean Site; sweep paved areas.
- E. Remove waste and surplus materials, rubbish, and construction facilities from Site.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used

END OF SECTION 017000

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.

1.2 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in accordance with Section 01 30 00.
- C. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 14 days before commencing demonstration and training. Commissioning Authority will return copy with comments.
 - 1. Correct or revise each manual to comply with Commissioning Authority's comments. Submit copies of each corrected manual within 14 days of receipt of Commissioning Authority's comments and prior to commencing demonstration and training.
- D. Comply with Section 01 70 00 "Execution and Closeout Requirements" for schedule for submitting operation and maintenance documentation.

1.3 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
2. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.4 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual to contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.

9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.5 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.

2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.6 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
 1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.

- 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
 - F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.7 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds, as described below.
- C. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.

6. Demonstration and training video recording, if available.
 - E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
 - G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds in accordance with Section 01 90 00 "Warranties and Bonds".
 1. Include procedures to follow and required notifications for warranty claims.
 - H. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
- 1.8 PRODUCT MAINTENANCE MANUALS
- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
 - B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
 - C. Product Information: Include the following, as applicable:
 1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
 - D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
 - E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds in accordance with Section 01 90 00 "Warranties and Bonds".

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

PART 1: GENERAL

1.01 SCOPE:

- A. This section covers the demolition of the structures and appurtenances of the existing wastewater treatment plant screening facility which are to be removed as a result of the construction of the new facilities as shown on the Drawings.
- B. Blower facilities are to remain in operation during the construction of the new facilities as outlined on the Drawings. Blower no. 3 (BL-003) will not be in use when removed. When the Engineer determines the new blower to be operational, the Contractor shall tie the new blower into the existing header pipe to work in conjunction with the existing blowers as indicated in the drawings. Removed equipment and materials shall be removed or salvaged as approved by the Owner.

PART 2: PRODUCTS

- 2.01 There are no products or materials required by this section except for surface restoration requirements which are covered by other sections.

PART 3: EXECUTION

- 3.01 DEMOLITION SCHEDULE: Equipment scheduled for demolition includes but is not necessarily limited to the following items. See the Drawings for additional requirements. Contractor shall:
- A. EXISTING BLOWER AND ASSOCIATED PIPING AND EQUIPMENT: As shown on the Drawings, remove the blower no. 3 (BL-003), associated motor, control panel, conduits and electrical wiring. Remove all the piping, valves and appurtenances as indicated on the Drawings, existing slide gates, gate frames, operators, stems, and stem guides except for the gates in the lift station wet well. Remove the guides on the gates in the lift station wet well and replace with new and guides.
- 3.02 DISPOSAL: Contractor shall be responsible for removal and disposal of all equipment scheduled for demolition. The Owner shall be contacted and offered any equipment prior to disposal. Equipment to be retained by the Owner shall be removed and placed at a designated area on site for removal by the Owner. Disposal of concrete and debris from units which are to be removed completely shall be the responsibility of the Contractor.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork for cast-in-place concrete.
2. Shoring, bracing, and anchorage.
3. Form accessories.
4. Form stripping.

1.2 SUBMITTALS

A. Product Data: Manufacturer information on form materials.

B. Shop Drawings:

1. Formwork, shoring, and reshoring.
2. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
3. Means of leakage prevention for concrete exposed to view in finished construction.
4. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift, and height of drop during placement.
5. Vertical, horizontal, and special loads according to ACI 347.
6. Procedure and schedule for removal of shores and installation.

C. Manufacturer's Certificate: Products meet or exceed specified requirements.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.3 QUALITY ASSURANCE

A. Perform Work according to ACI 347, 301, and 318.

B. For wood products furnished for Work of this Section, comply with AF&PA.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318 to conform to applicable code requirements to achieve concrete shape, line, and dimension as indicated.

2.2 WOOD FORM MATERIALS

- A. Form Materials: At discretion of Contractor.

- B. Lumber Forms:

- 1. Applications: Edge forms and unexposed finish concrete.
- 2. Boards:
 - a. Description:
 - 1) Shiplapped or tongue and groove.
 - 2) Surface boards on four sides.
 - b. Material: "Standard" grade Douglas fir according to WCLIB Standard No. 17.

- C. Plywood Forms:

- 1. Application: Exposed finish concrete.
- 2. Description:
 - a. Comply with APA/EWA PS 1.
 - b. Panels: Full size.
 - c. Label each panel with grade trademark of APA/EWA.
- 3. Plywood with "Smooth Finish" Indicated on Drawings:
 - a. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."

2.3 PREFABRICATED FORMS

- A. Manufacturers:

- 1. EFCO - Economy Forms Corp.
- 2. Molded Fiber Glass Construction Products.
- 3. Sonoco Products Co.
- 4. Symons by Dayton Superior.
- 5. Wall-Ties & Forms, Inc.
- 6. Western Forms.
- 7. Substitutions: Permitted.

- B. Preformed Steel Forms:
 - 1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
 - 2. Minimum Thickness: 16 gage.
- C. FRP Forms: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- D. Tubular Column:
 - 1. Description: Round spirally wound laminated fiber.
 - 2. Surface Treatment: Release agent, non-reusable.
 - 3. Sizes: As indicated.
 - 4. Manufacturers:
 - a. EFCO - Economy Forms Corp.
 - b. Molded Fiber Glass Construction Products.
 - c. Sonoco Products Co.
 - d. Western Forms.
 - e. Substitutions: Permitted.
- E. Steel Forms:
 - 1. Description: Sheet steel, suitably reinforced.
 - 2. Design: For particular use as indicated.
- F. Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.
- G. Framing, Studding, and Bracing: Stud grade or better.

2.4 FORMWORK ACCESSORIES

- A. Form Ties:
 - 1. Type: Removable; cone.
 - 2. Material: Galvanized.
 - 3. Length: Fixed.
 - 4. Free of defects capable of leaving holes larger than 1-1/2 inches in concrete surface.
 - 5. Manufacturers:
 - a. Heckmann Building Products, Inc.
 - b. Symons by Dayton Superior.
 - c. Wall-Ties & Forms, Inc.
 - d. Substitutions: Permitted.
- B. Form Release Agent:
 - 1. Description: Colorless mineral oil that will not stain concrete or absorb moisture.
 - 2. Manufacturers:

- a. Architectural Concrete Chemicals, LLC.
 - b. Nox-Crete Products Group.
 - c. Substitutions: Permitted.
- C. Corners:
 - 1. Type: Chamfer, rigid plastic or wood strip.
 - 2. Size: 3/4 by 3/4 inches.
 - 3. Lengths: Maximum possible.
 - 4. Manufacturers:
 - a. BoMetals, Inc.
 - b. Wall-Ties & Forms, Inc.
 - c. Substitutions: Permitted.
- D. Vapor Retarder:
 - 1. Description: Polyethylene sheet.
 - 2. Thickness: 15 mils.
- E. Bituminous Joint Filler: Comply with ASTM D1751.
- F. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with formwork.
- B. Verify that dimensions agree with Drawings.
- C. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, request instructions from Engineer before proceeding.

3.2 INSTALLATION

- A. Earth Forms: Not permitted.
- B. Formwork:
 - 1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
 - 2. Positioning:
 - a. Verify horizontal and vertical positions of forms.
 - b. Correct misaligned or misplaced forms before placing concrete.

3. Complete wedging and bracing before placing concrete.
4. Erect formwork, shoring, and bracing to achieve design requirements according to ACI 318.
5. Stripping:
 - a. Arrange and assemble formwork to permit dismantling and stripping.
 - b. Permit removal of remaining principal shores.
6. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.
7. Install chamfer strips on external corners.
8. Do not reuse wood formwork more than 4 times for concrete surfaces to be exposed to view.
9. Do not patch formwork.
10. Leave forms in place for minimum number of days according to ACI 347.

C. Form Removal:

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads, and removal has been approved by Engineer.
2. Form Release Agent:
 - a. Apply according to manufacturer instructions.
 - b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
 - c. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.
3. Form Cleaning:
 - a. Clean formed cavities of debris prior to placing concrete.
 - b. Flush with water or use compressed air to remove remaining foreign matter.
 - c. During cold weather, remove ice and snow from within forms without using de-icing salts, and use compressed air or other dry method to remove foreign matter.
4. Reuse and Coating of Forms:
 - a. Thoroughly clean forms and reapply form coating before each reuse.
 - b. For exposed Work, do not reuse forms with damaged faces or edges.
 - c. Apply form coating to forms according to manufacturer instructions.
 - d. Do not coat forms for concrete indicated to receive "scored finish."
 - e. Apply form coatings before placing reinforcing steel.

D. Forms for Smooth Finish Concrete:

1. Use steel, plywood, or lined-board forms.
2. Install form lining with close-fitting square joints between separate sheets without springing into place.
3. Use full-sized sheets of form liners and plywood wherever possible.
4. Tape joints to prevent protrusions in concrete.
5. Apply forming and strip wood forms in a manner to protect corners and edges.

6. Keep wood forms wet until stripped.
- E. Framing, Studding, and Bracing:
1. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
 2. Distribute bracing loads over base area on which bracing is erected.
- F. Form Anchors and Hangers:
1. Do not use anchors and hangers leaving exposed metal at concrete surface.
 2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
 3. Penetration of structural-steel members is not permitted.
- G. Inserts, Embedded Parts, and Openings:
1. Install formed openings for items to be embedded in or passing through concrete Work.
 2. Locate and set in place items required to be cast directly into concrete.
 3. Provide temporary ports or openings at bottom of formwork as required to facilitate cleaning and inspection.
 4. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.
- H. Form Ties:
1. Provide sufficient strength and quantity to prevent spreading of forms.
 2. Place ties at least 1-1/2 inches away from finished surface of concrete.
 3. Leave inner rods in concrete when forms are stripped.
 4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.
- I. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.
- J. Construction Joints:
1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
 2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
 3. Appearance:
 - a. Show no overlapping of construction joints.
 - b. Construct joints to present same appearance as butted plywood joints.
- K. Embedded Items:
1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers and other features.
 2. Do not embed wood or uncoated aluminum in concrete.

3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

L. Openings for Items Passing through Concrete:

1. Frame openings in concrete where indicated on Drawings.
2. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
3. Coordinate Work to avoid cutting and patching of concrete after placement.
4. Perform cutting and repairing of concrete required as result of failure to provide required openings.

M. Screeds:

1. Set screeds and establish levels for tops of and finish on concrete slabs.
2. Slope slabs to drain as required or as indicated.

N. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.
2. Staking through membrane is not permitted.

O. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

- A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.

3.4 FIELD QUALITY CONTROL

A. Inspection:

1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
2. Notify Engineer after placement of reinforcing steel in forms but prior to placing concrete.
3. Schedule concrete placement to permit formwork inspection before placing concrete.

END OF SECTION 031000

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Reinforcing bars.
 2. Welded wire fabric.
 3. Reinforcement accessories.

1.2 SUBMITTALS

- A. Shop Drawings:
1. Bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel and welded wire fabric.
 2. Bending and cutting schedules.
 3. Supporting and spacing devices.
- B. Manufacturer's Certificate: Products meet or exceed specified requirements.
- C. Submit certified copies of mill test report of reinforcement materials analysis.
- D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.
- E. Source Quality-Control Submittals: Indicate results of tests and inspections.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Qualifications Statement:
1. Welders: Qualify procedures and personnel according to AWS D1.1.

1.3 QUALITY ASSURANCE

- A. Perform Work according to CRSI 10-MSP.
- B. Prepare Shop Drawings according to ACI SP-66.
- C. Welders: AWS qualified within previous 12 months for employed weld types.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store materials according to manufacturer instructions.
- B. Protection:
 - 1. Protect materials from moisture by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.5 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

- A. Reinforcing Steel:
 - 1. Comply with ASTM A615.
 - 2. Yield Strength: 60 ksi.
 - 3. Billet Bars: Deformed.
 - 4. Finish: Uncoated.
- B. Plain Wire:
 - 1. Comply with ASTM A1064.
 - 2. Finish: Uncoated.
- C. Welded Plain Wire Fabric:
 - 1. Comply with ASTM A1064.
 - 2. Configuration: Flat sheets.
 - 3. Finish: Uncoated.

2.2 FABRICATION

- A. Fabricate concrete reinforcement according to CRSI 10-MSP.
- B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups and tie hooks, and seismic hooks as indicated.
- C. Form reinforcement bends with minimum diameters according to ACI 318.

- D. Form ties and stirrups from following:
 - 1. Bars No. 10 and Smaller: No. 3 deformed bars.
- E. Weld reinforcement according to AWS D1.4.
- F. Splicing:
 - 1. If not indicated on Drawings, locate reinforcement splices at point of minimum stress.

2.3 ACCESSORY MATERIALS

- A. Tie Wire:
 - 1. Minimum 16 gage, annealed type.
- B. Chairs, Bolsters, Bar Supports, and Spacers:
 - 1. Size and Shape: To strengthen and support reinforcement during concrete placement conditions.

2.4 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.
- B. Certificate of Compliance:
 - 1. If fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
 - 2. Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Place, support, and secure reinforcement against displacement.
- B. Do not weld crossing reinforcement bars for assembly.
- C. Spacing:
 - 1. Space reinforcement bars with minimum clear spacing according to ACI 318.
 - 2. If bars are indicated in multiple layers, place upper bars directly above lower bars.
- D. Maintain minimum concrete cover around reinforcement according to ACI 318 as follows:
 - 1. Footings and Concrete Formed against Earth: 3 inches.

2. Formed Concrete Surfaces Exposed to Earth or Weather: 2 inches.
3. Supported Slabs, Walls, and Joists: 2 inches.
4. Beams and Columns: 2 inches.
5. Equipment Pads: 2 inches.

E. Splice reinforcing according to manufacturer instructions.

3.2 TOLERANCES

A. Install reinforcement within following tolerances for flexural members, walls, and compression members:

1. Reinforcement Depth Greater Than 2 inches:
 - a. Depth Tolerance: Plus or Minus 1/4 inch.
 - b. Concrete Cover Tolerance: Minus 1/4 inch.
2. Reinforcement Depth Less Than or Equal to 2 inches:
 - a. Depth Tolerance: Plus or Minus 1/4 inch.
 - b. Concrete Cover Tolerance: Minus 1/4 inch.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed by Owner's testing laboratory according to ACI 318.

B. Provide unrestricted access to Work and cooperate with appointed inspection and testing firm.

C. Reinforcement Inspection:

1. Placement Acceptance: Inspect specified and ACI 318 material requirements and specified placement tolerances.
2. Welding: Inspect welds according to AWS D1.1.
3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.
4. Weldability Inspection: Inspect for reinforcement weldability if formed from steel other than ASTM A706.
5. Continuous Weld Inspection: Inspect reinforcement according to ACI 318.
6. Periodic Weld Inspection: Inspect other welded connections.

END OF SECTION 032000

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide all materials and labor necessary to complete all concrete, plain and reinforced, as indicated or as specified in these specifications and as required to complete the Project. Work, without limiting the generality thereof, includes:
1. Installation of concrete to provide foundations, slabs, walls, and other incidental concrete Work.
 2. Concrete pads for mechanical equipment.
 3. Furnishing and installation of admixtures.
 4. Work of other trades required to be built into concrete, such as inserts for connections to steel members, anchors, embedded plates, and reinforcing dowels.
 5. Finishing of concrete as specified herein or as indicated.

1.2 SUBMITTALS

- A. Product Data: Submit data on the following:
1. Portland cement.
 2. Fly ash.
 3. Slag cement.
 4. Silica fume.
 5. Aggregates.
 6. Admixtures:
 - a. Include limitations of use, such as restrictions on cementitious materials, supplementary cementitious materials, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
 7. Curing materials.
 8. Repair materials.
- B. Design Mixtures: For each concrete mixture, include the following:
1. Mixture identification.
 2. Minimum 28-day compressive strength.
 3. Maximum water-cementitious materials ratio.
 4. Slump limit.
 5. Air content.
 6. Nominal maximum aggregate size.

7. Indicate amounts of mixing water to be withheld for later addition at Project Site, if permitted.
8. Submit intended placement method.
9. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
10. Submit separate mix designs if admixtures are required for the following:
 - a. Hot and cold weather concrete Work.

C. Qualification Data: Submit data for the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.

D. Shop Drawings:

1. Construction Joint Layout:
 - a. Indicate proposed construction joints required to construct structure.
 - b. Location of construction joints is subject to approval of Engineer.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer Instructions: Submit installation procedures and interfacing required for adjacent Work.

G. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.3 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer employing Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor certified as ACI Flatwork Concrete Finisher/Technician, or an ACI Concrete Flatwork Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer, or manufacturer-certified installers.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced manufacturing ready-mixed concrete products that complies with ASTM C94 requirements for production facilities and equipment.

- C. Concrete Testing Service: Employ and pay an independent testing laboratory, acceptable to the Owner, to perform material evaluation tests and to review concrete mix designs proposed by Contractor to conform to this Specification.
- D. Additional Testing and Inspection Services:
 - 1. If required, Owner's testing agency will perform additional testing and inspection services to verify conformance to Contract Documents as listed below:
 - a. Inspect concrete batching, mixing, and delivery operations.
 - b. Inspect forms, foundation preparation, reinforcement, embedded items, reinforcement placement, and concrete placing, finishing, and curing operations.
 - c. Sample concrete at point of placement and other locations as directed by Engineer and perform required tests.
 - d. Review manufacturer's report for shipment of cement and reinforcement, and conduct laboratory tests or spot checks of materials received for compliance with specifications.
 - e. Other testing or inspection services as required by Engineer.
 - 2. Provide Owner's testing agency with requested documentation and access to perform testing and inspection activities.

1.5 AMBIENT CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301, ACI 306.1, and as follows:
 - 1. Protect concrete Work from physical damage or reduced strength caused by frost, freezing actions, or low temperatures.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Concrete Source Limitations:
 - 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.

3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Concrete Components:

1. Cement:
 - a. Comply with ASTM C150, Type I or Type II.
 - b. Type: Portland.
2. Fly Ash: Comply with ASTM C618, Class C or F.
3. Silica Fume: Comply with ASTM C1240, amorphous silica.
4. Slag:
 - a. Description: Ground granulated, blast furnace.
 - b. Comply with ASTM C989.
 - c. Grade 100 or 120.
5. Normal Weight Aggregates:
 - a. Comply with ASTM C33 Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
 - b. Coarse Aggregate Maximum Size: 3/8 inch to 3/4 inch nominal.
6. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - a. Water-Reducing Admixture: ASTM C494, Type A.
 - b. Retarding Admixture: ASTM C494, Type B.
 - c. Water-Reducing and -Retarding Admixture: ASTM C494, Type D.
 - d. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
7. Water and Water Used to Make Ice: ASTM C94, potable.

2.3 VAPOR RETARDERS

A. Polyethylene Sheet: ASTM D4397; not less than 10 mils thick.

1. Manufacturers:
 - a. Carlisle Coatings & Waterproofing Inc.
 - b. Fortifiber Building Systems Group.
 - c. GCP Applied Technologies Inc.
 - d. ISI Building Products.
 - e. Raven Industries, Inc.
 - f. Reef Industries, Inc.
 - g. Stego Industries, LLC.
 - h. W.R. Meadows, Inc.

2. Substitutions: Permitted.

2.4 CURING MATERIALS

- A. Concrete Curing Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Concrete Curing Reusable Moisture-Retaining Covers, ASTM C171:
 1. Burlap-polyethylene sheet.
 - a. 10 oz. burlap laminated onto 5 mil white coated polyethylene.
 - b. Reusable, natural burlap provides moisture absorption.
 - c. Coated white poly reflects sunlight and intense heat rays.
 - d. Quality lamination between the two fabrics.
 2. Provide wet cure blankets comprised of a non-woven polypropylene fabric coated with a white-pigmented polyethylene, complying with ASTM C171; total thickness varies per manufacturer. Acceptable products are as follows:
 - a. HydraCure reusable, reflective wet cure blankets as manufactured by PNA Construction Technologies, thickness 40 mils.
 - b. Transguard 4000 as manufactured by Reef Industries, Inc., thickness 42 mils.
 - c. Konkure 80 as manufactured by Raven Industries, thickness 17 mils.
- C. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.
 1. Manufacturers:
 - a. Anti Hydro International.
 - b. ChemMasters, Inc.
 - c. Dayton Superior Specialty Chemicals.
 - d. Euclid Chemical Company (The); an RPM company.
 - e. Kaufman Products, Inc.
 - f. Lambert Corporation.
 - g. Laticrete International, Inc.
 - h. Nox Crete products group.
 - i. SpecChem, LLC.
 - j. TK Products.
 - k. Vexcon Chemicals Inc.
 - l. W.R. Meadows, Inc.
 2. Substitutions: Not permitted.
- D. Nonshrink Grout:
 1. Manufacturers:
 - a. CGM, Incorporated.

- b. Euclid Chemical Company (The); an RPM company.
 - c. Laticrete International, Inc.
 - d. QUIKRETE.
 - e. Sika Corporation.
 - 2. Substitutions: Permitted.
 - 3. Description: Premixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing agents.
 - 4. Comply with ASTM C1107.
 - 5. Minimum Compressive Strength: 2,000 psi in 48 hours and 6,000 psi in 28 days.
- E. Bonding Agent:
- 1. Manufacturers:
 - a. Euclid Chemical Company (The); an RPM company.
 - b. Metalcrete Industries.
 - c. QUIKRETE.
 - d. Sika Corporation.
 - e. W.R. Meadows, Inc.
 - 2. Substitutions: Permitted.
 - 3. Description: two-component modified epoxy resin. Provide epoxy resin base bonding systems complying with ASTM C881, Type V for bonding load-bearing fresh concrete to hardened concrete.

2.5 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.
 - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit maximum percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent by mass.
 - 2. Slag Cement: 50 percent by mass.
 - 3. Silica Fume: 10 percent by mass.
 - 4. Total of Fly Ash, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash not exceeding 25 percent by mass, and silica fume not exceeding 10 percent by mass.
 - 5. Total of Fly Ash and Silica Fume: 35 percent by mass, with fly ash not exceeding 25 percent by mass, and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use in accordance with manufacturer's written instructions.
 - 1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete.

2.6 CONCRETE MIXTURES

- A. Select proportions for concrete ACI 318 trial mixtures or field test data or both.
- B. Performance and Design Criteria:
 1. Compressive Strength: 3000 psi at 7 days.
 2. Compressive Strength: 4000 psi at 28 days.
 3. Cement Type: ASTM C150 Type I or Type II.
 4. Aggregate Type: Normal weight.
 5. Maximum Water-Cementitious Materials Ratio: 0.50 by weight.
 6. Aggregate Size:
 - a. Maximum: 3/8 inch to 3/4 inch.
 7. Air Content: Maximum 3 percent.
 8. Slump: 4 inches, plus or minus 1-1/2 inches.
- C. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C94.
- D. Site-Mixed Concrete: Mix concrete according to ACI 318.
- E. High Early Concrete Mix Proportions: Provide high early concrete as a preblended, prepackaged material requiring only the addition of water and stone aggregate.

2.7 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified. Delete references for allowing additional water to be added to batch for material with insufficient slump. Addition of water to the batch will not be permitted.
 1. Retempering of concrete by adding water or any other material is not permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify requirements for concrete cover over reinforcement.
- B. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

- A. Previously Placed Concrete:
 - 1. Prepare previously placed concrete by roughening where indicated on the Drawings, cleaning with steel brush and applying bonding agent.
 - 2. Remove laitance, coatings, and unsound materials.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels, and pack solid with non-shrink grout.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.

3.3 INSTALLATION

- A. Placing Concrete:
 - 1. Place concrete according to ACI 301.
 - 2. Notify testing laboratory, Owner and Engineer, minimum 24 hours prior to commencement of operations.
 - 3. Ensure that reinforcement, inserts and embedded parts are not disturbed during concrete placement.
 - 4. Polyethene Sheet:
 - a. Install polyethylene sheet where indicated on the Drawings.
 - b. Lap joints minimum 6 inches and seal watertight by taping edges and ends.
 - c. Seal penetrations in accordance with manufacturer's instructions.
 - d. Protect polyethylene sheet during placement of reinforcement and concrete.
 - e. Repairs:
 - 1) Repair polyethylene sheet damaged during placement of concrete reinforcement.
 - 2) Using vapor retarder material, lap over damaged areas minimum 6 inches.
 - 5. Deposit concrete at final position, preventing segregation of mix.
 - 6. Place concrete in continuous operation for each panel or section as determined by predetermined joints.
 - 7. Consolidate concrete.
 - 8. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
 - 9. Place concrete continuously between predetermined expansion, control, and construction joints.
 - 10. Screeding:
 - a. Screed concrete level.
 - b. Surface Flatness:

1) Maximum 1/4 inch in 10 feet.

B. Concrete Finishing:

1. Provide formed concrete surfaces to be left exposed with smooth-rubbed finish.
2. Finish concrete floor surfaces according to ACI 301.
3. Steel trowel surfaces indicated to be exposed.

C. Curing and Protection:

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Protect concrete from freezing for minimum of 7 days.
3. Maintain concrete with minimal moisture loss at relatively constant temperature for period as necessary for hydration of cement and hardening of concrete.
4. Cure floor surfaces according to ACI 301.

3.4 FIELD QUALITY CONTROL

A. Inspection and Testing: Performed by Owner's testing laboratory according to ACI 318.

B. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.

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

D. Concrete Inspections:

1. Continuous Placement Inspection: Inspect for proper installation procedures.
2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.

E. Strength Test Samples:

1. Sampling Procedures: Comply with ASTM C172.
2. Cylinder Molding and Curing Procedures:
 - a. Comply with ASTM C31.
 - b. Cylinder Specimens: Field cured.
3. Sample concrete and make one set of three cylinders for every 25 cu. yd. or less of each class of concrete placed each day, and for every 50 sq. ft. of surface area for slabs and walls.
4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch if less than five batches are used.
5. Make one additional cylinder during cold weather concreting and field cure.

F. Concrete Maturity Testing Using Sensors:

1. Non-destructive Test: Gather information from wireless embedded sensors recording temperature and strength.

2. Data is logged and/or retrieved by external device in real-time.
3. Comply with sensor manufacturer's written instructions and ASTM C1074, CSA A23.1/A23.2, ACI 318, ACI 228.1R, and ACI 306R.

G. Field Testing:

1. Slump Test Method: Comply with ASTM C143.
2. Air Content Test Method: Comply with ASTM C173.
3. Temperature Test Method: Comply with ASTM C1064.
4. Compressive Strength Concrete:
 - a. Measure slump and temperature for each sample.
 - b. Measure air content in air-entrained concrete for each sample.

H. Cylinder Compressive Strength Testing:

1. Test Method: Comply with ASTM C39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at 7 days.
4. Test one cylinder at 28 days.
5. Retain one cylinder for 56 days for testing when requested by Engineer.
6. Dispose of remaining cylinders if testing is not required.

I. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 48 hours of completion of floor finishing and promptly report test results to Engineer.

J. Patching:

1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. Honeycombing or Embedded Debris in Concrete:
 - a. Not acceptable.
 - b. Notify Engineer upon discovery.
3. Patch imperfections according to ACI 301.

K. Defective Concrete:

1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

END OF SECTION 033000

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop-fabricated metal items.
2. Bollards.
3. Structural supports for miscellaneous attachments.
4. Anchor bolts.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- B. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

PART 2 - PRODUCTS

2.1 BOLLARDS

A. Description:

1. Steel pipe, concrete filled.
2. Crowned cap.
3. Size: 6-inch diameter, length as indicated.
4. Finish: Galvanized.

B. Concrete Fill:

1. Minimum Compressive Strength: 4000 psi.
2. As specified in Section 033000 - Cast-in-Place Concrete.

C. Anchors: Concealed type as indicated.

2.2 STRUCTURAL SUPPORTS

A. Other Structural Supports:

1. Description: Steel sections, shape and size as indicated.
2. Finish: Galvanized.

2.3 ANCHORS

A. Description:

1. ASTM F1554; Grade 55, weldable.
2. Shape: Straight, threaded.
3. Furnish with nut and washer.
4. Finish: None.

B. Epoxy Adhesive Anchors:

1. Manufacturers:
 - a. Hilti, Inc.
 - b. Simpson Strong-Tie Co., Inc.
 - c. DeWalt, Inc. (Powers)
 - d. Substitutions: Not permitted.
2. Grout: As specified in Section 033000 – Cast-in-Place Concrete.
3. Threaded Rod for Galvanized Steel: Hot-dip galvanized steel, ASTM F1554 Grade 55.
4. Threaded Rod for Stainless Steel: Type 316 stainless steel.

2.4 MATERIALS

A. Steel:

1. Structural W Shapes: ASTM A992.
2. Structural Channels, Angles and Plates: ASTM A36.
3. Channels and Angles: ASTM A36.
4. Steel Plate: ASTM A36 unless noted otherwise; ASTM A572; Grade 50 where indicated.
5. Hollow Structural Sections: ASTM A500, Grade B.
6. Steel Pipe: ASTM A53, Grade B, Schedule 40 unless noted otherwise; Schedule 80 where indicated.
7. Sheet Steel: ASTM A653, Grade 33 Structural Quality.
8. Bolts: ASTM A325; Type 1.
9. Nuts: ASTM A563; heavy-hex type.
10. Washers: ASTM F436; Type 1.
11. Welding Materials: AWS D1.1; type required for materials being welded.

B. Stainless Steel:

1. Bars and Shapes: ASTM A276; Type 304.
2. Tubing: ASTM A269; Type 304.

3. Pipe: ASTM A312, welded; Type 304.
4. Plate, Sheet, and Strip: ASTM A240; Type 304.
5. Bolts, Nuts, and Washers: ASTM A354.
6. Welding Materials: AWS D1.6; type required for materials being welded.

C. Bolts, Nuts, and Washers for Equipment and Piping:

1. Carbon Steel:
 - a. Structural Connections: ASTM A325, hot-dip galvanized.
 - b. Anchor Bolts: ASTM A36, hot-dip galvanized.
 - c. Pipe and Equipment Flange Bolts: ASTM A193, Grade B-7.
2. Stainless Steel: Type 316 stainless steel, Class 2; ASTM A193 for bolts; ASTM A194 for nuts.

2.5 FABRICATION

- A. Fabricate items with joints tightly fitted and secured.
- B. Continuously seal joined members by continuous welds.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small, uniform radius.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- F. Fabrication Tolerances:
 1. Squareness: 1/4-inch maximum difference in diagonal measurements.
 2. Maximum Offset between Faces: 1/4 inch.
 3. Maximum Misalignment of Adjacent Members: 1/4 inch.
 4. Maximum Bow: 1/4 inch in 60 inches.
 5. Maximum Deviation from Plane: 1/8 inch in 60 inches.

2.6 FINISHES

- A. Steel:
 1. Galvanizing: ASTM A123; hot-dip galvanize after fabrication.
 2. Galvanizing for Fasteners, Connectors, and Anchors:
 - a. Hot-Dip Galvanizing: ASTM A153.
 3. Bolts, Nuts, and Washers: Hot-dip galvanized.

4. Touchup Primer for Galvanized Surfaces:

- a. ASTM A780.

B. Stainless Steel:

- 1. Satin-Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

- A. Supply steel items required to be cast into concrete or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

- A. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.
- B. Field-weld components only if indicated on Drawings.
- C. Perform field welding according to AWS D1.1.
- D. Obtain approval of Engineer prior to Site cutting or making adjustments not scheduled.

3.4 TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story or for every 10 feet in height, whichever is greater, non-cumulative.
- B. Maximum Variation from Level: 1/4 inch in 10 feet and 1/8 inch in 2 feet.
- C. Maximum Offset from Alignment: 1/4 inch.
- D. Maximum Out-of-Position: 1/4 inch.

3.5 FIELD QUALITY CONTROL

- A. Inspect welds according to AWS D1.1.

- B. Replace damaged or improperly functioning hardware.
- C. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.
- D. Touch up factory-applied finishes according to manufacturer-recommended procedures.

3.6 ADJUSTING

- A. Adjust operating hardware and lubricate as necessary for smooth operation.

END OF SECTION 055000

DIVISION 09 - FINISHES
SECTION 09 90 00
COATING SYSTEM FOR WASTEWATER FACILITIES

PART 1: GENERAL

1.01 SUMMARY:

- A. Section Includes: Field painting as shown and/or herein required. See specific items not requiring field painting under Work Not Included.
- B. In general, exposed surfaces of factory and/or shop-primed work that are delivered to Site without a final finish shall be painted. The shop priming and intermediate shop coatings shall not be considered as included in the number of field coats specified under Part 2, Field Painting Systems Article, Finish Paints paragraph in this Section.
- C. Ferrous metal surfaces, excluding stainless steel surfaces that will be exposed in the completed Work, shall be sandblasted either at the point of fabrication or under this Section prior to placement of primers. Field fabrication, including welds and cuts, shall be sandblasted, primed, and painted as herein specified.
- D. Ferrous metal items that will be in contact with precast concrete slabs, masonry, etc., shall be finish painted.
- E. Galvanized steel items that are not included under "Work Not Included," shall be prepared, primed, and finish painted as herein specified.
- F. Bruises, mars, and/or scratches in the shop painting due to handling, shall be immediately touched up in the field by CONTRACTOR prior to any storage or installation.
- G. Painting of piping includes pipe hangers, valves, and piping accessories, and also includes surfaces that will be in contact with piping supports. ALL PIPING SHALL BE COMPLETELY PAINTED.
- H. Existing surfaces shall be painted where shown and/or called for. Preparation for repainting and priming shall be as herein specified.
- I. Altered existing Work or damaged surfaces that are a result of the revisions shall be painted under this item of Work. The finishes shall match the existing adjacent coatings.
- J. When called for on the plan set concrete shall be coated with Raven 405 or approved equal per manufacturing requirement.
- K. Miscellaneous equipment shipped to Site with factory-applied coatings as follows, shall be painted under this Work as specified:
 - 1. No Factory Finish: Surface preparation, priming, and finish painting.
 - 2. Prime Coat: Surface preparation, touch-up, and finish painting.
 - 3. Intermediate Coat: Surface preparation, touch-up, and finish painting.
 - 4. Pre-finished Equipment: Touch-up as required. Equipment manufacturer shall furnish necessary touch-up paint.

5. Factory finish coats, not matching the approved finish colors, that are provided in lieu of the shop prime specified shall be properly prepared and receive a final field coat to match the adjacent related Work.
- L. Painting as called for on Drawings is for guidance only and does not limit the requirements for painting.
- M. **WORK NOT INCLUDED:** Unless specifically called for on Drawings or specified in this Section, the following are not included:
 1. Exterior exposed concrete surfaces and exposed concrete surfaces below the ground floor plan.
 2. Nonferrous metals and stainless steel, except copper and brass.
 3. Exterior aluminum siding.
 4. Non-exposed surfaces of treated lumber.
 5. Conduits below the main floor, except in rooms that are painted.
 6. Exterior gratings with a hot-dipped galvanized finish.
 7. Manufacturer's name and identification plates.
 8. All interior and exterior sealant and caulking unless adjacent to latex-coated surfaces and approved by ENGINEER.

1.02 DEFINITIONS:

- A. **POTABLE WATER USE DEFINED:** Paint or coatings in contact with water anywhere within the potable water system (including intake/treatment/storage/distribution), shall be tested and certified by the National Sanitation Foundation (NSF) or Underwriter's Laboratory (UL) as a protective (barrier) material as per ANSI/NSF Standard 61 (Listed Drinking Water System Components - Health Effects).

1.03 SUBMITTALS:

- A. **SHOP DRAWINGS:** Submit in accordance with Section 01 30 00, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 1. Listing of all materials proposed for use on Work, including designation of the area, primer required, or purpose.
 2. Specification data sheets included for each specific material proposed.
 3. Application instructions included for each specific material proposed.
 4. Color samples.
- B. Furnish ENGINEER, for approval, a schedule for all painting as called for on Painting Schedule and Piping Color Code and Identification subsection.
- C. **WARRANTY:** Submit in accordance with requirements of Section 01 90 00, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE:

- A. **SINGLE SOURCE RESPONSIBILITY:** Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

- B. CONTRACTOR'S RESPONSIBILITY: It shall be CONTRACTOR's responsibility to check the compatibility of painting materials proposed for this Contract. CONTRACTOR shall coordinate this Work with other trades to ensure compliance with these Specifications.
- C. Acceptability of materials and performance shall be determined by ENGINEER.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver materials to Site in manufacturer's original, unopened packages and containers, bearing manufacturer's name and label and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Federal Specification number, if applicable.
 - 4. Manufacturer's stock number and date of manufacture.
 - 5. Contents by volume for pigment and vehicle constituents.
 - 6. Thinning instructions.
 - 7. Application instructions.
 - 8. Color name and number.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45° F (7° C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.
- C. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.06 PROJECT CONDITIONS:

- A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50° F (10° C) and 90° F (32° C).
- B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45° F (7° C) and 95° F (35° C).
- C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85%, at temperatures less than 5° F (3° C) above the dew point, or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

PART 2: PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Painting Materials:
 - a. Carboline Co., St. Louis, MO 63144.
 - b. PPG Industries, Pittsburgh, PA 15222.
 - c. Sherwin-Williams Company, Cleveland, OH 44101.
 - d. Tnemec, North Kansas City, MO 64141.

2.02 MATERIALS:

- A. Painting materials shall be those as herein specified under "Field Painting Systems" Article.
- B. The specification designations, manufacturers and/or trade names herein are intended to establish a quality and standard for the materials used.
- C. Colors and sheen, where not specified, shall be selected by ENGINEER.
- D. Oil, turpentine, and other thinners used in the finishing Work shall meet the requirements of the latest appropriate ASTM.

2.03 FIELD PAINTING SYSTEMS:

- A. The following systems may vary from the coverages and mil thickness shown if recommended by paint manufacturer and approved in writing by ENGINEER. Number of coats shall be as required to obtain the mil thickness specified.
- B. If no pre-treatment is required by paint manufacturer, the surfaces shall be solvent cleaned (SSPC-SP1); otherwise the surfaces shall be pre-treated as follows:
 - 1. Non-submerged Galvanized Metal: Apply 1 brush coat of phosphoric acid.
 - 2. Nonferrous Metals: Apply 1 coat of a 2-component wash primer formulated with a zinc chromate pigmented polyvinyl butyral resin and phosphoric acid at a minimum of 0.3 dry mils and maximum of 0.5 dry mils thickness.
- C. FIELD PRIMING AND SEALING:
 - 1. Concrete and Concrete Block Primer and Sealer: Apply 1 coat of an approved material.
 - 2. Metal Primer: Apply 1 coat of a universal rust-inhibitive primer which can be used on both submerged and non-submerged ferrous metal and has the ability to accept alkyds, epoxy, vinyl, coal tar, chlorinated rubber, emulsion, coal-tar epoxies, epoxy ester, asphalt, and phenolic paints as finish coats. Apply at the rate of 1.5 dry mils or as recommended by manufacturer.
 - 3. Non-submerged Galvanized Metal Primer: If the finish paint required is self-priming, no primer is required. Otherwise, apply 1 coat of approved galvanized iron primer that will form a permanent bond coat for the finish coat.

4. Sealant for Bituminous Coated Surfaces: Apply 2.5 dry mils of synthetic alcohol-soluble resin and titanium pigment, or as recommended by manufacturer in writing and approved by ENGINEER.
5. Exterior Wood Primer: Apply 2.0 to 3.5 dry mils of an alkyd-linseed oil mildew-resistant film.
6. Interior Wood Primer: Apply 2.0 to 3.5 dry mils of an oil alkyd undercoater to wood that has a painted finish called for.

D. FINISH PAINTS:

1. Existing Painted Walls, Water-Base Acrylic Epoxy Coated: Apply 2 coats of a water-base acrylic epoxy at 2.0 to 2.5 mils per coat.
2. Interior Concrete Floors, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils minimum per coat. The second coat shall provide a nonslip surface.
3. Interior Concrete, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils minimum per coat.
4. Interior Concrete Curbs and Platforms: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils minimum per coat.
5. Interior Concrete where Hydrostatic Back-pressure is Determined, Latex Coated: Apply 2 coats of an acrylic latex finish at 2.0 to 3.0 dry mil minimum per coat.
6. Exterior Non-submerged Poured Concrete, Modified Epoxy Masonry Texture Coating: Apply 1 coat of a modified epoxy masonry texture coating at coverage of 70 to 90 square feet per gallon. Backroll to assure proper penetration into concrete.
7. Interior Concrete Block, Latex Coated: Apply an acrylic emulsion sealer or leveler coat and 2 coats of an acrylic latex finish at 2.0 to 3.0 dry mils per coat.
8. Interior Concrete Block, Epoxy Coated: Apply a modified epoxy sealer at the rate of 60 to 80 square feet per gallon, and 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils per coat.
9. Concrete, Epoxy Coated: When called for apply Raven 405 Epoxy or approved equal according to manufacturing requirement.
10. Interior Non-submerged Metal: In rooms and areas that have the walls finished with latex or alkyd paint, apply 2 coats of a medium to long alkyd resin finish at 2.0 to 3.5 dry mils per coat. All other items of interior non-submerged metal that are specified to be painted shall be finished by applying 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.
11. Exterior Non-submerged Metal, Polyurethane Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.5 to 3.5 dry mils, and 1 final coat of an aliphatic polyurethane enamel at 2.0 to 3.0 dry mils. The second coat shall have a color close to the final finish.
12. Non-Potable Submerged and Intermittently Submerged Metal, Coal-tar Epoxy Coated: Apply 2 coats of a coal-tar epoxy finish at 8.0 to 10.0 dry mils per coat.
 - a. Spray application is necessary to obtain required film thickness. Spray application shall be made in crosshatches to achieve required dry film thickness. Brush or roller application will require additional coats to obtain the required film thickness at no additional expense to OWNER. Additional coats to meet the dry film thickness requirements must be applied within 24 hours of application of first coat of coal-tar epoxy. CONTRACTOR shall provide adequate protection of adjacent areas to protect against overspray.
13. Potable Submerged and Intermittently Submerged Metal, Epoxy Coated: Apply 2 coats of an epoxy-polyamide or epoxy-polyamine system as approved by the NSF for potable water service conforming to AWWA D102 inside System No. 1.

14. Interior Wood, Alkyd Coated: Apply 2 coats of an alkyd resin finish at 2.0 to 3.0 dry mils per coat.
15. Interior Wood, Stained: Apply 1 coat of pigmented stain and 3 coats of varnish.
16. Exterior Wood, Stained: Apply 2 coats of pigmented stain.
17. Exterior Wood and Interior Fire-Protected Wood Latex Coated: Apply 2 coats of an acrylic latex finish at 2.0 dry mils minimum.
18. Exterior PVC, Vinylester, or Epoxy Resin Fiberglass: These non-submerged materials shall be painted the same system as for exterior non-submerged metal. Submerged and intermittently submerged materials shall be painted the same system as for submerged and intermittently submerged metal.
19. Interior PVC, Vinylester, or Epoxy Resin Fiberglass, Epoxy Coated: Apply 2 coats of a polyamide-cured epoxy resin finish at 2.0 to 3.0 dry mils per coat.
20. Insulated Piping, Acrylic Coated: Apply 2 coats of an acrylic enamel at 2.0 to 2.5 dry mils per coat.
21. Interior Plaster and Drywall, Latex Coated: Apply 1 coat of latex primer at 1.5 dry mils minimum, and 2 coats of an acrylic latex finish at 1.0 to 1.5 dry mils.
22. Interior Plaster and Drywall, Epoxy Coated: Apply 1 coat of latex primer at 1.5 dry mils, and 2 coats of polyamide-cured epoxy finish at 2.0 to 2.5 dry mils per coat.
23. Exterior Plaster, Latex Coated: Apply 1 coat of a modified epoxy masonry texture coating at the rate of 80-100 square feet per gallon, and 1 coat of an acrylic latex finish at 2.0 to 3.0 dry mils.

2.04 PIPING COLOR CODE AND IDENTIFICATION:

- A. CONTRACTOR shall furnish ENGINEER for approval, prior to commencing any painting, a Schedule showing colors and markings proposed.
- B. Paint color and identification nomenclature shall be per owner schedule which shall be provided prior to construction. CONTRACTOR shall contact ENGINEER for an approved color and appropriate name if no designation is Scheduled.
- C. Pipe markings and banding shall be placed on exposed pipe by stenciling or other method as approved by ENGINEER. The markings shall include an appropriate name and direction of flow arrow. The markings shall be located at intervals not to exceed 15 feet and shall occur at least once in every room unless otherwise approved by ENGINEER. Letters and arrows shall be white-on-dark colored surfaces and black-on-light colored surfaces, shall be proportioned to the size of the pipe, and shall be located in an area that will facilitate readings.

Size of Identification Letters	
Outside Diameter of Pipe or Covering (inches)	Size of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
over 10	3-1/2

PART 3: EXECUTION

3.01 WORKMANSHIP:

- A. Workmanship shall be of the best grade with materials evenly spread and smoothly flowed on, without runs or sagging of materials. No adulterations or changes of proportions shall be permitted unless recommended by manufacturer and approved by ENGINEER. Paint shall be applied in strict conformity with the manufacturer's directions.

3.02 EXAMINATION:

- A. It is the responsibility of the painter to thoroughly inspect all surfaces prior to the commencement of Work to determine if the Work is ready to be prepared and painted.
- B. Report in writing to ENGINEER, all conditions that may potentially affect the application.
- C. Do not commence until such defects have been corrected.
- D. Start of painting shall be construed as the applicator's acceptance of surfaces and conditions within a particular area.

3.03 PREPARATION:

- A. **GENERAL PROCEDURES:** Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in places that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, removed items shall be reinstalled by workers skilled in the trades involved.
 - 1. Clean surfaces before applying paint or surface treatments. Remove oil and grease prior to cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- B. **SURFACE PREPARATION:** Prior to applying specific finishes, exposed surfaces requiring field painting shall be properly filled, scraped, sanded, etched, brushed, and/or cleaned as required to provide surfaces free from dirt, loose crystals, rust, scale, oil, and grease.
 - 1. Surfaces shall be prepared in accordance with manufacturer's recommendations. Surfaces shall be inspected and accepted by CONTRACTOR before coatings are applied.
 - 2. No change in treatment of surfaces shall be permitted unless recommended by manufacturer and approved by ENGINEER.
- C. **CEMENTITIOUS MATERIALS PREPARATION:** Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforcement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen, as required, to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - 1. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.

2. Cementitious Work shall be cured at least 28 days before painting.
3. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
4. Hidden dampness (moisture content) shall be checked by using a polyethylene cover test. A heavy gauge plastic film, approximately 18 inches square and 4 mils thick, is securely taped to a small section of the concrete. Pieces of test film should be placed at various locations not exposed to direct sunlight that are likely to be slow drying, such as below grade, low spots in floors, inside corners, and lower wall areas. The polyethylene sheet is checked after 24 hours for beads of moisture. If condensation appears on the back side of the film, or if the concrete under the film appears to be darker, damp or wet, this indicates the presence of moisture in the concrete. Painting shall not be performed until no condensation exists after the 24-hour test period.
5. Steel troweled surfaces shall be acid etched to a "fine sandpaper" finish with a muriatic solution of approximately 10 to 15 percent. Flush the floor with clean water to remove acids, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
6. Surfaces formed by smooth formwork shall be whipped (brush-off) sandblasted to remove all slag, laitance, form release agents, rough edges, and open air holes. All bug holes shall be filled with non-shrink, nonmetallic grout.

D. METALS PREPARATION: Submerged ferrous metals shall have all welds ground smooth to remove spatter, recesses, pinholes, and protrusions. Metal shall be degreased in accordance with SSPC-SP1 and abrasive blast cleaned in accordance with SSPC-SP10, "Near White Abrasive Blast Cleaning."

1. Non-submerged ferrous metals shall be degreased in accordance with SSPC-SP1 and sandblasted in accordance with SSPC-SP6, "Commercial Abrasive Blast Cleaning."
2. Nonferrous and galvanized metals shall be degreased in accordance with SSPC-SP1.
3. Submerged galvanized metals shall not be treated.
4. Steel surfaces that are to be repainted shall be commercial blast cleaned in accordance with SSPC-SP6 until at least 2/3 of each element is free of all visible residues.

E. WOOD PREPARATION: Wood surfaces to be finished shall be clean, dry, smooth, warm, and in proper condition to receive the finish. Remove surface deposits of sap or pitch by scraping and wiping clean with mineral spirits. Spot coat knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after the primer has dried and sand between coats. Back-prime interior and exterior woodwork.

F. PVC AND FRP PREPARATION: No special surface treatment is required. Surface shall be clean and dry.

G. DRYWALL CONSTRUCTION: Joint compound material shall be sanded to provide a smooth flat surface. Remove dust from surface by wiping with clean rags or other means.

3.04 PRE-TREATMENT OF METAL:

- A. Non-submerged galvanized metal and nonferrous metal shall be pre-treated. The galvanized pre-treatment shall be allowed 30 minutes for reaction to take place, then the residue shall be removed with a water rinse.

3.05 FIELD PRIMING AND SEALING:

- A. In general, metal surfaces requiring field painting shall receive a priming coat before shipment from the shop. Such priming coats shall be compatible to subsequent applied coats.
 - 1. Wherever Work requiring field painting bears no priming coat, or has a damaged shop coat, it shall have the surface prepared as specified and shall receive an approved priming coat, applied before and in addition to the finish coats required.
 - 2. Concrete surfaces, requiring field painting, shall be primed and sealed if recommended by the manufacturer of the finish paint.

3.06 PAINT MATERIALS PREPARATION:

- A. Carefully mix and prepare paint materials in accordance with manufacturer's directions.
 - 1. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density; stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.07 TINTING:

- A. Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.08 APPLICATION:

- A. **FIRST FIELD COAT:** The first field coat shall be the best suited for use with the surfaces to be covered and with the final coats. Whenever the finish color permits, the first coat shall be slightly tinted to the end that complete coverage of the final coat may be assured.
- B. **FINISH COATS:** Apply in a uniform manner and of the mil thicknesses as specified. Where the mil thickness recommended by manufacturer is in conflict with that thickness specified, the proposed thickness shall be submitted in writing by manufacturer, supported by evaluative data sheets, subject to approval by ENGINEER. Where the mil thickness is omitted, it shall be as recommended by the manufacturer to give an excellent surface finish. Finished surface thickness shall be subject to spot checking by ENGINEER using a wet and/or dry gauge. Deficiencies in required thickness shall be corrected by addition of extra coats at no additional cost to OWNER.
- C. **THINNERS:** Those recommended by manufacturer shall be used and the amounts shall not exceed recommendations by manufacturer.
- D. **CAUTION:** Paints shall not be applied on damp surfaces or on preceding coats not thoroughly dried, and shall not be applied on outside surfaces in extreme cold, frosty, foggy, or damp weather unless permitted by the materials manufacturer in the standard application specification. Materials shall not be applied when the temperature is below 50 degrees F. Drying time between coats shall be as recommended by paint manufacturer.

- E. **SPRAYING:** Spraying will be permitted only for such Work as approved by ENGINEER.
 - 1. Spraying equipment shall be of a type and capacity adapted to Work and shall be subject to ENGINEER's approval. Spraying equipment, including temporary rigid piping, flexible hose, nozzles, etc., shall be kept in such condition as will ensure against breakdowns and stoppage.
 - 2. Particular care shall be exercised to prevent the soiling or damaging of adjacent Work. Brushing shall immediately follow the spraying when necessary to eliminate wrinkling, blistering, and air holes.
- F. **PAINTING EXISTING SURFACES:** Repainted existing surfaces shall receive a finish to match the existing Work. Where the existing surfaces are irregular, they shall be made smooth with an approved leveler coat.

3.09 PROTECTION, SPECIAL PRECAUTIONS, AND CLEAN UP:

- A. Reasonable care shall be used to prevent splattering. Drop cloths and masking materials shall be used to protect surfaces and parts of equipment that are not required to be painted under the Contract. Splashes, drippings, and stains shall be thoroughly removed upon the completion of Work.
- B. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their Work after completion of painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- C. Lighting fixtures shall be covered and protected, or removed and replaced upon completion of Work. Electric switch plates, surface hardware, and similar equipment shall be removed, protected and replaced.
- D. Materials shall be stored and mixed in a well-ventilated location as designated or approved by ENGINEER. Paints and related materials shall be stored in an area that is protected in accordance with NFPA Bulletin No. 101. They shall be kept in a neat condition and shall be sealed or covered when not in use. Empty containers shall not be allowed to accumulate on the premises. Oily waste rags, etc., shall be collected each day and destroyed or stored in a tightly covered metal container.
- E. Comply with manufacturer's recommendations regarding environmental conditions under which coatings and coat systems can be applied.
- F. During surface preparation, CONTRACTOR shall take all precautions necessary to protect related Work. Equipment items and Work areas shall be tightly covered so as not to be damaged by the painting operation. Special attention shall be made to protect equipment items during sandblasting operations.
- G. CONTRACTOR shall be responsible for cleanup of painting materials upon completion of Work.
- H. As soon as painting Work is accepted by CONTRACTOR, it shall become its responsibility for protection, final cleaning, and touch-up.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: General administrative, procedural requirements, and installation methods for electrical installations specified in Division 16.
- B. The Drawings are schematic and are not intended to show every detail of construction.
 - 1. In general, conduits/raceways, transitions and offsets shown on Drawings indicate approximate locations in plan and elevation where the systems are intended to be run.
 - 2. CONTRACTOR shall fully coordinate electrical Work with other trades to avoid interferences.
 - 3. In the event of interferences, CONTRACTOR shall request clarification from ENGINEER in writing.
- C. Related Documents: Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to Work of this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with requirements of Section 01330, Shop Drawings covering the items included under this Section of Work. Shop Drawing submittals shall include:
 - 1. Submit product data covering the items included under this Section of Work.
- B. Conforming to Construction Drawings: Submit a complete set of Drawings showing the locations of the piping, ductwork, etc., as actually installed. Such Drawings shall be submitted to ENGINEER in electronic format (PDF), one full size print, and one 11x17 print.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01600, operation and maintenance manuals for items included under this Section. Include following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

1.03 RECORD DOCUMENTS

- A. Prepare Record Documents in accordance with requirements in Section 01770. In addition, CONTRACTOR shall submit, prior to final payment, Drawings conforming to construction records of systems it has installed. Vendor drawings shall be sized as manufacturers' standard.
- B. Provide typewritten data sheets on motor control circuits with following information on each branch feeder: Load name, horsepower or KVA (transformer), fuse size, starter size, service factor of motor, motor nameplate currents, power factor correction capacitor size (if used), and thermal overload part number.

1.04 QUALITY ASSURANCE

- A. National Electrical Code: Comply with NFPA 70, National Electrical Code.
- B. UL Compliance and Labeling: Use products and components labeled by UL.

1.05 PERMITS, INSPECTIONS, AND LICENSES

- A. CONTRACTOR shall procure all necessary permits and licenses, observe and abide by all applicable laws, codes, regulations, ordinances, and rules of the State, territory, or political subdivision thereof, wherein Work is done, or any other duly constituted public authority, and further agrees to hold OWNER harmless from liability or penalty which might be imposed by reason of an asserted violation of such laws, codes, regulations, ordinances, or other rules.
 - 1. Upon completion of Work, CONTRACTOR shall secure certificates of inspection from the inspector having jurisdiction and shall submit 3 copies of the certificates to OWNER. CONTRACTOR shall pay the fees for the permits, inspections, licenses, and certifications when such fees are required.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to Project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification. Equipment shall be packaged to prevent damage during shipment, storage, and handling. Do not install damaged units; replace, and remove damaged units from Site.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

- A. Provide electrical materials and equipment enclosures appropriate for areas in which they are installed. Each area will be designated on Drawings with a type of construction such as NEMA 4, 4X, 7 or 9 if it is other than NEMA 12. An area designated by a name and elevation includes space bounded by floor, ceiling, and enclosing walls.

1. Exception: Provide manufacturer's standard construction for indoor or outdoor application where equipment is not manufactured to NEMA specifications (e.g., switchgear, transformers, high voltage capacitors, bus duct, and light fixtures; materials and equipment used in finished areas such as offices, laboratories, etc.).
- B. Provide nonmetallic electrical materials and equipment enclosures in NEMA 4X areas; watertight NEMA 4 and equipment enclosures for outdoor applications and indoor applications below grade; explosion-proof NEC Class I, Division 1, Group D equipment for NEMA 7 areas; explosion-proof NEC Class II, Division 2, Group F equipment for NEMA 9 areas.
- C. Provide chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
- D. Supporting devices and sleeves shall be set in poured-in-place concrete and other structural components as they are constructed.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide maximum headroom possible. Locate light fixtures at approximately 8 feet above floor and where fixtures may be readily serviced.
- F. Install systems, materials, and equipment to conform with approved submittal data, including coordination Drawings, to greatest extent possible. Conform to arrangements indicated by Drawings recognizing that portions of Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to ENGINEER.
- G. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.
- H. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
- I. Install access panel or doors where units are concealed behind finished surfaces.
- J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.02 RACEWAY INSTALLATION

- A. Indoors, use the following wiring materials:
 1. Connection to Vibrating Equipment, including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: Liquidtight flexible metal conduit.
 - a. Exception: NEMA 7 or 9 areas require explosion-proof flexible conduit.
 2. Exposed Conduit: Rigid metal conduit or intermediate metal conduit.
 - a. Exceptions:
 - 1) Areas indicated as NEMA 4X, use rigid Schedule 40 PVC conduit.
 - 2) Areas indicated as NEMA 7 or NEMA 9 (such as grit and raw sewage rooms), use PVC externally coated rigid steel conduit.

- B. Minimum size conduit shall be 3/4 inch unless shown otherwise.
- C. Instrument Signal Conduit Requirements: Shielded signal wires for 4-20 mA type instruments or thermocouple wires assigned to the same control panel may be run in the same conduit. Shielded instrument signal wires, thermocouple wires, and shielded 2-wire intercom wires may be run in the same conduit. No other wires will be permitted in an instrument signal/2-wire intercom conduit. Conduit shall be RMC or PVC-coated RMC.
- D. Conduit Thread Paint: Make threaded conduit joints watertight by coating threaded portions with a spray-on or brush-on zinc-bearing paint. Provide paint containing 90 percent minimum by weight of metallic zinc powder in the dried film. Clean field-cut threads of oil using the recommended solvent prior to coating threads.
- E. Install expansion/deflection fittings where conduit passes a building expansion joint or where conduits are attached to two structures joined by a concrete expansion joint.
- F. Exposed or Concealed Construction: Install conduit exposed inside buildings except for areas with finished walls (e.g., offices, laboratories, lavatories, locker rooms, etc.) unless otherwise indicated.
- G. Exposed Raceways: Install parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. Make bends and offsets so the inside diameter is not effectively reduced. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. Conduits shall slope away from loads to keep moisture from entering the load. Run parallel or banked raceways together. Make bends in parallel or banked runs from the same centerline so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run, such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- H. Space raceways, fittings, and boxes 0.25 inch from mounting surface in NEMA 4 and NEMA 7 areas. Spacers shall be one-piece construction of stainless steel, galvanized steel, PVC, ABS, or other noncorrosive material.
- I. Sleeves: Install in concrete floor slabs except where conduit passes through a housekeeping pad. Install in exterior walls below grade.
- J. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid metal conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs with floor.
- K. Flexible Connections: Use short length (maximum 6 feet for lighting fixtures; maximum 3 feet for all other equipment) of flexible conduit for recessed and semi-recessed lighting fixtures,

equipment subject to vibration, noise transmission, or movement, and all motors. Use liquidtight flexible conduit in wet locations and rated flexible connections for hazardous locations. Install separate ground conductor across flexible connections.

- L. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- M. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate metal conduit, use threaded rigid metal conduit fittings. For PVC externally coated rigid metal conduit, use only factory-coated fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- N. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL listed sealing compound. For concealed raceways, install each fitting in a flush metal box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits enter or leave hazardous locations.
 - 2. Where conduits enter or leave NEMA 4X areas.
 - 3. Where required by the NEC.
- O. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- P. Install device boxes at the height above the floor as follows for:
 - 1. Light switches, 4 feet.
 - 2. Receptacles and telephone jacks, 18 inches except in NEMA 4 and 4X areas, 4 feet.
 - 3. Thermostats, 4'-0".
- Q. Avoid installing boxes back-to-back in walls. Provide not less than 6-inch (150 mm) separation.
- R. Position recessed outlet boxes accurately to allow for surface finish thickness.
- S. Fasten electrical boxes firmly and rigidly to substrates or structural surfaces to which attached, or solidly embed electrical boxes in concrete masonry.
- T. Provide fire-retardant barriers in all pull and junction boxes containing circuits that are otherwise continuously separated in conduit. Securely fasten these barriers within box. Size barriers so that space between barrier and box wall does not exceed 0.125 inch anywhere around the perimeter of barrier.
- U. Support exposed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, support at box and access fittings may be omitted where box or access fittings are

independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

- V. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from building structure.
- W. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box and tighten the chase nipples so no threads are exposed.
- X. Complete installation of electrical raceways before starting installation of conductors within raceways and prevent foreign matter from entering raceways by using temporary closure protection. Cap spare conduit. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- Y. Install pull wires in empty raceways: Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

3.03 WIRE AND CABLE INSTALLATION

- A. Use pulling means including fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.
- B. Keep branch circuit conductor splices to minimum. Splice feeders only where indicated. Use a standard kit. No splices are allowed for instrument and telephone cables except at indicated splice points.
- C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material and are UL listed as pressure type connectors.
- D. Provide adequate length of conductors within electrical enclosures and train conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at terminal.
- E. Terminate power conductors at equipment using pressure-type terminals specifically designed for type of terminations to be made. Terminate no more than 2 conductors No. 8 AWG and smaller within the same pressure-type terminal. These 2 conductors shall be no more than 4 wire gauge sizes apart. Terminate no more than 1 conductor larger than No. 8 AWG within any pressure-type terminal.
 - 1. Exception: Power factor correction capacitor conductors may be terminated at the motor disconnect switch load terminals.
- F. Seal wire and cable ends until ready to splice or terminate.

3.04 CUTTING AND PATCHING

- A. Perform cutting and patching in accordance with requirements in Section 01730. In addition, the following requirements apply.
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to uncover Work to provide for installation of ill-timed Work, remove and replace Work that is either defective or does not conform to requirements of Drawings.
 - 2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated including, but not limited to, removal of electrical items indicated to be removed and items made obsolete by new Work. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed. Provide and maintain temporary partitions or dust barriers adequate to prevent spread of dust and dirt to adjacent areas.
 - 3. Patch existing finished surfaces and building components using new materials matching existing materials.

3.05 EQUIPMENT CHECKOUT AND TESTING

- A. In addition to testing recommended by equipment or material supplier and called for in equipment or material specification, perform the following.

- B. Motor Testing: Motor insulation shall be tested by using a 500 VDC (minimum) megger and applying test until a constant megohm reading of the following magnitude is obtained:

$$R_{\min.} = 4 (KV + 1) \text{ at } 25 \text{ degrees C winding temp.}$$
$$R_{\min.} = IV + 1 \text{ at } 40 \text{ degrees C winding temp.}$$

1. If motors do not meet requirements of megger test, blow hot air through motors to dry out and repeat until test is passed. If desirable, drying can be done by applying an electrical potential to equipment. However, in no case, induced or direct, shall voltage or current exceed continuous rating of equipment being dried.
 2. After passing megger test, motors shall be hi-pot tested at 200 percent rated voltage for a minimum of 1 minute.
- C. Equipment Testing: The following tests which are applicable for a particular item of equipment shall be performed:
1. Megger bus work phase-to-phase and phase-to-ground. Minimum acceptable steady-state value is 100 megohms.
 2. Megger power circuit breakers and circuits supplied phase-to-phase and phase-to-ground (100 megohms minimum).
 3. Test current transformer circuits by applying current to secondary wiring at current transformer terminals until contactor trips.
 4. Test, time, and set protective relays. Relays shall be timed at various multiples (minimum of 3 points) of the pick-up value to determine agreement with published curves and adjust as necessary to agree with coordination study required settings. Exact tests to be performed vary with type of relay. Manufacturer's instructions for relay shall be complied with.
 5. After Work has been completed, demonstrate to OWNER's Representative that entire electrical installation is in proper working order and will perform functions for which it was designed by functional testing.
 6. Make any specific tests required by the manufacturer's installation instructions.
- D. Check-out Procedures. In general, check-out procedures (as listed below) which are applicable for a particular item of equipment shall be performed:
1. Vacuum interior of cubicles and remove foreign material.
 2. Wipe clean with a lint-free cloth insulators, bushings, bus supports, etc.
 3. Check and adjust time delay, under-voltage devices, phase relay, over-current relays, etc., as required by coordination study or ENGINEER.
 4. Fill motor bearings requiring oil.
 5. Check and change, as required, thermal overload heater elements to correspond with motor full-load current and service factors of installed motor.
 6. Check direction of rotation of motors and reverse connections if necessary. Check rotation with motor mechanically uncoupled where reverse rotation could damage equipment.
 7. Equipment with two or more sources of power connected by tie breakers, transfer switches, or generator receptacles shall be checked for rotation from each possible combination of power sources. Power sources must have the same phase sequence for each source throughout entire facility.
 8. Check exposed bolted power connections for tightness.
 9. Check operation of breakers, contactors, etc., and control and safety interlocks.

10. Check tightness of bolted structural connections.
11. Check leveling and alignment of enclosures.

12. Check operating parts and linkages for lubrication, freedom from binding, vibration, etc.
13. Check tightness and correctness of control connections at terminal blocks, relays, meters, switches, etc.
14. Clean auxiliary contacts and exposed relay contacts after vacuuming.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Low-Voltage Wire and Cable.
 - 2. Medium-Voltage Cable.
 - 3. Instrument Cable.
 - 4. Local Area Network Wiring (LAN).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Include Shop Drawings of wires, cables, connectors, splice kits, and termination assemblies.
- B. Reports of field tests prepared as noted in Section 01600.

1.03 QUALITY ASSURANCE

- A. UL Compliance: Provide components which are listed and labeled by UL. For cables intended for use in air handling space comply with applicable requirements of UL Standard 710, "Test Method for Fire and Smoke characteristics of cables used in Air Handling Spaces."
- B. NEMA/ICEA Compliance: Provide components which comply with following standards:
 - 1. NEMA WC 70-1999/ICEA S-95-658-1999, Nonshielded Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
 - 2. NEMA WC 71-1999/ICEA S-96-659-1999, Standard for Nonshielded Cables Rated 2,001-5,000 Volts for use in the Distribution of Electrical Energy.
- C. IEEE Compliance: Provide components which comply with the following standard.
 - 1. Standard 82, Test procedures for Impulse Voltage Tests on Insulated Conductors.
- D. Network Wiring Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of Local Area Network cable systems. Installation must include installation of Network cable, cable termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- E. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or typewritten onto adhesive labels. The font shall be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each Network cable segment shall be labeled at each end with its respective identifier.

- F. Network Wiring Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all Local Area Network cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- G. Patch Cords: Patch cords shall be provided for each Local Area Network port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed Local Area Network cable. Patch cord connectors shall be matched with patch panel connector type and network module connector type as required.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Low-Voltage Wire and Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. The Okonite Co.
 - d. Southwire Co.
 - 2. Connectors for Low-Voltage Wires and Cable Conductors:
 - a. AMP.
 - b. O-Z/Gedney Co.
 - c. Square D Company.
 - d. 3M Company.
 - 3. Medium-Voltage Cable:
 - a. American Insulated Wire Corp.
 - b. General Cable.
 - c. Kerite Co.
 - d. The Okonite Co.
 - e. Prysmian Cables & Systems.
 - f. Southwire Co.
 - 4. Medium-Voltage Cable Splicing and Terminating Products and Accessories:
 - a. Adelet-PLM.
 - b. Amerace Corp.
 - c. Electrical Products Division 3M.
 - d. G&W Electric Co.
 - e. M.P. Husky Corp.
 - f. Raychem Corp.
 - g. RTE Components.
 - 5. Instrument Cable:
 - a. Belden (Trade Nos. 1120A and 1118A).
 - 6. Local Area Network Cable:
 - a. Belden 7882A/7883A, or equal.

2.02 LOW-VOLTAGE WIRES AND CABLES

- A. Conductors: Provide stranded conductors conforming to ASTM Standards for concentric stranding, Class B. Construction of wire and cable shall be single conductor (1/c) unless multiconductor cable is shown by notation in form (x/c) where x indicates the number of separate insulated conductors per cable.
- B. Conductor Material: Copper. Minimum size power wire shall be No. 12 AWG.
- C. Insulation: Provide XHHW insulation for power conductors used in single- and 3-phase circuits.
 - 1. Provide XHHW insulation for grounding conductors installed in raceways.
 - 2. Provide THHN/THWN insulation for control conductors.

2.03 CONNECTORS FOR LOW-VOLTAGE WIRES AND CABLES

- A. Provide UL listed factory fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types, and classes for applications and services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

2.04 MEDIUM-VOLTAGE CABLE

- A. Cable shall be single-conductor type, size as indicated, and conforming to UL Standard 1072, "Medium Voltage Power Cables."
- B. Cable shall be ethylene propylene rubber (EPR) insulated and shall conform to NEMA Standard WC 74-2000 (ICEA S-93-639) "5-46 kV Shielded Power Cable for use in the Transmission and Distribution of Electrical Energy."
- C. Conductors: Class B stranded, annealed copper.
- D. Conductor Shield: Extruded, semiconducting.
- E. Insulation Shield: Extruded, semiconducting.
- F. Insulation: 133 percent insulation level.
- G. Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulation shield or evenly spaced solid copper wires applied concentrically over semiconducting insulation shield.
- H. Cable Jacket: Sunlight-resistant PVC, cross-linked polyolefin, or chlorosulfonated polyethylene (hypalon).
- I. Cable Voltage Rating: 8 kV phase to phase.

2.05 MEDIUM-VOLTAGE SPLICING AND TERMINATING PRODUCTS

- A. Types: Compatible with cable materials and shall be suitable for indoor or outdoor environments as required.
- B. Connectors: Compression type as recommended by cable or splicing kit manufacturer for application.
- C. Splicing and Terminating Kits: As recommended by manufacturer in writing for specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain components required for a complete splice or termination including detailed instructions and shall be the product of a single manufacturer. Completed splices and terminations shall provide insulation equivalent to the insulation class of cable it connects and maintain current carrying capacity and mechanical strength of cable.

2.06 INSTRUMENT CABLE

- A. Instrument Cable: 600 volt minimum insulated shielded cable with two or more twisted No. 16 or No. 18AWG stranded copper conductors; PVC, nylon, or polyethylene outer jacket; and 100 percent foil shielding.

2.07 LOCAL AREA NETWORK CABLE

- A. Category 6 (Ethernet) Data and Patch Cable:
 - 1. Paired, 4-pair, 24 AWG, solid bare copper conductors with polyethylene insulation, overall aluminum foil-polyester tape shield with 24 AWG stranded tinned copper drain wire, 100 percent shield coverage, PVC jacket.
 - 2. UL verified to Category 6.
 - 3. Provide plenum rated cable where installed exposed.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed 480 volt, 3-phase power circuits and higher wires and cables with a 1,000-volt megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable megohm meter reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to ENGINEER. Test reports shall include ambient temperature and humidity at time of testing. Notify ENGINEER 48 hours prior to test with schedule.
- B. Medium-Voltage Cable Tests shall include high-potential test of cable and accessories and such tests and examinations required to achieve specified objectives. Where new cables are spliced to existing cables, high-potential test shall be performed on the new cable prior to splicing. After test results for new cables are approved and splice is made, an insulation resistance test and continuity test on the length of cable including the splice with existing cables being tested to the nearest disconnect point.

- C. Local Area Network (LAN) Cable Tests: Testing of all cable segments shall be completed in compliance with EIA/TIA-568-B.1 Standards. Testing shall be done by CONTRACTOR with at least 5 years of experience in testing Network cabling systems.
1. TESTING: CONTRACTOR shall test each network cable segment. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER.
 2. DOCUMENTATION (Network Cable): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Network Cable Results: Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
 - a. Each cable installed shall undergo complete testing in accordance with TIA/EIA-568-B.1 to guarantee performance to this Standard.
 - b. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 - c. Test Criteria: Pass rate to conform to latest TIA/EIA-568-B.1 Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
 3. ACCEPTANCE: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and receipt of documentation.
- D. Reports (non-LAN cable): Testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit written reports to ENGINEER.

END OF SECTION

DIVISION 26 - ELECTRICAL
SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Electrical grounding and bonding Work as follows:
 - 1. Solidly grounded.

- B. Applications of electrical grounding and bonding Work in this Section:
 - 1. Metal building frames.
 - 2. Electrical power systems.
 - 3. Grounding electrodes.
 - 4. Separately derived systems.
 - 5. Raceways.
 - 6. Enclosures.
 - 7. Equipment.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. UL Compliance: Comply with applicable requirements of UL Standards No. 467, "Electrical Grounding and Bonding Equipment," and No. 869, "Electrical Service Equipment," pertaining to grounding and bonding of systems, circuits, and equipment. In addition, comply with UL Standard 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL listed and labeled for their intended usage.
 - 2. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141, and 142 pertaining to grounding and bonding of systems, circuits, and equipment.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING

- A. Materials and Components:
 - 1. Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials including, but not limited to, cables/wires,

connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2. Conductors: Electrical copper grounding conductors for grounding system connections that match power supply wiring materials and are sized according to NEC.
3. Grounding Electrodes: Steel with copper welded exterior, 3/4-inch diameter by 10 feet.
4. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. Connect grounding conductors to underground grounding electrodes using exothermic weld process or mechanical compression type connectors.
- B. Ground each separately derived system neutral to effectively grounded metallic water pipe, effectively grounded structural steel member, and separate grounding electrode.
- C. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- D. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.
- E. Connect building reinforcing steel, building steel beam, building steel roof and walls and duct bank and vault reinforcing steel to ground mat using No. 4/0 AWG bare copper grounding cable.
- F. Bond bare No. 4/0 AWG grounding cable in duct banks to grounding cable in vaults and to power equipment ground bus at ends of each duct bank.
- G. Bond strut and other metal inside of electrical manholes and vaults to bare No. 4/0 AWG grounding cable carried in duct bank.
- H. Bond grounding cables to both ends of metal conduit or sleeves through which such cables pass.
- I. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque-tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply

with tightening torque values specified in UL 486A to assure permanent and effective grounding.

- J. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible while following building lines to minimize transient voltage rises. Protect exposed cables and straps where subject to mechanical damage.

- K. Apply corrosion-resistant finish to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed and are subjected to corrosive action.

END OF SECTION

DIVISION 26 - GENERAL REQUIREMENTS
SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 013300, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.

1.03 QUALITY ASSURANCE

- A. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Slotted Metal Angle and U-Channel Systems:
 - a. Allied Tube & Conduit.
 - b. American Electric.
 - c. B-Line Systems, Inc.
 - d. Cinch Clamp Co., Inc.
 - e. GS Metals Corp.
 - f. Haydon Corp.
 - g. Kin-Line, Inc.
 - h. Unistrut Diversified Products.
 - 2. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Elliott Electric Mfg. Corp.
 - d. GS Metals Corp.
 - e. Killark Electric Mfg. Co.
 - f. Madison Equipment Co.
 - g. L.E. Mason Co.
 - h. O-Z/Gedney.
 - i. Producto Electric Corp.
 - j. Raco, Inc.
 - k. Red Seal Electric Corp.

- l. Spring City Electrical Mfg. Co.
- m. Thomas & Betts Corp.

2.02 COATINGS

- A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors, in NEMA 4 areas, or embedded in concrete shall be hot-dip galvanized.

2.03 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners. Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: Steel springhead type.
 - 3. Hanger Rods: 0.375-inch diameter minimum, steel.
- C. Conduit Sealing Bushings: Factory fabricated, watertight conduit sealing bushing assemblies suitable for sealing around conduit or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 12 gauge or 0.105-inch-thick steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacturer.

2.04 FABRICATED SUPPORTING DEVICES

- A. Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
- C. Pipe Sleeves: Provide a waterstop on pipe sleeves. Provide pipe sleeves of 2 standard sizes larger than conduit/pipe passing through it and of one of the following:
 - 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gauge metal for sleeve diameter noted:
 - a. 3-inch and smaller: 20-gauge.
 - b. 4-inch to 6-inch: 16-gauge.
 - c. Over 6-inch: 14-gauge.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe

PART 3 - EXECUTION

NOT USED

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including, but not limited to, the following:
1. Identification labeling for cables and conductors.
 2. Operational instruction signs.
 3. Warning and caution signs.
 4. Equipment labels and signs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product Data for each type of product specified.

PART 2 - PRODUCTS

2.01 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letter.
- B. Engraved, Plastic Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16 inch minimum thick for signs up to 20 square inches or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face and punched for mechanical fasteners.
- C. Baked Enamel Warning and Caution Signs for Interior Use: Pre-printed aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- D. Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, nonfading, pre-printed cellulose acetate butyrate signs with 20-gauge galvanized steel backing, with colors, legend, and size appropriate to location. Provide 1/4-inch grommets in corners for mounting.
- E. Fasteners for Plastic Laminated and Metal Signs: Self-tapping stainless-steel screws or Number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- F. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18 inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F. Provide ties in specified colors when used for color coding.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification Work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by Code.
- B. Install line marker for underground wiring, both direct buried and in raceway.
- C. Wiring Standards:
 - 1. 480/277 Volt, 3-Phase Power:
 - a. Brown.
 - b. Orange.
 - c. Yellow.
 - d. Grey Neutral.
 - 2. 208 Volt, 3-Phase Power:
 - a. Black.
 - b. Red.
 - c. Blue.
 - 3. 240/120 Volt, 1-Phase Power:
 - a. Black.
 - b. Red.
 - c. White Neutral.
 - 4. Motor Leads, Control Cabinet/MCC:
 - a. Black, numbered L1-T1, etc.
 - 5. Control Wiring:
 - a. Red Control circuit wiring that is de-energized when the main disconnect is opened.
 - b. Yellow Control circuit wiring that remains energized when the main disconnect is opened.
 - c. Blue DC.
 - d. Green Ground.
- D. Use conductors with color factory applied entire length of conductors except as follows:
 - 1. The following field applied color coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last 2 laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
 - b. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply 3 ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

- E. Power Circuit Identification: Securely fasten identifying metal tags of aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- F. Install wire/cable designation tape markers at termination points, splices, or junctions in each circuit. Circuit designations shall be as indicated on Drawings.

END OF SECTION

DIVISION 26 - ELECTRICAL
SECTION 26 05 73
COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Coordination Study detailing electrical system protection, protective equipment selectivity and arc flash hazard analysis studies.

The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed
8. Executive Summary including source of information and assumptions made

1.02 COORDINATION STUDY

- A. Include as part of Contract a complete Coordination and Short Circuit Study from incoming power lines through the high voltage switchgear, unit substations, and the motor control centers branch circuits. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Study shall include all coordinating curves with each fuse size, trip settings, and thermal overloads given for connected loads. Curves shall include feeder wire melting curves and transformer ANSI rating points. The study shall also include variable frequency drives for motors larger than 40 Hp, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear. Fuse sizes on motor control centers shall be those shown in Drawings throughout the short circuit and coordination study. Changes in loads from those shown on Drawings shall be incorporated in Study.
- B. Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors

< 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

- C. Studies shall be performed by a major electrical supplier (i.e., S&C, G.E., Westinghouse) local power company or equal. Study results shall be submitted to ENGINEER for approval.
- D. After approval all electrical equipment settings, thermal overloads, and fuses shall be made to conform to approved results. CONTRACTOR shall test all trip settings, time delays, and indicating devices on all switchgear, unit substations, and motor control centers. Tests shall be witnessed by ENGINEER.
- E. Data sheets for test are to be furnished by CONTRACTOR and shall be filled out showing the desired settings from Coordination Study and results obtained from witnessed test. Data sheets shall be signed by those performing test and witness. Test data sheets and motor list showing fuses, thermal overload sizes, etc. shall be submitted to ENGINEER as part of Contract.

1.03 ARC FLASH HAZARD ANALYSIS

PART 2 - PRODUCTS

2.01 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition. Transformer design impedances and standard X/R ratios shall be used when test values are not available.
- B. Provide the following information in the study report:
 - 1. Calculation methods and assumptions.
 - 2. Base per unit quantities.
 - 3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.
 - 4. Source impedance data, including electric utility system and motor fault contribution characteristics.
 - 5. Typical calculations and tabulations of calculated quantities.
 - 6. Results, conclusions, and recommendations.
- C. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
 - 1. Electric utility's supply termination point.
 - 2. Incoming switchgear.
 - 3. Unit substation primary and secondary terminals.
 - 4. Low voltage switchgear.
 - 5. Motor control centers.
 - 6. Standby generators and automatic transfer switches.
 - 7. Branch circuit panelboards.
 - 8. Other significant locations throughout the system.

- D. On grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short circuit ratings.
 - 2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.
 - 3. Adequacy of transformer windings to withstand short-circuit stresses.
 - 4. Cable and busway sizes for ability to withstand short-circuit heating.
 - 5. Notify Owner in writing, of existing circuit protective devices improperly rated for the calculated available fault current.

2.02 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.
- B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
- D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the curve sheets, where applicable:
 - 1. Electric utility's protective device
 - 2. Medium voltage equipment relays
 - 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 - 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 - 5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
 - 6. Conductor damage curves
 - 7. Ground fault protective devices, as applicable
 - 8. Pertinent motor starting characteristics and motor damage points
 - 9. Pertinent generator short-circuit decrement curve and generator damage point
 - 10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center
- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.03 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

- B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.
- C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- D. The Arc-Flash Hazard Analysis shall include all medium voltage and 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.
- E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.
- H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.04 REPORT SECTIONS

- A. Input Data:
 1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
 2. Short-circuit reactance of rotating machines with associated X/R ratios
 3. Cable type, construction, size, # per phase, length, impedance and conduit type
 4. Bus duct type, size, length, and impedance
 5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
 6. Reactor inductance and continuous ampere rating
 7. Aerial line type, construction, conductor spacing, size, # per phase, and length
- B. Short-Circuit Data:
 1. Source fault impedance and generator contributions
 2. X to R ratios
 3. Asymmetry factors
 4. Motor contributions
 5. Short circuit kVA
 6. Symmetrical and asymmetrical fault currents
- C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
 - a. Current transformer ratio.
 - b. Current setting.
 - c. Time setting.
 - d. Instantaneous setting.
 - e. Specialty non-overcurrent device settings.
 - f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground).
 - b. Adjustable time-current characteristic.
 - c. Adjustable instantaneous pickup.
 - d. Recommendations on improved trip systems, if applicable.
- D. Incident energy and flash protection boundary calculations.
 1. Arcing fault magnitude
 2. Device clearing time
 3. Duration of arc
 4. Arc flash boundary
 5. Working distance
 6. Incident energy
 7. Hazard Risk Category
 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 ARC FLASH WARNING LABELS

- A. The CONTRACTOR shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:
 1. Location designation
 2. Nominal voltage
 3. Flash protection boundary
 4. Hazard risk category
 5. Incident energy
 6. Working distance
 7. Engineering report number, revision number and issue date
- C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 1. For each 600, 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided.
 2. For each motor control center, two arc flash label shall be provided, one at each end of the motor control center.
 3. For each low voltage switchboard, one arc flash label shall be provided
 4. For each switchgear or unit substations, two arc flash label shall be provided, one at each end of the equipment or near each main breaker.

5. For each medium voltage switch, one arc flash label shall be provided.
- D. Labels shall be field installed by the electrical supplier performing the studies, local power company, or engineering service division of the equipment manufacturer during the Startup and Acceptance Testing.

3.02 ARC FLASH TRAINING

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION

DIVISION 26 - ELECTRICAL
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Product data for each type of product specified.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Sections 01600 and 13410, operation and maintenance manuals for items included under this Section, including circuits and motor disconnects.

1.02 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. Electrical Component Standards: Provide components which are listed and labeled by UL. Comply with UL Standard 98 and NEMA Standard KS 1.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Allen-Bradley.
 - 2. Appleton.
 - 3. Crouse-Hinds Co.
 - 4. Cutler-Hammer.
 - 5. Furnas Electric Co.
 - 6. General Electric Co.
 - 7. Siemens, Inc.
 - 8. Square D Company.

2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Provide NEMA 4, 4X, 7, 9, or 12 enclosure to match the rating of the area in which switch is installed. For motor and motor starter disconnects through 100 horsepower, provide units with horsepower ratings suitable to loads. For motor and motor starter disconnects above 100 horsepower, clearly label switch, "DO NOT OPEN UNDER LOAD."
- B. Non-fusible Disconnects: (Heavy-duty) switches of classes and current ratings as indicated.

2.03 ACCESSORIES

- A. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
1. Stainless Steel for NEMA 4 switches.
 2. Molded fiberglass-reinforced plastic for NEMA 4X switches.

PART 3 - EXECUTION

NOT USED

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Raceways for electrical wiring. Types of raceways in this Section include the following:
1. Intermediate metal conduit.
 2. Liquidtight flexible conduit.
 3. Rigid metal conduit.
 4. Conduit bodies.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for the following products:
 - a. Conduit.
 - b. Conduit bodies.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
 2. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering products which may be incorporated in Work include:
1. Conduit:
 - a. Allied Tube.
 - b. Carlon.
 - c. General Electric Co.
 - d. Johns Manville.
 - e. Occidental Coatings.
 - f. Orangeburg.
 - g. Perma-Cote Industries.
 - h. Republic Steel.
 - i. Robroy Industries.
 - j. Steelduct Co.

- k. Triangle Conduit.
- l. Wheatland Tube.
- m. Youngstown Sheet and Tube.
- 2. Liquidtight Conduit:
 - a. Anamet, Inc.
 - b. Carlon.
 - c. Electric-Flex.
 - d. Thomas and Betts.
- 3. Conduit Bodies:
 - a. Adalet-PLM.
 - b. American Electric.
 - c. Appleton Electric Co.
 - d. Carlon.
 - e. Crouse-Hinds Division, Cooper Industries, Inc.
 - f. Delta Industrial Products.
 - g. Killark Electric Mfg. Co.
 - h. Kraloy Products Co.
 - i. O-Z/Gedney Co.
 - j. Perma-Cote Industries.
 - k. Robroy Industries.
 - l. Spring City Electrical Mfg. Co.
- 4. Conduit Thread Paint:
 - a. CRC Chemicals, USA.
 - b. Sherwin Williams.
 - c. ZRC Chemical Products Co.

2.02 METAL CONDUIT AND TUBING

- A. Rigid Metal Conduit: ANSI C 80.1, hot-dip galvanized.
- B. Intermediate Metal Conduit: UL 1242, hot-dip galvanized.
- C. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

2.03 CONDUIT BODIES

- A. Provide matching gasketed covers secured with corrosion-resistant screws. Use cast covers in NEMA 4 areas and stamped steel covers in NEMA 1 and 12 areas. Use nonmetallic covers in NEMA 4X areas and threaded, ground joint covers in NEMA 7 and NEMA 9 areas.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies as follows:
 - 1. Rigid Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.
 - 2. Intermediate Metal Conduit: Use cast or malleable iron conduit bodies with zinc electroplating, aluminum enamel or lacquer finish, and threaded hubs.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 26 05 33.16 – BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other Sections. Types of products specified in this Section include:
1. Outlet and device boxes.
 2. Pull and junction boxes.
 3. Terminal boxes.
 4. Bushings.
 5. Locknuts.
 6. Conduit hubs.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings for floor boxes and boxes, enclosures, and cabinets that are to be shop-fabricated, (nonstock items). For shop-fabricated junction and pull boxes, show accurately scaled views and spatial relationships to adjacent equipment. Show box types, dimensions, and finishes.
 2. Product data for boxes, fittings, cabinets, and enclosures.

1.03 QUALITY ASSURANCE

- A. Codes and Standards:
1. UL Listing and Labeling: Items provided under this section shall be listed and labeled by UL.
 2. NEMA Compliance: Comply with NEMA Standard 250, "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
1. Outlet Boxes, Concealed Conduit System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Bell Electric, Square D Company
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.

- i. Thomas & Betts Co.
- 2. Outlet Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type JB, GS, or SHE.
 - b. Crouse-Hinds, Type GS or GRF.
- 3. Device Boxes, Concealed Conduit Systems:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric; Emerson Electric Co.
 - c. Bell Electric, Square D Company.
 - d. Eagle Electric Mfg. Co., Inc.
 - e. Midland-Ross Corp.
 - f. OZ/Gedney, General Signal Co.
 - g. Pass and Seymour, Inc.
 - h. RACO Div., Harvey Hubbell, Inc.
 - i. Thomas & Betts Co
- 4. Device Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 5. Junction and Pull Boxes, Concealed System:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. Appleton Electric, Emerson Electric Co.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Bell Electric, Square D Company.
 - e. GTE Corporation.
 - f. Keystone Columbia, Inc.
 - g. OZ/Gedney Co.; General Signal Co.
 - h. Spring City Electrical Mfg. Co.
- 6. Junction and Pull Boxes, Exposed Conduit System:
 - a. Appleton Electric, Type FS/FD.
 - b. Crouse-Hinds, Type FS/FD.
- 7. Terminal Boxes:
 - a. AMFCO.
 - b. Boss.
 - c. Hoffman.
 - d. Keystone.
 - e. Hope.
- 8. Bushings, Knockout Closures, Locknuts, and Connectors:
 - a. Adalet-PLM Div., Scott Fetzer Co.
 - b. AMP, Inc.
 - c. Arrow-Hart Div., Crouse-Hinds Co.
 - d. Appleton Electric Co., Emerson Electric Co.
 - e. Bell Electric; Square D Co.
 - f. Midland-Ross Corp.
 - g. Midwest Electric, Cooper Industries, Inc.
 - h. OZ/Gedney Co., General Signal Co.
 - i. RACO Div., Harvey Hubbell, Inc.
 - j. Thomas & Betts Co., Inc.

2.02 CABINETS, BOXES, AND FITTINGS - GENERAL

- A. Outlet Boxes: Suitable for the conduit system installation as follows:

1. Exposed Conduit: Provide cast or malleable iron, zinc, electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide the appropriate explosion-proof rating for outlet boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes where PVC-coated conduit is specified.
- B. Device Boxes: Suitable for the conduit system as follows:
 1. Exposed Conduit: Provide cast or malleable iron, zinc electroplated device boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs on device boxes.
 - a. Exception: Provide non-metallic outlet boxes for NEMA 4X areas. Provide appropriate explosion-proof rating for device boxes installed in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated device boxes where PVC-coated conduit is specified.
- C. Junction and Pull Boxes: Suitable for the conduit system installation as follows:
 1. Exposed Conduit: For pull and junction boxes 50 cubic inches and smaller, provide cast or malleable iron, zinc electroplated boxes finished with aluminum lacquer or enamel. Provide exterior mounting lugs and cast covers with neoprene gaskets. For pull and junction boxes larger than 50 cubic inches provide watertight sheet metal boxes. Grind exposed edges smooth or roll edges to prevent scuffing of wire during installation. Provide code-gauge sheet steel construction for boxes smaller than 1,000 cubic inches. Provide 0.10-inch steel construction, hot-dip galvanized after fabrication for boxes larger than 1,000 cubic inches. Secure box covers using No. 8 or larger machine screws spaced at intervals not exceeding 6 inches. Provide a continuous neoprene or rubber gasket cemented to the box cover where it contacts the box body.
 - a. Exceptions: Provide nonmetallic pull and junction boxes in NEMA 4X areas. Provide appropriate explosion-proof construction for boxes located in NEMA 7 and NEMA 9 areas. Provide factory PVC-coated boxes for areas where PVC conduit is used.
- D. Terminal Boxes: Provide compression lug type terminal strips in each terminal box with a minimum of 20 percent spare terminals. Provide appropriate NEMA enclosure rating for area in which terminal box is installed.
- E. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications. Provide watertight hubs on conduits terminated at sheet steel enclosures in NEMA 4 areas.

PART 3 - EXECUTION

NOT USED

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Product and installation requirements for the following:
1. Fiber-optic (FO) Cables.
 2. Fiber-optic Connectors, Couplers, and Patch Panels.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01330, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each type of product specified.
 2. Product certificates, signed by the communication system manufacturers, certifying that the cables are suitable for the connected equipment as described in "Quality Assurance" Article below.

1.03 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Connected Equipment Manufacturer Certifications: Where cables specified in this Section are used to provide signal paths for systems specified in other sections of these Specifications, or for systems furnished under other contracts, obtain review of the cable characteristics and certification for use with the connected system equipment by the connected equipment manufacturers.
- C. UL Compliance: For cables that may be run in plenum ceilings or other air-handling spaces, provide cables tested for compliance with applicable requirements of UL Standard 910, "Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air-Handling Spaces." In addition, provide FO cables that have passed the UL VW-1 flame test.
- D. EIA/TIA Compliance: Comply with applicable requirements of EIA Standards, EIA-440, -455, -458, -475, -509, -568-b.3, and 598-a pertaining to optical fiber cable and system component construction and installation. EIA/TIA-455-61, FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR.
- E. Fiber Optics Experience: CONTRACTOR must be able to prove to the satisfaction of OWNER that it has significant experience in the installation of fiber-optics cable systems. Installation must include installation of fiber-optics cable, fiber termination, knowledge of interconnect equipment, and a thorough knowledge of testing procedures.
- F. Labeling: Handwritten labels are not acceptable. All labels shall be machine printed on clear or opaque tape, stenciled onto adhesive labels, or type written onto adhesive labels. The font shall

be at least 1/8 inch in height, block characters, and legible. The text shall be of a color contrasting with the label such that it may be easily read. If labeling tape is utilized, the font color shall contrast with the background. Patch panels shall exhibit workstation numbers or some type of location identifier, in sequential order, for all workstations or devices attached. Each fiber-optics cable segment shall be labeled at each end with its respective identifier.

- G. Fiber-Optics Interconnect Equipment (Patch Panels): Interconnect equipment shall be used in all fiber cable installations. Patch panels shall be mounted in the equipment racks or panel mounted. Interconnect equipment mounted in racks shall be affixed to the rack by at least 4 screws. All fiber-optics interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations.
- H. Patch Cords: Patch cords shall be provided for each fiber-optic port on the patch panel. Patch cords shall meet or exceed technical specifications of all installed fiber-optic cable. Patch cord connectors shall be matched with patch panel connector type and network fiber module connector type as required.

1.04 COMMISSIONING

- A. Subsequent to hook-ups of FO system to signal sources and destination equipment, operate systems to demonstrate proper functioning. Replace malfunctioning FO cabling system items with new materials, and then retest until satisfactory performance is achieved.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. FO Cables:
 - a. Corning Infinicor SX+ Optical Fiber, or Equal, for multi-mode applications.
 - 2. FO Connectors and Couplers:
 - a. AMP Netcon.
 - b. AT&T Network Systems.
 - c. Corning.
 - d. Honeywell, Inc.
 - e. ITT Corp.
 - f. Thomas and Betts Corp.
 - 3. FO Patch Panels:
 - a. Panduit.
 - b. Volition.

2.02 OPTICAL FIBER CABLING SYSTEMS

- A. Fabricate system using manufacturer's standard materials as indicated by published product information and in sizes, types, and performance characteristics as indicated.
- B. FO Cables: Factory fabricated, single channel, all dielectric, low loss glass type, fiber-optic multimode graded-index cables with the following operational and construction features:

1. Multi-mode Fibers:
 - a. Cable Type shall be Corning FREEDM One Indoor/Outdoor Tight-Buffered Cable.
 - b. Number of Fibers: 6 minimum or as listed on Drawings.
 - c. Core Diameter: 50 microns or as listed on Drawings.
 - d. Cladding Diameter: 125 microns or as listed on Drawings.
 - e. Subunit Size: 2.0 mm or as listed on Drawings.
 - f. Maximum Attenuation: Less than 2.5 dB/850 nm.
 - g. Minimum Bandwidth: Greater than 500 MHz-km.
 - h. Minimum Bend Radius (Unloaded): 10 cm (3.1 in).
 - i. Operating Temperature Range: -20 to +70 degrees C.

- C. FO Connectors: Stainless steel, fiber-optic cable connectors, capable of terminating FO glass cables with diameters from 8 through 1,000 microns. Fabricate connectors with optical fiber, self-centering, axial alignment mechanisms. Select ST or SC style connectors as required or shown on Drawings. Connectors shall have an insertion loss of 0.5dB or better.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions with the Installer present for compliance with requirements, and other conditions affecting the performance of optical fiber cabling system. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 INSTALLATION

- A. Install fiber-optic cables and associated equipment and devices in accordance with industry standards and manufacturer's written instructions.
- B. Install fiber-optic cable without damage to fibers, cladding, or jacket. Ensure that media manufacturer's recommended pulling tensions are not exceeded. Do not, at any time, bend cables to smaller radii than minimums recommended by manufacturer.
- C. Install FO cables simultaneously where more than one cable is being installed in same raceway. Use pulling lubricant where necessary; compound used must not deteriorate cable materials. Do not use soap. Use a pulling means, including fish tape, rope, and basket-weave grips, that will not damage media or raceway.
- D. No splices are allowed, except at indicated splice points.

3.03 GROUNDING

- A. Provide grounding connections for other system components as required by manufacturer's written instructions.

3.04 APPLICATIONS

- A. Install optical fiber cabling for project applications as detailed on drawings.

3.05 FIELD QUALITY CONTROL

- A. Testing: Testing shall be done by CONTRACTOR with at least 5 years of experience in testing fiber-optic cabling systems. CONTRACTOR shall test each fiber strand. **OWNER reserves the right to have representation present during all or a portion of the testing process. CONTRACTOR must notify OWNER 5 days prior to commencement of testing.** If OWNER elects to be present during testing, test results will only be acceptable when conducted in the presence of OWNER. Any fiber-optic cable left non-terminated at the discretion of OWNER, shall be tested using an adequate light source to determine that all installed strands are not damaged.
- B. Fiber-Optics Cable: Each fiber strand shall undergo bi-directional testing for signal attenuation losses using power meter and light source. Testing shall also include Optical Time Domain Reflectometer (OTDR) at both 850 and 1,300 nanometers for all installed fiber strands.
1. Recommended Test Equipment:
 - a. Multimode: Siecor OM-100F and OS-100D or equivalent power meter and light source.
 - b. Multimode: Siecor OTDRPlus with appropriate modules for testing.
 2. Tests:
 - a. Multi-mode: Bi-directional signal attenuation at 850 and 1,300 nm.
 3. Test Criteria: Signal loss of less than 10 dB through entire fiber path, including cable, couplers and jumpers.
- C. Documentation (Fiber Optic): CONTRACTOR shall provide documentation to include test results and as-built Drawings. Fiber Test Results: The results of the fiber testing shall be entered into the form "Fiber Attenuation Tests Results." Handwritten results are acceptable provided the test is neat and legible. Copies of test results are not acceptable. Only original signed copies will be acceptable.
1. Each cable installed shall undergo complete testing in accordance with TIA/EIA TSB-67 to guarantee performance to this standard.
 2. All required documentation shall be submitted within 30 days at conclusion of the project to OWNER.
 3. Test Criteria: Pass rate to conform to latest TIA/EIA Standards that incorporate link performance testing through entire path, including cable, couplers, and jumpers.
- D. Acceptance: Acceptance of the Data Communications System, by OWNER, shall be based on the results of testing, functionality, and the receipt of documentation.

3.06 CLEANING

- A. Clean optical fiber cabling and components of dirt and construction debris upon completion of installation.

END OF SECTION

DIVISION 40 – PROCESS INTEGRATION
SECTION 40 05 00
COMMON WORK RESULTS FOR PROCESS INTEGRATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General administrative and procedural requirements for instrumentation installations. Administrative and procedural requirements are included in this Section to expand on requirements specified in Division 01.

1.2 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01 30 00, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Product data for each product specified.
 2. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field-installed wiring.
 3. Digital Systems: Provide the following:
 - a. Digital equipment layouts of input and output racks showing complete module model number and addressing assignment. Layouts of port pin assignment, connection schematic indicating cable types and port addresses.
 4. Software Programs: One fully annotated printed copy of program prior to factory test. In addition, provide required number of copies of latest revisions of program at time of acceptance by OWNER. Submittal of printouts, listings, and screen images shall be supplied on paper (hard copy). With concurrence of OWNER and ENGINEER, machine readable magnetic copies may be supplied in addition to printed copies as a matter of convenience. Format of magnetic media shall be as mutually agreed with OWNER.
 5. Programmable Logic Controllers: Submits lists of input and output assignments, data file structures used, and internal data points. Show points used to communicate with between PLCs and the operator interface and data collection segments. Include complete, fully annotated ladder logic diagrams complete with cross-reference listings.
 6. Operator Interface and Supervisory Control: Submit "screen dump" images of each proposed operator interface screen. Describe color schema, mouse button use, function key controls and communication protocol with PLCs. Provide a flow diagram showing screen navigation. Show sample event and alarm log outputs.
 7. Data Collection: Submit details of data structures, communications protocols, data exchange formats, sampling intervals, and file storage space management. Provide "screen dump" images of historical trending.
 8. Data Management and Reporting: Includes process data management, laboratory management, and reporting. Submit data definitions, customization of base software, data entry screens, menus, and report formats. Describe data entry, collection, and reporting scenarios. Describe data file storage management including backup and archive operations.
- B. Record Drawings: At Project closeout, submit record drawings of installed products, in accordance with requirements of Section 01 10 00.

1. Where Drawings are drafted by computer equipment, CONTRACTOR shall furnish files on a disk, thumb drive, or e-transmittal. These Drawings shall include changes made by Field Orders, Change Orders, Addenda, and errors discovered during start-up and acceptance.
 2. Drawings shall include terminal numbers at each wiring termination and piping termination. A complete system diagram shall be included.
- C. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 78 23, operation and maintenance manuals for items included under this Section.
1. Instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating equipment. Instructions shall include procedures for tests required, adjustments to be made, and safety precautions to be taken with equipment. These documents are to be submitted to ENGINEER's office.
 2. Provide 1 complete set of manufacturer's documentation covering programmable equipment supplied. Include hardware manuals and prints as manufacturer normally ships with programmable equipment.
 - a. Include complete software manuals for operating system, as well as manuals for any other software. Written instructions for the operations and maintenance of software shall be provided. The instructions shall be short, easy-to-understand directions specifically written for this Project describing various possible methods of operating software.
 - b. Include program listings, point/address lists, cross-reference listings, images of screens, data entry forms, and sample reports.
 - c. Manuals shall include instructions for program users and instructions for maintenance programmers.
- D. Warranty: Submit in accordance with requirements of Section 01 30 00, warranties covering the items included under this Section.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment, of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
1. National Electric Code.
 2. Applicable State and local requirements.
 3. UL listing and labeling shall be adhered to.
- C. Items covered by this Section are designated as undelivered specifically manufactured equipment for which associated progress payments will be made in accordance with this Specification.
- D. Equipment that does not have a UL, FM, CSA, or other listed testing laboratory label shall be furnished with a notarized letter signed by the supplier stating that equipment furnished has been manufactured in accordance with National Electric Code and OSHA requirements.
- E. CONTRACTOR shall provide permits and licenses, observe and abide by applicable laws, regulations, ordinances, and rules of State, territory or political subdivision thereof, wherein the

Work is done. CONTRACTOR shall pay fees for permits, inspections, licenses, and certifications when such fees are required.

- F. To ensure timely performance and conformance with Specifications, Project meetings shall be held at OWNER's facility once every 3 months during course of Project. Cost of such meetings shall be included.
- G. Calibration Equipment and Testing Apparatus: Equipment supplier shall have available test and calibration equipment for factory panel tests, installation, start-up, service contract, and maintenance or troubleshooting purposes.
 - 1. The equipment required for these tests is as follows:
 - a. One - Digital Multimeter with an accuracy of plus or minus 0.1 percent.
 - b. One - Signal calibrator for analog signals.
 - c. One - Programming terminal with software to configure programmable equipment.
- H. Component Requirements: For the purposes of uniformity and conformance to industry standards, signal transmission modes shall be either electronic 4-20 mA DC or pneumatic 3-15 psi only. No other signal characteristics are acceptable, except for remote temperature detector (RTD) and thermocouple (TC) sensing circuits; 4-20 mA DC signals shall be such that devices may be wired in parallel for 1-5 volt DC as required. 1-5 volt DC mode shall be employed only within control panel enclosures.
- I. Responsibility and Coordination: Drawings and Specifications are intended to include details of a complete equipment installation for purposes specified. CONTRACTOR shall be responsible for details which may be necessary to properly install, adjust, and place in operation complete installation. Any error on Drawings or in Specifications which prevents proper operation of supplied system shall be shown correct at time of Shop Drawing submittal for approval or brought to attention of ENGINEER with or prior to submittal.
- J. CONTRACTOR shall be responsible for costs incurred to correct aforementioned errors brought to ENGINEER's attention. CONTRACTOR shall assume full responsibility for additional costs which may result from unauthorized deviations from Specifications.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Manufactured material shall be adequately packed to prevent damage during shipping, handling, storage, and erection. Material shipped to Site shall be packed in a container properly marked for identification. Blocks and padding shall be used to prevent movement.
- B. CONTRACTOR shall inspect the material prior to removing it from carrier. If damage is observed, CONTRACTOR shall immediately notify carrier so that a claim can be made. If no such notice is given, material shall be assumed to be in undamaged condition; any subsequent damage that occurs to the equipment shall be the responsibility of CONTRACTOR. Repair and replacement of damaged parts will be done at no expense to OWNER.
- C. CONTRACTOR shall be responsible for any damage charges resulting from handling of materials.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPLIERS

- A. Subject to compliance with specified requirements, equipment suppliers shall be the following (no "or equals"):
 - 1. Motor City Technologies
 - 2. Commerce Controls
 - 3. CEC Controls
 - 4. Perceptive Controls
- B. References made in these Specifications to specific manufacturer's products are intended to serve as a guide to type, construction, and materials. Listing of a manufacturer does not imply acceptance by ENGINEER of a manufacturer's particular product, product line, or latest product revision if it does not meet Specifications.
- C. Equipment Supplier: Equipment specified under Section 40 and shown on Drawings shall be designed as a system, fabricated or purchased, shipped to Site, and started up by one of the qualified and approved equipment suppliers listed under this Section. Intent is for unit responsibility.
 - 1. Equipment supplier shall not assign any of its rights or delegate any of its obligations under these Sections without prior written acceptance by ENGINEER.
 - 2. Direct purchase of any items in these Sections by CONTRACTOR is not in compliance with this Specification and will not be permitted.
 - 3. When a Service Contract is included, it shall be performed by factory-trained personnel employed by equipment supplier. Equipment supplier shall assign a qualified Engineer employed by the supplier as Project Engineer/Project Manager.
 - a. Project Engineer/Project Manager's name shall be forwarded to CONTRACTOR and ENGINEER within 30 days after receipt of a purchase order by equipment supplier.
 - b. Project Engineer/Project Manager shall be focal point for design, fabrication, Contract communications, and shall be responsible for start-up and acceptance. Project Engineer/Project Manager shall be at factory test at Site for start-up and at the Site during entire acceptance procedure. Only qualified and approved equipment suppliers shall be accepted as meeting this Specification.

2.2 EQUIPMENT

- A. Transmitted electronic signals to equipment of other vendors and between control panels shall be a separate isolated-floating output for each item of equipment and shall conform to ISA Standard S50.1.
- B. Enclosures shall be NEMA 12, 4, 4X, or 7 as indicated on Drawings. Intrinsically safe systems, as approved by Factory Mutual, shall be furnished when called for.
- C. No external power connections shall be allowed unless specifically called for in Specification. Where an external power source is called for, unit shall accept 120 VAC, plus or minus 10 percent power.
- D. Current-to-current converters shall be used as power boosters to provide sufficient signal power as required. It is equipment supplier's responsibility to determine under what

circumstances and locations power boosters are required, provide them, and integrate them into the instrumentation system to make system function properly.

- E. Separate power supplies shall be totally enclosed with solderless terminals for connections. They shall be short circuit current limiting type that will automatically resume regulation after removal of short circuit. They shall operate from 120 volt AC, plus or minus 10 percent power. Regulated voltage shall be fixed. Units with internal trim potentiometers will be accepted.
 - 1. Pneumatic instruments shall have an input and output range of 3-15 psig. Units shall require a 20 psi supply. Provide an air set for each pneumatic unit or for each 20 psi manifold. Bubbler air sets, regulators, valves, etc., must be factory assembled on a subplate as specified and detailed.
 - 2. Instruments shall be panel-mounted or enclosed for wall mounting as shown on Drawings.
- F. Size and style of instruments are defined in Specifications. Pneumatic panel-mounted units shall match in appearance similar electronic components.
- G. Charts and scales are shown on Drawings. Standard scales shall not be accepted without ENGINEER's approval if it differs from those shown. Ratio station scales and other scales shall be graduated such that major graduations fall on whole numbers (i.e., 1, 2, 3, or 5, 10, 15, etc.) and minor graduations fall on 0.1 or 0.2 intervals (i.e., 1.1, 1.2 or 11, 12, etc.). If two scales are called for on ratio stations, each scale shall be indexed to meet Specification. Drawing of each scale for ratio stations shall be submitted with Shop Drawings for approval.
- H. Solid-state output switches, where used, shall be overvoltage transient protected and not be damaged by dI/dT or dv/dt for their design application under this Contract.
- I. Instruments shall be equipped with permanently attached identification tag. Tag shall be included on field- and panel-mounted devices. Tags shall include ENGINEER's tag identification and manufacturer's tag identification if different from ENGINEER's.
 - 1. Tags shall be either stamped metal or laminated phenolic with black letters engraved on a white background. Field-mounted devices shall have tags fastened with screws. Devices mounted in panels will be tagged inside panel on subplates or on device itself where it can be easily read.
- J. Finish on instruments and accessories shall provide protection against corrosion by elements in environment in which they are to be installed. Both the interior and exterior of enclosures shall be finished. Extra paint of each color used on material shall be provided by manufacturer for touch-up purposes.
- K. Provide equipment identification nameplates complying with Section 260553. Nameplates shall contain ENGINEER's item designation and, for indicators and transmitters, design range and units of device shown.

2.3 SOURCE QUALITY CONTROL

- A. Control and monitoring system control panels and computer equipment, if any, shall be tested at the factory and witnessed by ENGINEER prior to shipment to Site. ENGINEER shall be given 4 weeks notice before factory test date. Factory test shall include checking for conformity to Specifications, fabrication, and nomenclature. Control and monitoring system logic and

terminals shall be checked line by line and function by function in total for conformity of Drawings.

- B. Conduct preliminary testing prior to factory checkout by executing programs supplied for this Project. Exercise inputs to test logic for correct function and proper response of outputs. Verify correct interface with programs. Verify correct communications.
- C. Factory testing shall be used to validate fieldbus and plant LAN/WAN interconnections. Proper communication between devices and software components shall be demonstrated. Data Collection and Data Management Reporting shall be demonstrated.
- D. Equipment supplier shall have test equipment available at the factory. A full set of annotated logic programs and wiring diagrams with the latest revisions shall be made available to ENGINEER at factory for checking purposes. Drawings shall include wire numbers and terminal numbers.
- E. Control panels and programmable equipment shall not be shipped to Site until logic conforms to Contract requirements, physical changes required by testing are made, and tags conform to factory test corrections. Equipment delivered to Site without factory test or corrections will be returned to factory at CONTRACTOR's expense.
- F. Once the PLCs, etc., are connected at the equipment supplier's factory, and it has been demonstrated that the equipment properly communicates, the panels shall remain at the supplier's facility for 4 additional weeks to allow ENGINEER to check out the PLC software and operator interface software.
- G. Test Procedures:
 - 1. Hardware testing to verify system wiring, layout, workmanship, and appearance. Demonstrate correct function of inputs and outputs using a switch and lamp "mimic board." Perform a PLC load test to verify that outputs can be driven at full load simultaneously.
 - 2. Communications tests to verify inter-processor messaging via data highway, serial links, data management computer, and modems.
 - 3. Control logic tests begin with loading ENGINEER-developed ladder logic software. Control logic and sequences shall be tested and verified using a switch and lamp "mimic board."
 - 4. Operator interface integration test builds upon previously completed phases by exercising entire system from the data management computer.
- H. Provide services of PLC manufacturer's application engineer at factory test for 4 days.
- I. CONTRACTOR shall include in his Bid an amount, when the instrumentation system factory test facility in this Section is more than 80 miles from ENGINEER's Ann Arbor, Michigan office. CONTRACTOR shall pay transportation for weekly trips and lodging costs for 2 members of ENGINEER's staff over entire factory test.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer as approved by ENGINEER.
- B. Install equipment as indicated, in accordance with manufacturer's written instruction, and in compliance with recognized industry practices to ensure that products fulfill requirements.
- C. Elements that are supported by plumbing or piping, or that have only plumbing or piping connections shall be installed under those Sections.
- D. Plumbing, piping, or pneumatic signal connections to elements requiring such connections shall be made under those Sections. Control panels shall be installed in accordance with Division 16 Sections, with piping connections to control panels installed under Division 15 Sections.
- E. Drawings are not intended to show every detail of construction or location of piping, ductwork, or equipment. Where proper operation or construction makes it necessary or advisable to change location of piping, instrumentation equipment, air ducts, or other equipment, CONTRACTOR shall so inform ENGINEER for his approval and permission.

3.2 FIELD QUALITY CONTROL

- A. Calibrate equipment in accordance with manufacturer's instructions to ranges or set points indicated on Drawings.
- B. Installation and Start-up: Equipment supplier shall have an established service facility from which qualified technical service personnel and parts may be dispatched upon call. Such a service facility shall be no more than 6 hours travel time from Site.
 - 1. Equipment supplier shall provide an experienced, factory-trained, competent, and authorized service representative for a minimum of 3 times at the Site, including once during installation and start-up and once during acceptance to inspect, check, and calibrate any part of system. Supplier's service representative shall revisit Site for 8 hours per day as often as necessary after installation until trouble is corrected and equipment has passed acceptance test and is operating satisfactorily to ENGINEER.
 - 2. Third trip is after equipment has been accepted and shall be used to instruct OWNER's personnel in aspects of operation and maintenance, such as fuse locations, use of controls, instruction manuals, etc. Third trip shall be for duration of one 8-hour day at OWNER's facility.

3.3 DEMONSTRATION

- A. Upon completion of installation and calibration, demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at Site, then retest to demonstrate compliance; otherwise, remove and replace with new or repaired units, and retest to demonstrate compliance.

END OF SECTION

DIVISION 40 – PROCESS INTEGRATION
SECTION 40 05 07
SUPPORTS FOR PROCESS PIPING AND EQUIPMENT

PART 1 : GENERAL

1.01 SUMMARY:

A. SECTION INCLUDES:

1. Pipe hangers and supports
2. Hanger rods
3. Structural attachments
4. Pipe guides
5. Formed steel channel

B. RELATED REQUIREMENTS:

1. Section 03 30 00 - Cast-in-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this Section.
2. Section 09 90 00 – Coating System for Wastewater Facilities

1.02 REFERENCE STANDARDS:

A. AMERICAN SOCIETY OF MECHANICAL ENGINEERS:

1. ASME B31.1 - Power Piping

B. ASTM INTERNATIONAL:

1. ASTM A36 - Standard Specification for Carbon Structural Steel
2. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings
3. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality ASTM A181 - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

C. AMERICAN WELDING SOCIETY:

1. AWS D1.1 - Structural Welding Code Steel - Reference Manual

D. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY:

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacturer, Selection, Application, and Installation

1.03 COORDINATION:

- A. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.04 SUBMITTALS:

- A. SECTION 01 30 00 - SUBMITTALS: Requirements for submittals.
- B. PRODUCT DATA: Submit manufacturer's catalog data including load capacity.

1.05 MAINTENANCE MATERIAL SUBMITTALS:

A. SPARE PARTS:

1. Furnish two sets of manufacturer's recommended spare parts.

- B. TOOLS: Furnish special tools and other devices required for Owner to maintain.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. INSPECTION: Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.
- B. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.07 EXISTING CONDITIONS:

- A. FIELD MEASUREMENTS: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.08 WARRANTY:

- A. SECTION 01 90 00 – CONTRACT CLOSEOUT: Requirements for warranties.
- B. Furnish two-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.01 HANGERS AND SUPPORTS:

A. MANUFACTURER LIST:

- 1. Eaton Cooper Industries B-Line
- 2. Anvil International
- 3. Substitutions: Permitted upon approval of Engineer.

B. DESCRIPTION:

- 1. Conform to ASME B31.1.
- 2. Provide means of vertical adjustment after erection
- 3. Pipe Hangers:
 - a. ASTM A576, steel.
 - b. Allow for expansion and contraction of piping while eliminating undue stress on piping appurtenances and equipment.
 - c. Provide linkage to permit lateral or axial movement where anticipated.
 - d. Where horizontal pipe movement is greater than 1/2 in or where hanger rod deflection from the vertical is greater than 4° from cold to hot position of pipe, hanger rod and structural attachment shall be offset to maintain rod vertical in hot position.
 - e. Riser Supports: Support risers on each floor with riser clamps and lugs, independent of connected horizontal piping.
- 4. Pipe Supports:
 - a. Base Plate: Welded to vertical support, and attached to floor with anchor bolts.
 - b. Vertical Support: Provide means of vertical adjustment after erection.
 - c. Pipe Support: Saddle with yokes and u-bolt.
 - d. Material: SS 316 unless otherwise indicated on Drawings.
- 5. Flange Supports:
 - a. Base Plate: Welded to vertical support, and attached to floor with anchor bolts.
 - b. Vertical Support: Provide means of vertical adjustment after erection.
 - c. Flange Support: Plate with flange bolt attachments.
 - d. Material: SS 316 unless otherwise indicated on Drawings.

6. Valve Supports:
 - a. Base Plate: Welded to vertical support, and attached to floor with anchor bolts.
 - b. Vertical Support: Provide means of vertical adjustment after erection.
 - c. Valve Support: Plate shaped as required to support valve.
 - d. Material: SS 316 unless otherwise indicated on Drawings.

2.02 HANGER RODS:

A. HANGER RODS:

1. ASTM A576, steel.
2. Threaded both ends.
3. Diameter: ASME B31.1.

2.03 STRUCTURAL ATTACHMENTS:

A. CONCRETE INSERTS:

1. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
2. Size inserts to suit threaded hanger rods.

B. MOUNTING BRACKETS: ASTM A36 welded steel.

C. BEAM CLAMPS:

1. ASTM A36, steel; MSS SP-58.
2. Clamp Size: Based on load to be supported and load configuration.
3. Anchoring: Locknuts and cup-point set screws.
4. Reversible top or bottom flange.

D. RISER CLAMPS:

1. ASTM A36, steel.
2. Support of Copper Tubing: Provide copper-plated clamps.

E. OFFSET CLAMPS:

1. Double leg, two-piece.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify field dimensions as indicated on Drawings.

3.02 INSTALLATION:

- A. Do not drill or cut structural members.

B. PIPE HANGERS AND SUPPORTS:

1. Install according to: ASME B31.1.
2. Support horizontal piping as indicated on Drawings.
3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
7. Support riser piping independently of connected horizontal piping.

8. Design hangers for pipe movement without disengagement of supported pipe.
9. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
10. Use beam clamps where piping is to be suspended from building steel.
11. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
12. Use offset clamps where pipes are indicated as offset from wall surfaces.

C. INSULATION:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.

D. EQUIPMENT BASES AND SUPPORTS: As Indicated.

1. Provide housekeeping pads as detailed on Drawings.
2. Using templates furnished with equipment, install anchor bolts and accessories for mounting and anchoring equipment.

E. PRIME COAT:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 09 90 00 - Coating System for Wastewater Facilities.

END OF SECTION

PART 1: GENERAL

1.01 SUMMARY:

- A. Section Includes:
 - 1. Valves.
 - 2. Valve actuators.

1.02 REFERENCE STANDARDS:

- A. ASTM INTERNATIONAL:
 - 1. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 2. ASTM B84 - Standard Test Method for Temperature-Resistance Constants of Alloy Wires for Precision Resistors.
- B. AMERICAN WATER WORKS ASSOCIATION:
 - 1. AWWA C504 - Rubber-Seated Butterfly Valves.
 - 2. AWWA C541 - Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - 3. AWWA C542 - Electric Motor Actuators for Valves and Slide Gates.
 - 4. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
- C. NSF INTERNATIONAL:
 - 1. NSF/ANSI Standard 14 - Plastic Piping System Components and Related Materials.

1.03 COORDINATION:

- A. Coordinate Work of this Section with piping and appurtenances.

1.04 SUBMITTALS:

- A. SECTION 01 30 00 - SUBMITTAL PROCEDURES: Requirements for submittals.
- B. PRODUCT DATA:
 - 1. Submit data for actuator, with model number and size indicated.
 - 2. Submit valve cavitation limits.
- C. SHOP DRAWINGS:
 - 1. Provide assembly drawings indicating parts list, materials, sizes, position indicators, limit switches, control system, actuator mounting, wiring diagrams, and control system schematics.

- D. VALVE-LABELING SCHEDULE: Indicate valve locations and nametag text.
 - E. MANUFACTURER'S CERTIFICATE: Certify that products meet or exceed specified requirements.
- 1.04 CLOSEOUT SUBMITTALS:
- A. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS: Requirements for closeout procedures.
 - B. Record actual locations of valves and actuators.
- 1.05 MAINTENANCE MATERIAL SUBMITTALS:
- A. SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS: Requirements for maintenance materials.
 - B. SPARE PARTS:
 - 1. Furnish manufacturer's recommended spare parts.
- 1.06 QUALIFICATIONS:
- A. MANUFACTURER: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
- 1.07 DELIVERY, STORAGE, AND HANDLING:
- A. SECTION 01 00 20 – EQUIPMENT STIPULATIONS: Requirements for transporting, handling, storing, and protecting products.
 - B. Accept materials on-Site in original factory packaging, labeled with manufacturer's identification.
 - C. Protect from weather and construction traffic, dirt, water, chemicals, and damage by storing in original packaging.
- 1.08 EXISTING CONDITIONS:
- A. FIELD MEASUREMENTS: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.
- 1.09 WARRANTY:
- A. Section 01 90 00 - Requirements for warranties.

PART 2: PRODUCTS

2.01 VALVES

- A. Provide valves, operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.
- B. VALVE ENDS: Compatible with adjacent piping system.
- C. OPERATION: Open by turning counterclockwise; close by turning clockwise. Cast opening/closing directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.
- D. VALVE MARKING AND LABELING:
 - 1. Marking: According to MSS SP25.
 - 2. Labeling: As specified in Plans.
- E. VALVE CONSTRUCTION:
 - 1. Bodies: Rated for maximum temperature and pressure to which valve will be subjected as specified in the project manual and/or as shown on the drawings.
 - 2. Bonnets: Clamped, screwed, or flanged to body and of same material and pressure rating as body; provide glands, packing nuts, or yokes as specified in valve Sections.
 - 3. Stems and Stem Guides:
 - a. Of materials and with seals as specified in valve Sections.
 - b. Space stem guides 10 ft o.c.
 - c. Submerged Stem Guides: Type 304 stainless steel.
 - 4. Nuts and Bolts: According to Section 05 50 00 - Metal Fabrications.

2.02 VALVE ACTUATORS:

- A. Provide actuators with position indicators for shutoff valves 6 in. and larger; according to AWWA C5410.
- B. Provide chain actuators for shutoff valves mounted 7 ft above floor level.
- C. Provide gear and power actuators with position indicators.
- D. GEAR-ASSISTED MANUAL ACTUATORS:
 - 1. Provide totally enclosed gears.
 - 2. Maximum Operating Force: 60 lbf.
 - 3. Bearings: Permanently lubricated bronze.
 - 4. Packing: Accessible for adjustment without requiring the removal of actuator from valve.
 - 5. Butterfly Valves: According to AWWA C504.

- E. CHAIN ACTUATOR: Sprocket-rim chain wheels, chain guides, and hot-dip galvanized operating chain extending to 5-1/2 ft above floor level. Provide for chain storage where chains may interfere with pedestrian traffic.
- F. VALVE ACTUATORS IN NEC CLASS I, GROUP D, DIVISION 1 OR 2 HAZARDOUS LOCATIONS: UL approved.
- G. PNEUMATIC ACTUATORS: Provide isolating valves, filter regulators, pressure gages, and condensate drains.
- H. ELECTRIC MOTOR ACTUATORS:
 - 1. Electrical Characteristics: According to Section 26 05 00 – Common Work Results for Electrical: NEMA MG 1.
 - 2. Gearing: Single or double reduction unit; spur or helical gears and worm gearing; grease or oil lubricated in sealed housing.

2.03 INSULATION:

A. Manufacturers:

- 1. CSG.
- 2. Keene Corp., Fibrous Glass Board.
- 3. Owens/Corning Fiberglass, Type 705.

B. General:

- 1. Indoor Exposed Insulation shall be inorganic glass fibers pre-formed into rigid boards with a minimum density of 3.0 pcf with an all-service jacket facing. Insulation shall be impaled on pins, on flat surfaces, and cut in segments and bonded in place on irregular surfaces.
- 2. Joints and holes shall be sealed to form a completely vapor tight system.
- 3. All exposed ductwork shall be protected with a 0.016 aluminum jacket with aluminum bands.

2.05 FINISHES:

- A. VALVE COATING: According to AWWA C550.
- B. EXPOSED VALVES: According to Section 09 90 00 – Coating Systems for Wastewater Treatment Plants.
- C. Do not coat flange faces of valves unless otherwise specified.

2.06 ACCESSORIES:

- A. HANDWHEEL: Provide permanently attached handwheel for emergency manual operation.
 - 1. No rotation during powered operation.
 - 2. Permanently affix directional arrow and cast OPEN and CLOSE on handwheel to indicate the appropriate direction to turn the handwheel.

3. Maximum Operating Force: 40 lbf
4. Minimum handwheel diameter: 12 in.

2.07 SOURCE QUALITY CONTROL:

A. TESTING:

1. Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.
2. Certification of Valves Larger than 12 in: Certified copies of hydrostatic factory tests, indicating compliance with applicable standards.

B. CERTIFICATE OF COMPLIANCE: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

1. Specified shop tests are not required for Work performed by approved fabricator.

PART 3: EXECUTION

3.01 INSTALLATION:

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer's instructions.

B. Firmly support valves to avoid undue stresses on piping.

C. Coat studs, bolts, and nuts with anti-seizing lubricant.

D. Clean field welds to remove slag and splatter to provide a smooth surface.

E. Install valves with stems upright or horizontal, not inverted.

F. Install valves with clearance for installation of insulation and allowing access.

G. Provide access where valves and fittings are not accessible.

H. Flanged Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces insert gasket and bolts and tighten nuts progressively and uniformly.

I. Comply with Section 40 05 07 - Supports for Process Piping and Equipment for pipe hangers and supports.

J. Comply with Division 40 - Process Integration, for piping materials applying to various system types.

K. VALVE APPLICATIONS:

1. Install valves at locations as indicated on Drawings, according to this Section.
2. Install shutoff and isolation valves; isolate equipment, part of systems, or vertical risers, as indicated on Drawings.
3. Install valves for throttling, bypass, or manual flow control services, as indicated on Drawings.

L. Valve Installation and Orientation:

1. General:

- a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
- b. Install valves in location for easy access for routine operation and maintenance.
- c. Install valves per Manufacturer's recommendations.

2. Gate and Ball Valves:

- a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
- b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

3. Butterfly Valves:

- a. When butterfly valve actuation will result in the disc conflicting with adjacent valves, fittings, or equipment provide spool pieces to resolve conflicts and maintain proper clearances.
- b. When installed immediately downstream of a swing check valve, install valve with shaft perpendicular to swing check shaft.
- c. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.

4. Check Valves:

- a. Install valve in horizontal piping only for liquid services.
- b. Install swing check valve with shaft in horizontal position.

3.02 TESTS AND INSPECTION

- A. Valves may be either tested while testing pipelines, or as a separate step.

- B. Test that valves open and close smoothly under operating pressure conditions. Demonstrate that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Count and record number of turns to open and close valve, account for any discrepancies with manufacturer's data.
- D. Set, verify, and record set pressures for relief and regulating valves.
- E. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- F. Test hydrostatic relief valve seating, record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Labor, materials, and equipment necessary for fabrication, production, installation, and erection of the items specified in this Section and as shown on Drawings or on Valve Schedule on Drawings.
- B. Items furnished under this Section shall be erected per Section 40 05 07, Supports for Process Piping.

1.02 REFERENCES

- A. ANSI:
 - 1. B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, 250, and 800.
 - 2. B16.3, B2.1 Threaded Valve Joint Standards.
 - 3. B16-104 Reinforced Teflon Steel Standard.
- B. ANSI/AWWA:
 - 1. C110/A21.10 Ductile Iron and Gray Iron Fittings, 3-inch through 48-inch for Water and Other Liquids.
 - 2. C111/A21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
 - 3. C500 Metal Seated Gate Valves for Water Supply Service.
 - 4. C507 Ball Valves.
 - 5. C504 Rubber Seated Butterfly Valves, 3-Inch through 72-Inch.
 - 6. C508 Swing-Check Valves for Waterworks Service, 2-Inch Through 24-Inch
 - 7. C509 Resilient Seated Gate Valves for Water Supply Service.
 - 8. C512 Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - 9. C515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
 - 10. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves
 - 11. C530 Pilot Operated Control Valves
 - 12. C541 Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
 - 13. C542 Electric Motor Actuators for Valves and Slide Gates
 - 14. C550 Protective Interior Coating for Valves and Hydrants
- C. ASTM:
 - 1. A 48 Specification for Gray Iron Castings.
 - 2. A 126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 3. A 182/A 183M Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
 - 4. A 183 Specification for Carbon Steel Track Bolts and Nuts.

5. A 194/194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
6. A 276 Specification for Stainless and Heat Resisting Steel Bars and Shapes.
7. A 436 Specification for Austenitic Gray Iron Castings.
8. A 536 Specification for Ductile Iron Castings.
9. B 148 Specification for Aluminum Bronze Castings.
10. B 584 Specification for Copper Alloy Sand Castings for General Applications.
11. B 61 Specification for Steam of Bronze Castings.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01 30 00, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 1. Each valve, including accessories, shall be identified on Shop Drawings by its respective mark as noted on Valve Schedule.
- B. Operation and Maintenance Manuals: Submit in accordance with requirements of Section 01 78 23, operation and maintenance manuals for items included under this Section.
- C. Warranty: Submit in accordance with requirements of Section 01 90 00, warranties covering the items included under this Section.

1.04 QUALITY ASSURANCE

- A. All Work under this Section shall be performed in accordance with standard practices as recommended by manufacturer and AWWA.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 1. Industrial Butterfly Valves (IB):
 - a. Cooper Cameron Corp. (Demco Valve).
 - b. DeZurik SPX.
 - c. Henry Pratt Co.
 - d. Hilliburton Co. (Dresser Valve Div.).
 - e. Kennedy Valve.
 - f. Keystone Valve.
 - g. Mark Controls Corp. (Center Line Valve).
 2. Resilient Seated Gate Valves (RA):
 - a. American Flow Control Valves.
 - b. Clow Valve Co.
 - c. M&H Valve Co.
 - d. Mueller Co. (A-2360 Resilient Wedge).
 - e. U.S. Pipe (Metroseal 250).
 3. Standard Swing Check Valves (C):

- a. Clow Valve Co.
- b. G.A. Valves (Golden Anderson).
- c. Kennedy Valve.
- d. M&H Valve Co.
- e. Rensselaer Valve Mfg. Co.
- 4. Double Vane Check Valves (DC):
 - a. Mission Manufacturing Co. - Duo-Chek.
 - b. Techno Corporation - Technocheck.
- 5. Limit Switches, spring-centered:
 - a. Allen-Bradley.
 - b. Square D Co.
- 6. T-handle Wrench:
 - a. Clow Valve Co.

2.02 VALVE AND GATE IDENTIFICATION

- A. Each valve and gate shall be tagged with its distinguishing mark letter and number. Mark letter and number will be as listed on Valve Schedule. Identification tag shall be 1-1/2-inch in diameter, 18-gauge polished brass or aluminum with 1/2-inch-high, embossed, black-filled mark letter and number placed thereon. Tags shall be securely fastened to the valve or gate operator with No. 16 brass jack chain or plastic seals.

2.03 COMPONENTS

- A. Industrial Butterfly Valves (IB):
 - 1. Shall be suitable for installation between ANSI B16.1, Class 125 flanges, and shall be designed for 150 psi working pressure or as herein specified or noted on Valve Schedule. Valves shall meet or exceed the design strength, testing and performance requirements of AWWA Standard C504.
 - 2. Valve bodies shall be cast iron ASTM A 126, Class B, gray iron ASTM A 48, Class 20 or ductile iron ASTM A 536, Class 65-45-12 or 65-45-15. Valve bodies on exterior valves shall have exposed surfaces protected with a weather-resistant thermosetting multipolymer resin coating.
 - 3. Valve discs shall be ductile iron and, where noted on Valve Schedule, coated with EPDM/EPT. Discs shall be one-piece cast design with no external ribs transverse to the flow. Disc hub and edge shall be ground and polished to a rounded contour to give full concentric seating.
 - 4. Valve seats shall totally encapsulate the inside surfaces of the valve body and shall also serve as the flange gaskets. The resilient elastomer valve seat shall be bonded to metallic or plastic backup ring. Valve seats shall be designed with integral seals at the disc shaft hub areas to completely isolate the stem, stem bearings and body area from the flowing media. Valve seats shall be completely field replaceable at the Site without the use of special tools. Seats shall be Buna N or EPDM/EPT for air.
 - 5. Shafts shall be 316 or 416 stainless steel construction. Valve shafts shall be securely fastened to the valve disc by 316 stainless steel taper pins, or by a broached connection. Shafts shall be provided with both a primary and secondary shaft sealing device at each end of the shaft where the shaft enters the valve body. Upper shaft bearing surfaces shall be adequately designed to absorb the loads imposed by the service conditions and any side thrusts developed by the operator and shall be of the permanently lubricated type for valves 12-inch and smaller and self-lubricating bushing type on valves larger than 12

inches. On valves 30 inches and larger, shaft seals shall be of the double-chevron bi-directional type suitable for both pressure and vacuum. Seals may be pre-loaded by a packing gland mechanism. The packing gland, studs, and nut shall be constructed of corrosion-resistant materials.

B. Resilient Seated Gate Valves (RA):

1. Resilient seated gate valves shall be designed for 150 psi working pressure and shall meet the requirements of AWWA Specification C509 or C515 except as otherwise specified herein. Valves shall be cast or ductile iron body, bronze stem, O-ring stem seal, and non-rising stem. The interior and exterior surfaces of the valve body shall be coated with an epoxy coating meeting the requirements of AWWA C550. The bronze or iron or ductile iron wedge shall be fully encapsulated with molded rubber. No bare metal shall be left exposed. The valve shall seal on both sides of the wedge. Gate valves shall have a clear waterway equivalent in area, when fully open, to that of the connecting pipe. Valves shall be made to open when turned to the left, or counterclockwise. The gate valves shall have square wrench nuts mounted on non-rising stems. All fasteners shall be stainless steel. Ground-buried gate valves shall be furnished with valve boxes. Flanges shall meet the requirements of AWWA C115 (ANSI 21.15). Two complete sets of joint accessories shall be furnished with each valve.
2. The force mains will be laid with a minimum 5 feet of cover or as noted on Drawings. One operating wrench of suitable length shall be provided under this Section.

C. Standard Swing Check Valves (C):

1. Standard swing check valves shall meet the requirements of ANSI/AWWA C508. Check valves shall be cast or ductile iron body with end flanges conforming to ASME B16.1 Class 125. Resilient to metal type seat shall be provided with stainless steel seating surface mechanically attached to machined body area with the buna-N seat material integral with or mechanically attached to the disc. Check valves shall be of the balanced single disc type with the disc hinged at the top, with outside lever and adjustable weight or spring. A clear waterway opening equal to the full area of the connecting pipe shall be provided when the valve is open.
2. Disc shall be cast or ductile iron. Hinge pins shall be one piece stainless steel and protrude through both sides of the body. Bronze or stainless steel bushings with adjustable packing or O-ring seal shall be provided where pins pass through the valve body.
3. Valves shall be interior coated with epoxy meeting requirements NSF/ANSI 61 approved epoxy in accordance with AWWA C550 and, as minimum, be painted with primer on the exterior.

D. Double Vane Check Valves (DC):

1. Valves shall be of the spring-loaded, double-vane type with flanged ends or suitable for mounting between two flanges. Valves shall be designed for 150 psi working pressure except as herein specified or shown on Valve Schedule. Torsion springs shall be of a heat-resistant material.
2. Valves shall be furnished with cast iron bodies, bronze mounted, Buna-N seal, nickel-plated steel stops, 316 stainless steel pin and spring and cast iron pin retainer.

2.04 VALVE JOINTS

- A. Bell and Spigot Lead: Bell lead joints shall meet the requirements of ANSI/AWWA C110/A21.10.
- B. Flange Joint: Flanges shall meet the requirements of ANSI-B16.1 Standard Class 125, except that bolt holes at shaft hubs may be drilled and tapped on the flanges. Flange faces shall be coated with a rust inhibitor immediately after drilling.
- C. Grooved Coupling: Grooved coupling joints shall be the rigid type and shall have housing fabricated in 2 or more parts of malleable iron in accordance with ASTM Specification A 47, Grade C32510. Ends shall be factory grooved in accordance with the coupling manufacturer's standard groove dimension. Bolts shall be oval neck track head type with hexagonal heavy nuts, per ASTM A 183 and A 194/A 194M. Gasket material shall be Grade H, E chlorinated butyl, or E.P.D.M. for water service and Grade T Buna-N for sewage.
- D. Mechanical joints shall conform to ANSI/AWWA C110/A 21.10 and ANSI/AWWA C111/A 21.11.
- E. Push-on joints shall conform to ANSI A21.11 and AWWA C111.
- F. Screwed joints shall conform to American Standard dimensions ANSI B16.3 and threads ANSI B2.1.
- G. Wafer joints shall be flat face or raised face for use between standard flanges.

2.05 ACCESSORIES

- A. Manual Operators: Operators shall be designed with a safety factor of 5 for torsional and shear stresses. The operating mechanism shall be so located and so designed that parts subject to the maintenance shall be easily accessible.
 - 1. Manual operators shall be so sized that a maximum of 80 pounds of rim force/pull is required for operation.
 - 2. Positions of operators shall be approved by ENGINEER.
 - 3. Valve shall be made to open when turned to the left or counterclockwise.
 - 4. The direction of the operator to open position shall be indicated on the operator.
 - 5. Bevel gear activators shall provide vertical mounting of the handwheel. Handwheels shall be included.
 - 6. Crank/Handle: Cranks shall be cast iron with a rotating brass grip. They shall be a maximum of 15 inches in length and keyed to the operator nut.
 - 7. Chainwheels shall be cast iron and furnished complete with chain and guides. Chain shall be galvanized and shall be looped to extend to within 4 feet of the floor below the valve.
 - 8. Handwheels shall be fabricated steel. They shall be a maximum of 30 inches in diameter and keyed to the operating nut.
 - 9. Lever shall be fabricated steel, shall include a setscrew and be grease lubricated.
 - 10. Chain lever shall indicate chain and lever. Materials shall be galvanized.
 - 11. Infinite lever shall be of extra heavy steel and capable to be moved to any position and locked in place by a simple wing nut.
 - 12. Position lever shall be of extra heavy steel with a multiple position throttling plate.

13. Wrench heads shall be cast iron with setscrew. They shall be furnished for wrench nuts except where extension stems or T-handle wrenches are required.
 14. Wrench nuts shall be provided with a 2-inch operating nut when a T-handle wrench or extension stem is required. Other wrench nuts shall be furnished with a wrench head.
- B. Bench Stand: Bench stands shall meet the requirements of floor stands as specified in this Section, except that baseplates shall replace pedestals.
 - C. Remote Control Station: The control package shall consist of indicating lights, Open-Close-Stop push-button stations, Local-Remote control selector, strip headers, and wiring factory assembled, mounted in a NEMA 4 enclosure unless otherwise noted on Valve Schedule.
 - D. Extension Bonnet (Length): Extension bonnets shall be cast iron and be provided complete with galvanized assembly bolts.
 - E. Extension Stem/Shaft (Length): Extension stems shall be 304 or 303 stainless steel with bronze couplings. Stems of more than one section shall be jointed by bronze couplings threaded and keyed to the stems. Extension stems shall have a 2-inch wrench nut end connection for T-handle wrench operation.
 1. Extension shafts shall be 304 or 303 stainless steel with universal joint couplings.
 - F. Position Indicator: Position indicators shall be of bronze or cast iron construction.
 1. Limit Switch. Two limit switches shall be factory-mounted to the valve for indicating full open and full closed positions.
 - G. Manual Screw: Manual screw operators shall meet the requirements of AWWA C504 operators.
 - H. Remote Position Indicator: Remote position indicators shall be the isolated 1,000 ohm potentiometer design for use with a remote position indicator. Resolution of 1/2 percent shall be required and potentiometer shall be directly attached to or geared from the valve operating shaft.
 - I. Stem Cover: Stem covers shall be galvanized steel with position indicators and cap.
 - J. Stem Guide: Stem guides shall be cast iron ASTM A 126, Class B, construction with bronze bushings adjustable in two directions and provided with mounting assembly and anchor bolts of stainless steel. The minimum thickness of any portion shall be 1/2 inch.
 - K. Wall Bracket: Wall brackets shall be cast iron and provided with stainless steel assembly and anchor bolts.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail drawings, specifications, engineering

data, instructions, and recommendations of the equipment manufacturer approved by ENGINEER.

B. Equipment furnished under this Section shall be installed under Section 01 00 20.

3.02 FIELD QUALITY CONTROL

A. Installation: Special attention shall be given by CONTRACTOR to ensure that items furnished under this Section are installed in accordance with manufacturer's recommendations.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
1. Provide all labor, materials, and equipment necessary for fabrication and production of the items specified in this Section and as shown on Drawings or listed on Schedule.
 2. Unless otherwise noted on Drawings, or in this Section, pressure process piping 4 inches in diameter and larger shall be part of this Work.
 3. Dismantling of existing piping and supports, where required or shown or noted on Drawings; piping connections to existing piping, structures, valves, gates, measuring devices, pumps and other equipment, including equipment erected under other Contracts, are included in Work of this Section. Piping shall contain necessary unions or companion flanges to allow ease of equipment removal.
 4. Complete all the demolition work and repair thereof to existing walls and slabs as required for the installation of this Work including grouting of all sleeves and castings. Provide all necessary joint and coupling materials, including bolts, nuts and gaskets, wall castings or sleeves, and standard or special fittings. Furnish hangers, supports, anchors, blocking, harnesses, and other necessary closure pipe sections and special fittings. Provide and secure in proper alignment, all sleeve and casting openings in existing walls and slabs, including repair thereof.
 5. Provide all shop-applied interior and exterior pipe linings and coatings. Provide plugs in open ends of pipe, temporary bulkheads, protection of surface and subsurface improvements, cleaning, painting, testing, and disinfection, as required to accomplish Work as specified and shown on Drawings.
- B. Products Installed But Not Furnished Under This Section: Install process valves, hydraulic gates, flow meters, and other appurtenances which are furnished under other Sections and incorporated in the piping systems as shown on Drawings and specified in this Section.
1. All pipe insulation shall be accomplished under Section 40 05 07. Under this Section of Work, all shop-applied surface coating shall be furnished as herein specified and pipe testing accomplished prior to insulating.
 2. All exposed pipe, field-applied finish painting preparation and repair of existing painted surfaces shall be done under Section 09 90 00.
- C. Products Supplied But Not Installed Under This Section:
1. All piping, fittings, appurtenances, and shop-applied coatings shall be supplied as specified under this Section.
 2. The installation and testing of Water Distribution and Pumping Mains shall be performed as specified in this Section.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01 30 00, Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
1. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and

appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.

2. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.
3. Design details of joints and joint restraint shall be submitted to ENGINEER for ENGINEER's consideration and approval before ordering any pipe.
4. Product Data: Submit product data covering the items included under this Section.

B. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of Section 01 70 00.

1.03 QUALITY ASSURANCE

- A. All Work under this Section shall be done in accordance with standard practices as recommended by manufacturer and AWWA.
- B. Codes, Ordinances, and Standards: Manufacture, storage, and erection of equipment under this Contract shall be in accordance with current ASA (ANSI), AWWA, and ASTM Standards. Standards and Specifications referenced herein shall be the current published edition. The manufacturer of the pipe and fittings shall furnish ENGINEER a certified statement that all pipe and fittings furnished by manufacturer meet the material requirements and have been inspected and tested in accordance with the applicable Specification and Standard.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Storage:
 1. All pipe and related items installed under this Section shall be stored as recommended by manufacturer.
 2. CONTRACTOR shall take all actions necessary to protect all items installed under this Contract including furnishing all special storage areas required by equipment manufacturers.
 3. Pipe shall be stored on suitable timber skids free from contact with the ground. Gaskets shall be stored in as cool, clean, and shaded a place as practical.
- B. Handling:
 1. All items installed under this Contract shall at all times be handled as recommended by manufacturer and in such a manner as to avoid any damage.
 2. All special handling equipment and temporary supports shall be provided by CONTRACTOR.
 3. Items will be subject to inspection and approval upon delivery to the Site and after storage. No cracked, broken, or damaged pipe shall be used.
 4. In the event coatings are damaged, the damaged area shall be recoated with an approved coating similar to that specified for that item.
 5. Steel pipe shall be handled by means of rubber or fabric slings. No hooks shall be permitted to come in contact with joint rings or be inserted in the ends of the pipe and fittings for any reason.
 6. During handling, hauling, and storage of pipe, each piece shall be kept from contact with adjacent pieces by means of wooden blocks or timbers.

1.05 PROJECT CONDITIONS

- A. Existing Conditions: The Drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, CONTRACTOR shall so inform ENGINEER for ENGINEER's approval.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Adapter Flange Coupling (AFC):
 - a. EBAA Iron Sales, Inc. (Series 2100 Megaflange).
 - b. Smith-Blair, Inc.
 - c. Uni-Flange Corp.
 - d. Victaulic Co.
 - 2. Bolted Flexible Coupling (BFC):
 - a. Dresser Industries, Inc.
 - b. Smith-Blair, Inc.
 - 3. Grooved Couplings (GC):
 - a. Victaulic.
 - b. Grinnell.
 - c. Anvil.
 - 4. Push-On Joints (POJ):
 - a. Bell-Tite.
 - b. Ring-Tite.
 - c. Tyton.
 - d. Fastite.
 - 5. Equipment Connections:
 - a. Garlock.
 - b. Metra Flex.
 - c. Mercer Rubber Co.
 - d. Redflex.
 - e. Atlantic Metal Hose Co. (Vibra-flexor).
 - f. Allied Metal Hose Company.
 - g. Universal Oil Products Flexonics Division.
 - 6. Expansion Coupling:
 - a. Victaulic or Equal.

2.02 PIPE JOINTS

- A. All joint material and lubricants shall be furnished with the pipe, including all joint material required for connection to equipment furnished under other Sections. All joint materials shall be assembled in accordance with standard practice and manufacturer's recommendations. All

equipment connections shall be flanged, union, or grooved coupling so that equipment can be removed without disassembly of the connecting piping.

B. Bolted Flexible Couplings (BFC): Bolted flexible couplings shall consist of a steel sleeve, with centering bead removed, rubber gaskets, follower rings, and a full complement of nuts and bolts. Couplings shall allow a deflection of approximately 4 degrees per joint.

1. Couplings shall have a minimum middle ring thickness and minimum length as follows:

<u>Pipe Size (inches)</u>	<u>Middle Ring Thickness</u>	<u>Middle Ring Length</u>
4	0.203-inch	5-inch
6 to 12	1/4-inch	5-inch
14 to 20	5/16-inch	7-inch
24	3/8-inch	7-inch
30 to 48	3/8-inch	10-inch
54 to 72	1/2-inch	10-inch

2. Couplings shall have a maximum gap between pipe ends as follows:

<u>Sleeve Length</u>	<u>Max. Gap Allowed</u>
5-inch	1-inch
7-inch	2-inch
10-inch	3-inch

3. Couplings and accessories shall be galvanized and shall be shop coated with a sealer suitable for subsequent field painting or coating.

C. Expansion Couplings: All couplings shall be carbon steel with a coating to resist the corrosive environment of the air and be suitable to handle 280 degree F air service.

1. Type 1A: Each joint shall be capable of 1 1/2-inches of growth. Piping is to be anchored at ends of pipe run and guided to coupling. The coupling gaskets shall be suitable for 280 degree F air service. The working pressure shall be 30 psi and the test pressure shall be 60 psi. Stainless steel cladding shall be supplied with the coupling and welded to the pipe end which will accommodate movement. Coupling to be Victaulic Type F x E coupling or equal.

D. Rubber Expansion Joints: Shall be used in the aeration piping to allow for expansion and contraction of the piping.

1) Expansion joints shall be arch type and constructed of multiple plies of woven, polyester fabric, impregnated with Buna N or chlorobutyl rubber elastomer and reinforced with welded steel rings imbedded in the body.

1) They shall have ANSI 125-pound flanges and be hypalon coated. Each end flange shall be backed up with 3/8-inch-thick galvanized steel retaining ring. Control rods shall be provided on the expansion joint to restrain the piping in the axial direction.

E. Flanged Joints (FJ): Pipe flanges shall conform to American Standards: dimensions, ANSI B16.1 and threads, ANSI B2.1. Flange faces except stainless steel shall be coated with a rust inhibitor immediately after drilling.

1. Flanges for cast or ductile iron pipe and fittings shall be ductile iron and meet the requirements of AWWA C115 (ANSI 21.15).
 2. Flanges for steel plate pipe and fittings shall meet the requirements of AWWA C207 Standard Steel Ring Flanges, Class B, except high service discharge piping as noted on Drawings or on Schedule, shall be Class D.
 3. Flanges for stainless steel pipe shall be fabricated from stainless steel flat plate of the same composition as the pipe.
 4. Flanges for stainless steel tubing shall be constructed using standard steel angle face rings (Van Stone Connection) and galvanized carbon steel backup flanges.
 5. Flanged joints shall be made up with full-face 1/8-inch rubber gaskets. Gaskets for gas lines shall be neoprene.
 6. Flanges shall be firmly bolted with machine, stud or tap bolts of the proper size and number meeting the requirements of ASTM A 307, Grade B. Joints made with bolts or bolt studs shall have a nut on each side. Bolt projection through nuts shall be equal, and where studs are used, bolt projection on each side of the flange shall be equal.
 7. All nuts and bolts shall be zinc plated or hot-dip galvanized except on stainless steel flanges shall be 316L stainless steel.
 8. Flange connections to all flexible connectors and expansion joints shall have a lock washer under all nut and bolt heads, 2 control rods across each joint and steel retainer rings at each flange. All steel materials shall be galvanized.
 9. Flange joints shall not be used on ground-buried pipe.
- F. Grooved Couplings (GC): Provide rigid grooved couplings where shown or noted on Drawings or noted on Pipe Schedule. Flexible type shall only be used in applications approved by ENGINEER.
1. Grooved couplings and fittings may be used in lieu of flanged joints.
 2. Couplings shall conform to AWWA Standard C606.
 3. Gaskets shall be molded or extruded of an elastomer that is recommended by coupling manufacturer and that will satisfy the end use. End use includes consideration for pipe material and material being transmitted by the pipe.
 4. Generally, ductile iron pipe gaskets shall be halogenated Butyl compound, and steel pipe shall be an ethylene, propylene, diene-monomer (EPDM) compound.
 5. Shop Drawings submitted shall identify the gasket material, pipe material, and material being transmitted in the pipe.
 6. Cast iron or ductile iron fittings shall conform to the requirements of ANSI Specifications A21.10 or AWWA C110 with end preparation of a radius cut groove configuration.
 7. Standard weight steel pipe or better may be cut grooved in accordance with manufacturer's standard groove dimensions. Where pipe is less than or standard weight, a ring shall be welded to steel pipe to form the necessary shoulder for the joint, or the pipe may be roll-grooved in accordance with manufacturer's recommendation for roll-grooving pipe as approved by ENGINEER.
 8. Ductile iron pipe in sizes 4-inch to 24-inch shall be radius cut grooved in accordance with manufacturer's specifications.
- G. Screwed Joints (SJ): Screwed joints in steel plate, galvanized steel, or black steel pipe shall conform to American Standards: dimensions, ANSI B16.3; threads, ANSI B2.1. The ends of pipe shall be reamed and all burrs and cuttings shall be removed. Joints shall be sealed with Teflon thread tape or an approved compound.

- H. Welded Joint (WJ): Butt-welded joints shall be used whenever shown or noted on Drawings. Welding shall comply with the current AWWA Standard C206. Lap-welded joints may be used if approved by ENGINEER.

2.03 PIPING

- A. Stainless Steel Pipe (SSP): Stainless steel pipe shall be designed and fabricated in accordance with the ASTM Standards 316, and as shown on Drawings.
 - 1. The pipe and fittings and all appurtenant supports specified shall be made from 304 L stainless steel with a minimum No. 1 mil finish and a maximum carbon content of 0.035 percent.
 - 2. Pipe schedule shall be as shown on Drawings or on Pipe Schedule.
 - 3. Fittings shall be made to ASTM A 403 standards, to MSS SP-43 dimensional tolerances, and shall be equal in wall thickness to, and meet the conditions of, the pipe.
 - 4. Special fittings shall meet the requirements of the pipe and shall be as shown on Drawings.
 - 5. All welding shall be performed in shop and be accomplished using inert gas shielded-arc method. Where consumable electrode or filler wire is used, they shall be the same material as the parent metal. Butt welds shall have full penetration to the interior surface and gas shielding provided to the interior and exterior of the joint.
 - 6. All interior weld finishes shall equal the smoothness of a minimum No. 1 mil sheet finish. The weld bead shall be smooth evenly distributed with an interior projection not exceeding 1/16 inch beyond the I.D. of the pipe or fitting. All unevenness shall be finely ground to meet the above requirements. Coarse grinding shall not be permitted.
 - 7. All exterior weld finishes shall be wire brushed with stainless steel brushes used only on stainless steel. The joints shall then be cleaned of all discoloration, and deposits left during welding shall be removed by pickling.

- B. Steel Plate Pipe (SPP): Steel plate pipe shall be designed, fabricated, and installed in accordance with these Specifications, AWWA Manual on Steel Pipe Design and Installation M11, and as shown or noted on Drawings.
 - 1. Provide layout drawings as indicated under the section Shop Drawings including detailed calculations of pipe system expansion joints, restrained joints, and support locations.
 - 2. Steel pipe shall meet the requirements of ASTM A 134 with steel plates meeting the requirements of ASTM A 283, Grade B, or ASTM A 139, Grade B, or ASTM A 36, spirally welded, straight seam or seamless equal to Armco or U.S. Steel welded steel pipe.
 - 3. SPP shall conform to the requirements of AWWA C200.
 - 4. In general, standard lengths of 40 feet shall be furnished except where shorter lengths are necessary for installation as shown or noted on Drawings and approved by ENGINEER.
 - 5. Fittings shall meet the requirements of AWWA C208. All buried fittings shall be Table II. Welded fittings shall be equal in thickness to the pipe.
 - 6. Specials shall be fabricated of steel plate and designed for the same conditions as the pipe. Collars, stiffeners, and other reinforcement shall be used as required to obtain the necessary strength in all parts of the special. A plate collar shall be welded around all outlet connections.
 - 7. All steel plate pipe, fittings and specials shall receive a shop application of the coating and lining on the interior of the pipe..
 - 8. Coating and lining for all steel air piping shall be galvanized in accordance with ASTM A 153.

9. Interior linings for the other steel pipe shall meet the requirements of AWWA C203 for hot coal-tar enamel, or AWWA C210 for coal-tar epoxy (3 coats, 24 mil total thickness minimum), except for high-pressure discharge piping and as noted on Drawings.
10. High service discharge piping as noted on Drawings shall be shop lined on the inside with centrifugally spun cement mortar lining 5/16-inch thick for 16- to 23-inch pipe, 3/8-inch thick for 24- to 36-inch pipe, and 1/2-inch thick for over 36-inch pipe. Mortar lining shall be in accordance with AWWA Standards C205, latest revision.
11. SPP joints shall be bell and spigot steel, bolted flexible coupling, grooved coupling, screwed or welded, in accordance with the paragraph on "Pipe Joints, " as shown or noted on Drawings, listed on Schedule, and approved by ENGINEER.
12. Pipe taps in steel pipelines shall include a steel 3,000-pound coupling fitting welded into the wall of the pipe and threaded to receive small piping, special fittings, or corporation stops of a size and location as noted or shown on Drawings.
13. All 8 inch to 12 inch exposed piping for Aeration supply and discharge piping shall be minimum of ASTM A53 Schedule 20 with Buttwelding Fittings. CONTRACTOR may furnish thicker wall pipe with ENGINEER approval of submittals.
14. All 14 inch to 42 inch exposed piping for Aeration supply and discharge piping shall be a minimum of ASTM A53 Schedule 10 with Buttwelding Fittings. CONTRACTOR may furnish thicker wall pipe with ENGINEER approval of submittals.
15. Pipe Thickness: Nominal pipe size indicated for pipe less than 14 inches shall be I.D. and pipe 14 inches and larger shall be O.D. Pipe shall be fabricated meeting special design conditions as shown or noted on Drawings or listed on Piping Schedule with the minimum thickness as given in the following table:

<u>Pipe Diameter (Inches)</u>	<u>Thickness</u>
15 and less	0.135
15 to 28	0.188
30 to 40	0.250
42 to 51	0.313
54 to 66	0.375

2.04 WALL AND SLAB SLEEVES AND CASTING

- A. At all points where pipes must pass through the walls, floors, or slabs of structures, CONTRACTOR shall furnish and install suitable sleeves or wall castings.
- B. In general, the wall sleeve or castings shall be of the same material as the pipe.
- C. Steel sleeves and wall pipe shall not be painted in areas to be embedded in the concrete. Under this Section, all loose rust, scale, grease, or oil shall be removed prior to pouring of the concrete.
- D. Sleeves and castings at the point of manufacture shall be coated on the inside with a universal rust-inhibitive primer 1.5 to 2.0 mils minimum dry thickness.

2.05 EQUIPMENT CONNECTIONS

- A. The connecting piping to pumps and other equipment shall be supported independently of the pump or equipment so as to avoid any strain on the pump or equipment.
- B. All equipment connections shall be flanged or have unions to facilitate removal of the equipment.
- C. Piping to vibrating equipment shall contain control-rodded, retainer ringed flanges, flexible spool-type expansion joint of duct and chlorobutyl or Buna-N material as shown or noted on Drawings.
- D. All carbon steel shall be galvanized.

2.06 JOINT HARNESSING

- A. Pipe and fittings that require harnessing shall be provided with standard lugs ASTM A 283, Grade B, or A 285, Grade C, or equal, meeting the requirements of AWWA Specification C111 or AWWA Manual M11, unless otherwise noted.
- B. Harness tie rods and nuts shall be mild steel meeting the requirements of ASTM A 193, Grade B7, or A 307, Grade B, or equal with American Standard threads. The nuts shall seat on steel plate washers. The rod, washers, and nuts shall be hot-dip galvanized ASTM A 153.

2.10 SOURCE QUALITY CONTROL

- A. Tests, Inspections:
 - 1. All pipe and fittings delivered to the Project shall be accompanied by certification papers showing that the pipe and fittings have been tested in accordance with the applicable Specifications and that pipe and fittings meet the Specifications for this Project. All pipe and fittings will be inspected upon delivery to the Site by ENGINEER or OWNER's Representative. No cracked, broken, or damaged pipe or fittings will be allowed in this Work.

PART 3 - EXECUTION

3.01 ERECTION

- A. Equipment provided under this Section shall be fabricated, assembled, erected, and placed in proper operation condition in full conformity with detail Drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer approved by ENGINEER.

3.02 INSTALLATION

- A. Laying and Erecting Pipe: Pipe shall be installed as recommended by manufacturers or by the applicable AWWA installation manual or specification.
 - 1. Pipe shall be carefully laid to line and grade as shown on Drawings. Care shall be taken to keep the interior of the pipe clean and free from dirt and other foreign materials.

2. Bulkheads or other means shall be used at the open ends of the pipe for this purpose. At the end of each day's work, ground-buried pipe shall have its working end bulkheaded.
- B. Field Cutting Piping: The spigot ends of all pipe lengths, which have been cut in the field, shall be ground to a smooth surface and painted with 2 coats of asphaltum metal protective paint.
- C. Bolted Flexible Couplings (BFC): All bolted flexible couplings shall be harnessed with tie bolts or studs across the joint, design based on test pressures.
 1. Piping of materials shall be furnished with lugs. The number and size of the bolts and studs and other details of the harnessed joint shall be submitted to ENGINEER for review.
 2. Tie bolts or studs shall be galvanized.
- D. Joints: All joints shall be assembled in accordance with that described in the "Pipe Joints" Article.
- E. Connections to Existing Facilities:
 1. CONTRACTOR shall furnish all labor and materials required for the connection of piping under this Contract to existing structures as called for on Drawings.
 2. Where breaking holes for connections to existing structures, care shall be taken to prevent debris from entering.
 3. After installation of the pipe, the structure shall be pointed up around the pipe, both on the inside and outside so that it is restored to a watertight condition.

3.03 REPAIR

- A. For field-welded joints, both inside and outside, coatings shall be left off for a distance of 6 inches from each end. These areas shall be shop primed. After completing the welded joint and under this. Exposed field-welded joints shall be cleaned under this Section to remove slag and scale, and then shall be finish cleaned, primed and painted under Division 9.
- B. Damaged linings, coatings, and wrapping shall be repaired under this Section and, if possible, before pipe is laid.
 1. Surfaces shall be thoroughly cleaned, dried, and free of old materials.
 2. They shall then be given a field coating of the same material as specified for the pipe.
 3. Coating shall meet the requirements of AWWA C203, AWWA C210, or AWWA C602 as approved by ENGINEER.
 4. All other pipe coatings and linings shall be as stated in "Piping" Article.

3.04 FIELD QUALITY CONTROL

- A. Defective Pipe: No pipe or special casting known to be defective shall be laid in Work.
 1. Any piece found to be defective after it has been laid shall be removed by CONTRACTOR and replaced by a sound and perfect piece.
 2. If the major part of a defective pipe is sound, the good end may be cut off and used. The cutting of pipes for this and any other purpose shall be done by skilled workers, and in such manner as will not injure the pipe. Every such cut shall be square and smooth. Cut surfaces shall be recoated as specified for the pipe.

END OF SECTION

DIVISION 40 – PROCESS INTEGRATION
SECTION 40 27 00.08
STAINLESS STEEL PIPE AND FITTINGS

SECTION 40 27 00.08		
STAINLESS STEEL PIPE AND FITTINGS - GENERAL		
Item	Service	Description
General	All	Material shall conform to ASTM A778
Piping	ARV & ARVV Inlet and Outlet Supplemental Carbon	Schedule 40, Type 316 stainless steel, screwed fittings. Material shall conform to ASTM A312. Schedule 40S, Type 316 or 316L seamless stainless steel, welded fittings with flanges where field connections are required and for connecting to valves. Material shall conform to ASTM A312. Piping shall be shop welded in as large a section as feasible. Piping and welds shall be immersion pickled and passivated.
Bolts	Stainless steel pipe	Type 316 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	Stainless steel pipe	Gaskets shall be PTFE, model Flexitallic Sigma 600 or approved equal. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.

SECTION 40 27 00.08A

STAINLESS STEEL PIPE AND FITTINGS-UNSUBMERGED SERVICE

Item	Service	Description
Pipe	8" thru 12"	Schedule 20: ASTM A53, with Buttwelding Fittings.
	14" thru 42"	Schedule 10: ASTM A53, with Buttwelding Fittings.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting.
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F304 or cast Class 150, ASTM A351/A351M, Grade CF8/304.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled, and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise
	3" & larger	Butt-Welded: ASTM A774/A774M Grade 304L conforming to MSS SP 43, "as-welded" grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tube Fittings	All	Flareless Compression type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.

SECTION 40 27 00.08A

STAINLESS STEEL PIPE AND FITTINGS-UNSUBMERGED SERVICE

Item	Service	Description
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
	Flanges	<p>Forged Stainless Steel: ASTM A182/A182M, grade F304L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face.</p> <p>Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240 Type 304L "as-welded grade," conforming to MSS SP 43, wall thickness same as pipe.</p>
	Unions	<p>Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.</p> <p>Threaded Forged: ASTM A182/A182M, Grade F304, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.</p>
Bolting	All	<p>Forged Flanges: Type 304 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.</p> <p>Van Stone Flanges: Carbon steel ASTM A307 Grade B hex head bolts and ASTM A563 Grade A hex head nuts.</p> <p>Provide same on mating cast iron flange on valve or equipment with flat ring gasket.</p>

SECTION 40 27 00.08A

STAINLESS STEEL PIPE AND FITTINGS-UNSUBMERGED SERVICE

Item	Service	Description
Gaskets	All Flanges	<p>Flanged, Water and Sewage Service: 1/8 inch thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D1330, Grade 1 and Grade 2.</p> <p>Flanged and Hot Air Service: 1/8-inch thick, unless otherwise specified, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 300 degrees F, conforming to ASME B16.21 and ASTM D1330 Steam Grade.</p> <p>Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.</p>
Thread Lubricant	2" & smaller	General Service: 100% virgin PTFE Teflon tape.

END OF SECTION

PART 1 - GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this Section:
1. American Society of Mechanical Engineers (ASME):
 - a. B 16.1, Gray Iron Pipe Flanges and Flanged Fittings.
 - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.
 2. American Water Works Association (AWWA):
 - a. C153, A21.53, Ductile-Iron Compact Fittings for Water Service.
 - b. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - e. C800, Underground Service Line Valves and Fittings
 - f. Manual M11, Steel Pipe-A Guide for Design and Installation.
 3. ASTM International (ASTM):
 - a. A153/A153M7 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 SUBMITTALS

- A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with Section 01 30 00 and the following:
1. Descriptive literature, bulletins, and/or catalogs of the equipment.

2. Operating and maintenance manuals shall be furnished in accordance with Section 01 78 23.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
- C. All products shall be suitable for contact with applicable fluid, sludge or chemical.

2.02 CONNECTORS

- A. Elastomer Bellows Connectors or Expansion Joints in Exposed Piping:
 1. Type: Fabricated spool with single filled arch.
 2. Materials: Elastomeric tube with reinforcement, lining, and cover.
 3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and galvanized steel retaining rings.
 4. Working Pressure Rating:
 - a. All Applications: 150 psi.
 5. Manufacturers and Products:
 - a. Red Valve.
 - b. General Rubber.
 - c. Or approved equal.
 6. Neutral lay length for 10" and 12" expansion joints shall be a maximum of 8".
- B. Rubber Expansion Joint for Air Service
 1. Type: Fabricate Spool with open double arch
 2. Materials: reinforced EPDM tube and EPDM cover
 3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and stainless-steel retaining rings.

4. Working Pressure Rating: 20 psi
5. Performance: Allowable lateral deflection shall be a minimum of 1.4" for a 10" expansion joint and 1.6" for a 12" expansion joint.
6. Thrust Restraint: 316 stainless steel control rods to limit travel of elongation and compression. Number and size of rods shall be sufficient to restrain against force developed as a result of pressure test.
7. Manufacturers and Products:
 - a. Proco Style 232.
 - b. General Rubber.
 - c. Or approved equal.

2.03 COUPLINGS

A. General:

1. Couplings shall be rated for working pressure not less than the test pressure set forth in Piping Schedule for the service and not less than 150 psi.
2. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
3. Provide restraint appropriate for test and operating pressures.
4. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flexible Sleeve Type Coupling:

1. Pressure Rating: Per Paragraph 2.03A1 above.
2. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties Style 38.
 - 2) Smith-Blair, Inc. Style 411.

C. Transition Coupling:

1. Pressure Rating: Per Paragraph 2.03A1 above.
2. Restraint: Provide restraint per section 2.03E below.

3. Materials: Ductile Iron meeting or exceeding ASTM A 536, SBR gaskets per ASTM D 2000 MBA 710, high strength, low alloy, corrosion resistant steel nuts and bolts per AWWA C111.
4. Manufacturers and Products:
 - a. Romac Industries, Inc. Style 501
5. Manufacturers: EBAA Iron Sales Co.; Dresser, Romac, Smith-Blair or an approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

- A. General:
 1. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

3.03 COUPLINGS

- A. General:
 1. Install in accordance with manufacturer's written instructions.
 2. Before installation clean pipe holdback area of oil, scale, rust, and dirt.
 3. Do not remove pipe coating. If damaged, repair before joint is made.

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following:
 - 1. Pressure seals.
 - 2. Pressure to current (P/I).

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01 30 00, Shop Drawings covering the items included under this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Pressure Seals:
 - a. Ashcroft.
 - b. OPW (Ronningen-Petter).
 - c. Red Valve.
 - 2. Pressure to Current:
 - a. ABB.
 - b. Siemens.
 - c. Endress Hauser.
 - d. Yokogawa.
 - e. Rosemount.
 - f. Honeywell.

2.02 PRESSURE SEALS

- A. Pressure seals shall be of the isolation ring type.
- B. The seal construction shall consist of a body, 360-degree flexible elastomeric cylinder with positive O-ring type sealing arrangement, captive sensing liquid and 2 assembly flanges. The Iso-Ring ID shall match the pipeline ID. The Iso-Ring OD shall not exceed the ID of the piping flange bolt circle. Units shall be designed to fit 125-pound, 150-pound, and 300-pound ANSI piping flanges, as shown on Drawings.
- C. When not shown, this information shall be obtained by CONTRACTOR from ENGINEER.
- D. The process liquid pressure is transmitted through the flexible cylinder wall and the captive sensing liquid to the pressure seal.

- E. The seal body shall be stainless steel unless otherwise required. Two assembly flanges are 316SS. Flexible elastomeric cylinder is Buna-N or natural rubber. Captive sensing liquid is 50 percent ethylene glycol and water mix.
- F. Seal weight in pounds not to exceed four times the nominal pipe size in inches.
- G. Installation: Centering gauges shall be provided to align the ID of the isolation ring with the ID of the process pipeline, holding the ring in place during installation.

2.03 PRESSURE TO CURRENT (P/I)

- A. Pressure to current signal converter shall be 2-wire, solid-state electronic, temperature-compensated, strain gauge or capacitive type. Process pressure shall be applied to sealing diaphragm in measuring section. This pressure shall be transmitted to a measuring element connected to the electronics of the transmitter. Converter shall include a repairable circuit board mounted in a cast aluminum explosion-proof housing. Transmitter shall output an isolated 4-20 mA signal proportional to pressure measurement. Adjustable electronic damping shall be provided from 0 to 16 seconds in electronically adjustable increments of 0.1 second.
- B. Positive overage protection shall be provided to 2,000 psig. Diaphragms and wetted parts shall be 316 stainless steel, except where other special alloys are required to prevent corrosion.
- C. Accuracy shall be within plus or minus 0.1 percent of calibrated span for spans from 1:1 to 15:1 of URL. Stability shall be plus or minus 0.1 percent of URL for 6 months. Zero suppression and elevation shall be at least 500 percent of range.
- D. In applications where pressure transients may occur (i.e., level for elevated and ground storage tanks, pumping pressure, etc.), CONTRACTOR shall include snubbers in pressure tap line and an electronic signal time constant which will reduce pressure transients to plus or minus 1 percent of calibrated span. Time constant is to be achieved by placing it in panel providing power to pressure transmitter.
- E. Units shall be supplied with an integral digital indicator calibrated 0 to 100 percent. Provide hand-held configurator.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 13410.

END OF SECTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: This section specifies the leakage testing requirements for plant piping.
- B. Related Work Described Elsewhere:
 - 1. Section 40 27 01.08: Stainless Steel Pipe and Fittings.
 - 2. Section 40 05 23.10: Process Valves.

1.02 QUALITY ASSURANCE

- A. Test Pressures: Test pressures for the various services and types of piping shall be as shown in the pipe schedule on the drawings and at a minimum shall be 1.5 times the working pressure.

1.03 SUBMITTALS

- A. Materials and Shop Drawings (Not Applicable)
- B. Additional Information:
 - 1. Testing Plan: Submit prior to testing and include at least the information that follows:
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Test type.
 - d. Method of isolation
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested
 - 2. Certification of Calibration: Testing equipment
 - 3. Certified Test Report.

4. Testing Records

- a. Provide a record of each piping installation during the testing. These records shall include:
- 1) Date of test.
 - 2) Identification of pipeline tested or retested.
 - 3) Identification of pipeline material.
 - 4) Identification of pipe specification.
 - 5) Test fluid.
 - 6) Test pressure.
 - 7) Remarks: Leaks identified (type and location), types of repairs, or corrections made.
 - 8) Certification by Contractor that the leakage rate measured conformed to the specifications.
 - 9) Signature of Owner's representative witnessing pipe test.
- b. Submit five (5) copies of the test records to the Engineer's representative upon completion of the testing.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Air piping shall be tested using compressed air.

2.02 MATERIALS AND EQUIPMENT

- A. Provide pressure gauges, necessary bracing and restraint, test plugs, pipes, bulkheads, pumps, and meters to perform the hydrostatic and pneumatic testing.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Pipes shall be in place and anchored before commencing pressure testing.
- B. Conduct pneumatic tests on exposed and aboveground piping after the piping has been installed and attached to the pipe supports, hangers, anchors, expansion joints, valves, and meters.
- C. For pneumatic tests, blow air through the pipes.

- D. Test new pipelines which are to be connected to existing pipelines by isolating the new line from the existing line by means of pipe caps, special flanges, or blind flanges. After the new line has been successfully tested, remove caps or flanges, and connect to the existing piping.
- E. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to ENGINEER.
- F. Pressure Test:
 - 1. All tests shall be made in the presence of and to the satisfaction of the Owner or Engineer and, to the satisfaction of any local or state inspector having jurisdiction.
 - a. Provide not less than three (3) days' notice to the Owner, Engineer, and the authority having jurisdiction when it is proposed to make the tests.
 - b. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of the Engineer shall be retested in part or in whole as directed by the Engineer.
 - c. The piping systems may be tested in sections as the work progresses, but no joint or portion of the system shall be left untested.
 - 2. All elements within the system that may be damaged by the testing operation shall be removed or otherwise protected during the operation.
 - 3. Repair all damage done to existing or adjacent work or materials due to or on account of the tests.

3.02 INSTALLATION (NOT APPLICABLE)

3.03 INSPECTION AND TESTING

- A. Hydrostatic Testing of Aboveground or Exposed Piping: The maximum filling velocity shall be 0.25 feet per second, applied over full area of pipe. Open vents at high points of the piping system to purge air while the pipe is being filled. Subject the piping system to the test pressure indicated. Maintain the test pressure for a minimum of four (4) hours. Examine joints, fittings, valves, and connections for leaks. The piping system shall show no leakage or weeping. Correct leaks and retest until no leakage is obtained.
- B. Pneumatic Test for Pressure Piping:
 - 1. Do not perform on PVC or CPVC pipe.
 - 2. Fluid: Oil-free, dry air.

3. Procedure:
 - a. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
 - b. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
 - c. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
 - d. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
 - e. Correct visible leakage and retest as specified.
4. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

C. Test Pressure:

1. All pipe shall be tested at a minimum of 1.5 times the maximum working pressure of the pipe.

3.04 START-UP AND INSTRUCTION (NOT APPLICABLE)

END OF SECTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Control panels and consoles.
 - 2. Switches, push-buttons, lights.
 - 3. Relays.
 - 4. Intrinsically safe isolator relays.
 - 5. Timing devices.
 - 6. Terminal blocks.
 - 7. Control power transformers.

1.02 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Sections 01 33 00 and 40 05 00, Shop Drawings covering the items included under this Section.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Codes, Ordinances, and Industrial Standards: Design, testing, assembly, and methods of installation for materials, electrical equipment, and accessories proposed under this Section shall conform to National Electric Code and to applicable State and local requirements.
 - 2. UL listing and labeling of custom-built panels (UL 508) shall be adhered to under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products which may be incorporated in Work include:
 - 1. Switches, Push-Buttons, Lights:
 - a. Allen-Bradley (Type 800MR).
 - b. American Solenoid Company.
 - c. Arrow Hart (Type OB).
 - d. Electroswitch.
 - e. Microswitch (Series PW).
 - 2. Relays:
 - a. Potter-Brumfield (Type KUP).
 - b. Schrack North America, Inc. (Type CAD).
 - c. Square D Co. (Type KU).

- d. Struthers-Dunn (Type A283).
- 3. Intrinsically Safe Isolator Relay:
 - a. B/W Controls, Inc.
 - b. MTL, Inc.
 - c. R. Stahl, Inc.
 - d. Symcom, Inc.
 - e. Warrick Controls.
- 4. Synchronous Timers:
 - a. ATC (Series 305D or 355).
 - b. Eagle Signal (Type HP5 or BR4).
- 5. Solid-State Timers:
 - a. ATC (Series 306D).
 - b. Eagle Signal (Type DG100).
- 6. Terminal Blocks:
 - a. Allen-Bradley (Type 1492F1 or Type 1492CA1).
 - b. Altech (Type CTS4U-N).
 - c. Square D Co. (Class 9080, Type KCA-1).
 - d. Thomas & Betts (100 series or 200 series).
 - e. Weidmueller (SAKD2.5N or SAK2.5).
- 7. Fusible Terminal Blocks:
 - a. Allen-Bradley (Type 1492-CE6).
 - b. Altech (Type CAFL4U).
 - c. Square D Co. (Class 9080, Type KH-1).
 - d. Thomas & Betts (Series 300 or 0300).
 - e. Weidmueller (SAKS1 or ASK1).
- 8. Control Power Transformers:
 - a. Acme.
 - b. Sola.
- 9. Textured Polyurethane Enamel:
 - a. Sherwin-Williams, Polane T and/or Polane HST.
- 10. Wire Markers:
 - a. Brady.
 - b. T&B.
 - c. Westline.

2.02 CONTROL PANELS AND CONSOLES

- A. Sheet Metal Construction:
 - 1. Panels and consoles shall be fabricated from sheet steel welded and bolted into a rigid self-supporting structure a maximum of 90 inches high and a minimum of 16 inches deep. Overall length shall be coordinated with space requirements as indicated by Drawings. Changes in length from that shown on Drawings must be brought to attention of ENGINEER within 90 days of Contract Award. Cost to modify floor plan or wall opening shall be at CONTRACTOR's expense after this 90-day period. Panel face layouts shown on Drawings are intended to indicate relative position of all components. Supplier shall fix exact locations and overall dimensions to meet requirements of its equipment.
 - 2. Panel and console bodies shall be 12 gauge minimum steel for panels up to 42 inches in width, and 10 gauge minimum steel for panels exceeding 42 inches in width. Panel subplates shall be same gauge as enclosure. Stiffening members shall be provided for strength and stiffness as required.

3. A minimum of 3 inches shall be provided between edge of panel subplate and outside walls of panel body to ensure adequate wire-way space for external wires entering panel. Panel subplate shall be mounted on collar studs for easy removal. Print pockets shall be provided on each panel. Brackets welded to inside of panel, complete with lights, shall be provided on panels where indicated by Drawings.
4. Identification plates shall be laminated phenolic with black letters engraved on a white background and mounted with screws.
5. All components inside panel shall have identification plates. This includes instruments, relays, switches, circuit boards in plug-in racks, etc. Identification plates shall include engineering symbols (FBQ-1, SW-3, FIC-4, CR-1, etc.). Switches and circuit breakers inside panel shall have names (Horn, Audio Tone, Panel Power, etc.) on identification plates as well as engineering symbol.
6. Identification plates shall be located on or adjacent to device they are identifying and shall be readable without looking around, under, or on top of device to find identification plate.

B. Access:

1. Wall- and/or floor-mounted control panels shall have continuous piano-hinged doors for ease of access. Door openings shall expose a minimum of 80 percent of panel interior. Door openings shall be sealed with a 0.125-inch thick minimum cellular neoprene gasket cemented with oil-resistant adhesive and held in place with a retaining strip. Print pockets shall be provided on each door. Two door enclosures shall have a removable center post. Panel doors less than 40 inches high shall be equipped with a 2-point latching mechanism. Panel doors 40 inches high or more shall be equipped with a 3-point latching mechanism.
2. Components and terminals shall be accessible without removing another component except covers. Swing out sections shall be used if mounting space is required that is not normally accessible.
3. Panels shall have open bottoms except where structural members are required.

C. Finish:

1. Panel face openings for mounting equipment shall be smoothly finished cut with counterboring and trim strips provided as required to give a neat finished appearance. Bezels shall be used on all front panel-mounted devices to cover panel cutouts. A chrome-plated or stainless steel bezel shall be used at parting line of panels that have shipping splits or at parting line of panels placed end to end.
2. After fabrication, panel surfaces shall be given a phosphatizing treatment inside and out, and then finished with 2 coats of textured polyurethane enamel. Panel interior shall be painted white, ANSI No. 51. Exterior color will be selected by ENGINEER.
3. Panels shall have identical exterior finishes as selected by ENGINEER. Panel finishes on matching colored panels shall be identical. It is supplier's responsibility to achieve this result, especially for panels fabricated in different shops.

D. Pneumatics:

1. Interior panel piping shall be grouped, supported, and terminated at bottom of panel at bulkhead fittings unless indicated otherwise. Terminations shall be clearly tagged.
2. Tubing shall be color-coded per ISA RP7.2. Pneumatic systems shall be tested per ISA RP7.1.

E. Electrical:

1. Internal panel wiring shall be 19 strand No. 16 AWG, 90oC MTW, Class C stranded, or THHN/THWN approved as 90oC MTW. All panel wiring not run in wire ducts shall be

- bundled and tied. Each wire shall be identified at both ends with same exclusive number. Number shall be same number shown on control schematic. Number shall not be used again for any other purpose. Wires marked differently on each end will not be accepted. Wire markers shall be provided on end of each wire at termination point.
2. Control wiring associated with control circuits de-energized when main disconnect is opened shall be color-coded red. Control wiring associated with control circuits which remains "hot" when main disconnect is opened shall be color-coded yellow. DC control wiring shall be color-coded blue. Ground wires shall be color-coded green. Terminal blocks shall be numbered in numerical order. Yellow wiring leaving panel shall be brought to an isolated set of terminal blocks.
 3. Provide an instrument common bus 0.1 by 0.5 by 6-inch minimum in enclosure and isolated from enclosure. A separate instrument common wire shall be run from each common terminal on an instrument to instrument common bus. Instrument common wires looped from one terminal to another and then to instrument common bus will not be accepted.
 4. Instrument common bus shall be connected to power supply common with a wire or wire braid strap as short as practical and of sufficient capacity to prevent troublesome voltage drop. Common terminals and common bus for instrument common shall be tagged "Instrument Common." Instrument signal wires of 4-20 mA or 1-5V shall be shielded wire. Telephone wires and telemetry equipment interconnection wires shall be shielded wires.
 5. Provide a copper ground bus 0.1 by 0.5 by 6-inch minimum in enclosure to which all instrument grounds and panel enclosure are tied. Separate ground wire shall be run from instrument enclosure ground terminal directly to ground bus. Instrument ground wires looped from one instrument to another will not be accepted. Under no circumstances shall neutral side of power source or any other terminals used for grounding power circuits be used as an instrument common.
 6. Wires to internal components shall be connected to inside of terminal strip. Wires to external components shall be connected to outside of terminal strip. No more than 2 wires shall be connected to one terminal point.
 7. Panel wire duct shall be provided between each row of components and adjacent to each terminal strip. Wire ducts shall be a minimum of 1-inch wide and 3 inches deep with removable snap-on covers and perforated walls for easy wire entrance. Wire ducts shall be constructed of nonmetallic materials with a voltage insulation in excess of maximum voltage carried therein.
 8. Floor-standing panels and consoles shall be equipped with a flange mounted 600V rated main non-automatic trip circuit breaker or disconnect switch. Single phase, 60 hertz power at voltage shown on Drawings shall be supplied to main disconnect. Panel fabricator shall provide any additional voltages and power requirements at control panel to meet requirements of equipment contained therein.
 9. Disconnect and transformer shall have enclosed protected terminations to prevent accidental shock.
 10. Relays, timers, etc., installed on panel subplate shall be provided with a minimum spacing between component and wire duct of 1.5 inches above and 1 inch below. Minimum spacing between adjacent components shall be 0.25 inch. Relays, timers, etc., shown in schematics are intended to show function. Additional relays may be required in conjunction with items shown to provide total number of contacts required. Where limit, pressure, float switches, etc., are used and more than SPDT contacts are indicated by schematics, provide additional contacts required by using auxiliary relays. However, if a DPDT switch is called for, using a SPDT with a relay will not be accepted. All control and

pilot devices such as relays, timers, etc., shall be 120V, 3 amp rated except where noted with coil voltage as required. One N.O. spare contact shall be provided on each relay.

F. Panel/Subplate Layout:

1. Panel face-mounted equipment shall consist of pilot lights, push-buttons, selector switches, meters, indicating timer, etc. Spacing between horizontal rows of components shall be 1.5 inches minimum; spacing between vertical columns of components shall be 1.875 inches minimum. Components shall be grouped and/or located as indicated on Drawings. Distance from bottom row of components to floor shall be not less than 36 inches. Top row of recording and indicating instruments shall be centered approximately 60 inches above floor. Maximum height for annunciator windows shall be 85 inches above floor. In general, indicating lights, push-buttons, etc., shall be mounted in accordance with sequence of operation from left to right and top to bottom.
2. A minimum of 2 inches shall be provided between terminal strips and wire ducts or terminal strips and terminal strips. In general, terminal strips shall be mounted on vertical edges of subplate. Where terminal strips are mounted side-by-side, terminals shall be elevated 1.5 inches above subplate to allow wires to pass underneath.
3. Subplates shall have a minimum of 15 percent spare mounting space, and terminal strips shall have a minimum of 20 percent spare terminal blocks.

2.03 SWITCH, PUSH BUTTONS, LIGHTS

- A. Selector switches shall be 120 VAC/VDC rated, oil-tight construction with standard operator knob.
- B. Start push buttons shall be 120 VAC/VDC rated, oil-tight construction with extended guard and black color insert.
- C. Stop push-buttons shall have a half-guard with red color insert. Contacts shall be rated NEMA B-150 and P-150.
- D. Pilot lights shall be LED push-to-test oil-tight construction with cap colors and voltages as required. Nameplates for each switch and light shall conform to manufacturer's series and type with engraving as called for on Drawings.

2.04 RELAYS

- A. Control Relays: Switching and output relays shall be plug-in type with contacts rated 120 VAC, 3 amp with 120 VAC or 24 VDC coil, indicating light, manual operator, and plastic transparent cover. Relays shall have a retainer mechanism to prevent loosening from vibration. Relays shall not be used for switching 1-5 VDC or 4-20 mA signals associated with instruments.
- B. Intrinsically Safe Isolator Relay:
 1. Intrinsically safe relay shall be provided between raw sewage floats and control circuits or where shown on Drawings.
 2. Relay shall operate at 120 VAC or 24 VDC plus 10 percent with a switch rating of 1 amp rms and maximum holding current of 20 milliamp for solid-state devices. Relay shall be rated for ambient temperatures of 32 degrees F to 120 degrees F.
 3. Output shall be N.O. or N.C. Equipment supplier is responsible for choosing proper output for float specified and circuits specified. If float and circuit are not defined, intrinsically

safe relay shall be of such a polarity as to fail in a safe condition for function being performed.

4. When intrinsically safe relay is required in panels exposed to outdoor temperatures, relays shall be rated for ambient temperatures of -40 to 120 degrees F, or thermostatically controlled heaters must be added to panel to maintain an ambient in panel of 32 to 120 degrees F.

2.05 TIMING DEVICES

- A. Synchronous and solid-state timers shall be plug-in type.
- B. Synchronous timers with ON or OFF delay cycles shall operate at 120 VAC or 24 VDC. Time interval shall be as shown on Drawings or as required.
- C. Solid-state timers with ON or OFF delay cycles shall operate at 120 VAC or 24 VDC. Solid-state device may be analog or digital in operation. Time interval shall be as shown on Drawings or as required.

2.06 TERMINAL BLOCKS

- A. Terminal blocks shall be 300 or 600 volt rated, channel-mounted box lug with pressure plate type or binding head screw type with pressure plate, and shall have a white marking strip. Terminal blocks shall be color-coded according to the following coloring scheme:

Black	120V power circuits de-energized when main disconnect is opened.
White	120V neutral conductors.
Red	120V control circuits de-energized when main disconnect is opened.
Yellow	120V control circuits which remain hot when main disconnect is opened.
Blue	Terminal blocks for DC wiring.
Gray	Terminal blocks for shields in DC wiring.
Green	Ground terminal blocks.
- B. For terminals associated with input cards, individually fused terminal blocks shall be used.
- C. Provide a minimum of 20 percent spare terminals for each type and color of terminal used. All terminals of a given color shall be grouped with other terminals of the same color.

2.07 CONTROL POWER TRANSFORMERS

- A. Control power transformers shall be sized to handle in-rush currents and to accommodate continuous load of circuits plus 25 percent future load with 5 percent or less voltage drop. Transformer primary voltage shall be as indicated on Drawings.

PART 3 - EXECUTION

3.01 GENERAL

- A. Examination, Installation, Field Quality Control, Demonstration: In accordance with Section 40 05 00.

END OF SECTION

DIVISION 43 – PROCESS GAS AND
LIQUID HANDLING, PURIFICATION,
AND STORAGE EQUIPMENT
SECTION 43 11 11
HIGH SPEED TURBO BLOWER

PART 1: GENERAL

1.01 SUMMARY:

A. Section Includes:

1. High Speed Turbo Blowers.
2. Controls.

B. Related Requirements:

1. Section 01 33 00 "Submittals"
2. Section 260583 "Wiring Connections" for execution and product requirements for connecting equipment specified by this Section.
3. Section 262923 "Variable-Frequency Motor Controllers" for execution and product requirements for equipment specified by this Section.
4. Section 400593 "Common Motor Requirements for Process Equipment" for electric motors and accessories normally supplied as part of equipment assemblies.

C. Work Included:

1. Furnish, test, and install one (1) NX700D UL/CE,CSA Listed, factory assembled, high speed, dual layer bump foil air bearing, dual core turbo blower system. The packaged blower system shall be complete, including sound enclosure, motors, variable frequency drives, control panels, programmable logic controllers, inlet air filter/silencers, blow-off valves, check valves, discharge valves, flexible connectors and other appurtenances as shown on the Drawings, as specified herein, and as needed for a complete and operational blower system. Nuts, bolts, pipe spools & elbows, washers, lock-washers and gaskets needed to install the loose appurtenances are not part of the scope of supply.
2. Blower shall be complete pre-packaged unit consisting of PMSM, integrated air filter, variable speed drive, and PLC based LCP.
3. The equipment shall be furnished by a single Manufacturer.

D. Design Criteria:

1. The equipment, sizes, materials, and arrangements described in this specification section are based on recommendations by equipment Manufacturers and shall be considered minimum limits of acceptability. The equipment Manufacturer shall be responsible for design, arrangement and performance of all equipment supplied under this section. Arrangements other than those shown on Drawings shall be subject to the Engineer's approval.
2. All equipment including controls and drives specified herein shall be specifically designed for this service and the environment encountered in this installation.

3. Equipment shall be capable of either continuous or intermittent operation.
4. All equipment, supports, anchors and fasteners shall be of adequate strength to withstand loads associated with starting, turbulence, thrusts, thermal expansion and contraction and other loads encountered under normal operating conditions.

DEFINITIONS

- A. CFD: Computational Fluid Dynamics
- B. LCP: Local Control Panel
- C. PLC: Programmable Logic Controller
- D. PMSM: Permanent Magnet Synchronous Motor
- E. RMS: Remote Technical Support
- F. SPD: Surge Protective Devices
- G. THD: Total Harmonic Distortion
- H. VFD: Variable Frequency Drive

1.01 REFERENCES:

1. Conform to the latest edition of the following reference standards:
2. American National Standards Institute (ANSI)
 - a. ANSI H35.1, Alloy and Temper Designation Systems for Aluminum.
 - b. ANSI B16.1, Cast Iron Pipe Flanges and Flange Fittings, Class 25, 125, 250 and 800.
 - c. ANSI B16.5, Pipe Flanges and Flanged Fittings.
 - d. ANSI-B11.19, Performance Requirements for Safeguarding.
3. American Society of Mechanical Engineers
 - a. ASME PTC-10-65, Power Test Code (PTC) for Centrifugal Compressors and Exhausters.
 - b. ASME PTC-13, Power Test Code (PTC) for Centrifugal Compressors and Exhausters.
4. American Society for Testing and Materials
 - a. ASTM A36, Specifications for Structural Steel.
 - b. ASTM A48, Specification for Gray Iron Castings.
 - c. ASTM A276, Stainless Steel and Heat-Resisting Steel Bars and Shapes.
5. ABMA STD 9, Load Ratings and Fatigue Life for Ball Bearings.
6. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE 519: Harmonic Specifications.
7. National Electrical Manufacturers Association (NEMA).

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer information, including installation instructions, accessories, performance curves with specified operating point plotted, capacities and pressure differentials, power, rpm, sound power levels for both inlet and outlet at rated capacity, electrical characteristics, connection requirements, construction details, material descriptions, dimensions of individual components and profiles and finishes for each component.

- B. Shop Drawings:

1. Furnish diagrams showing complete layout of system, including equipment, piping, valves, wiring and ladder diagrams, controls, and control sequences.
2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
3. Manufacturer and model number of all equipment within this specification and an itemized list of components being furnished.
4. Layout drawings and equipment cut sheets showing dimensions, clearances, sizes, arrangement, and size of connections, supports, anchors and total weights of the supplied product.
5. Detailed specifications and data describing the materials of construction.
6. Wiring Diagrams: For power, signal and control wiring diagrams, including terminals and numbers.
7. Motor requirements in accordance with applicable motor specification section.
8. Equipment weights and lifting points.
9. Submittals shall be signed and sealed by the qualified professional engineer responsible for their preparation.

C. Information Submittals:

1. Factory functional and motor performance test reports.
2. Prior to supplying power feed to unit, coordinate with Engineer to develop a lock-out-tag-out procedure for this unit to be included in the operations and maintenance manual. A laminated copy of the procedure shall be attached to the outside of the unit. See "Water and Sewer Department Water Pollution Control – NSWWTP Lockout Tagout Procedure Blowers 1, 2, 3, 4, 5" attached after this section for reference. Update current procedure to exclude blower 3 references.
3. Special shipping, storage and protection and handling instructions.
4. Manufacturer's instructions for installation.
5. Manufacturer's equipment installation report.
6. Location of nearest stocking distributor for spare parts.
7. Recommended spare parts list to maintain the equipment in service for a period of three years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current pricing information.
8. List special tools, materials and supplies furnished with equipment for use prior to and during start-up and for future maintenance.
9. Warranty certificate.

D. Performance Data:

1. Blower certified past performance test reports for each blower (as outlined later in this specification) and including, but not limited to, certified blower curves showing pressure, capacity, horsepower demand and blower efficiency over the entire operating range of the blower. The equipment Manufacturer shall also indicate separately the pressure, capacity, horsepower demand and efficiency required at the design point(s).
2. Submit complete instruction manual for operation and maintenance of the equipment in accordance with this section. Include the following data:
3. Alignment, adjustment, and repair instructions.
4. Manufacturer's installation and operation instructions.
5. Assembly diagrams.

6. Troubleshooting guide.
7. Recommended spare parts lists and predicted life of parts subject to wear.
8. Scheduled maintenance intervals.
9. Manufacturer's service plans.

1.3 SUBMITTALS

A. Manufacturers Qualifications:

1. Manufacturer shall be experienced in manufacturing dual-core high speed turbo blowers in operation in similar municipal wastewater treatment applications in the USA with oldest unit in operation for over ten (10) years.
2. Manufacturer must have similar blowers permanently installed and operational in at least sixty (60) wastewater treatment facilities in North America. Twenty (20) of these facilities must be similar in design to what is specified.
3. Manufacturer shall have a history of manufacturing, providing and servicing this equipment for at least Ten (10) years in North America.
4. A list of similar installations shall be furnished, to show conformance with article 1.4
5. B.1 to B.3, with the Manufacturer's bid as well as with the shop drawing submittal, including names and telephone numbers of contacts.
6. Manufacturer shall have a domestic service facility and factory personnel located within four hours of driving time.

B. Installers Qualifications: A Manufacturer authorized representative who is trained and approved for installation of units is required for this Project

1.4 EQUIVALENTS AND ALTERNATIVES

A. Acceptable Manufacturers:

1. Basis of Bid
 - a. APG-Neuros.
2. The equipment shown in the contract documents was based on the quality and product design of the Manufacturer of the Basis of Bid offer, the Contractor will rely on the equipment of the Basis of Bid offer for its offer.
3. The first named primary process equipment (Basis of Bid) must be used to establish the Total Tender Price. The named alternative manufacturer will only be considered by the Owner/Engineer following the award of the contract.
4. Alternatives: means that the Contractor may, at its own choice and cost, propose at the time of issuance of an Order to Start Work alternatives that meet at least the quality, performance and experience listed in paragraph 1.4.B of the supplier and product of the Base Offer. The use of an alternatives is subject to the review and consideration of the Owner and/or Engineer after the award of the offer to the lowest responding Bidder. Accepted Alternatives can only participate if listed by Name in Addendum.
5. All Equipment Proposals that are proposed as alternatives must be supported by sufficient technical documentation, such as product performance, shop drawings, evidence of past performance with details of experience, references and to allow proper analysis and evaluation of the Alternative proposed by the Owner to be considered.
6. Any Equivalent proposal must provide the Owner with at least the proposed price savings, energy savings, quality improvements, maintenance, and operating cost savings, scheduling benefits, or any combination thereof. The Alternative proposal must include a

detailed point by point comparison listing differences between the proposed Alternative and the first named supplier, first-named product, or first-named vendor.

7. Technical documentation provided by the contractor must include information verifying that the vendor of the Alternate meets the hydraulic profile and performance requirements, and make all structural building, HVAC mechanical, electrical, instrumentation and control alterations required at no additional cost to the City. Any design drawing modifications to accommodate alternates must be submitted by the Contractor in accordance with all City Standards.
8. The Contractor may use an Equivalent named in the Contract Documents and shall include the supply and installation of such Equivalent and all Product and labour necessary to complete the Work at no additional cost to the City, whether or not the use of such Equivalent affects the design or manner of completion of the Work.
9. The Contractor shall carry out all the necessary modifications to the structural building, especially the HVAC Equipment (considering that the Base Offer Equipment extracts air from outside the ventilation room), mechanical, electrical, instrumentation and control at no additional cost for the Owner to accommodate the proposed Equivalent equipment.
10. CONTRACTOR shall comply with all provisions regarding substitute items and shall include in the Bid and be responsible for the cost of any changes to accommodate substitute equipment including, but not limited to, structural, mechanical, and electrical work. CONTRACTOR shall also pay costs of engineering services for review of substitutes and for revisions of drawings and/or specifications by ENGINEER to accommodate substitutes.
11. Work shown on the drawings is based on APG-Neuros blowers. If an alternate Manufacturer is allowed, it shall be the responsibility of the Contractor to perform any required redesign and coordination associated with, but not limited to, mechanical equipment layout, electrical wiring, conduit and controls and structural/architectural work at no additional cost to the Owner. The proposed redesign shall be subject to review and approval of the Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Shipping: The equipment, material and spare parts shall be shipped complete except where partial disassembly is required by transportation regulations or for the protection of components.
- B. Packaging: Spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.
- C. Unloading: The Contractor shall unload, store and safeguard equipment, materials, and spare parts in accordance with the Manufacturer's instructions.
- D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- E. Protection:
 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Provide additional protection according to manufacturer instructions.

1.6 WARRANTY

- A. Manufacturer shall provide an equipment warranty in the Owner's name for a One (1) year period from substantial completion of the blower equipment.

- B. Blower warranty shall cover all material provided by the Manufacturer for the project for the period required in paragraph A including core, VFD, valves, harmonic filters, transformers, and external control panels. Blower warranty offering a coverage period less than what is specified herein will not be accepted.
- C. Blower Manufacturer shall include a maintenance service contract for the duration of the warranty. Maintenance service contract shall account for bi-annual visits to the owner’s facility for blower maintenance, inspection, implementation of upgrades and refresher training of the staff performed by the Manufacturer’s certified technician.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE CRITERIA

- A. Aeration Blower shall meet the following design conditions. Blower will be evaluated based on the data in the table below. Guaranteed wire power table must be supplied with the bid. Failure to complete and submit guaranteed wire power table with the bid will result in immediate rejection.

Total Number of Blowers	One (1)
Method of Operation	In parallel, continuous, alternating start
Bearing Type	double-layer bump foil air bearing
Drive Type	Direct
Blower Type	High Speed Turbo Blower with Dual Core Technology

Design Ambient Barometric Pressure (psia)	14.35
Design Site Elevation (feet)	604
Design Maximum Inlet Air Temperature (°F) and Relative Humidity (%)	100°F / 60%
Design Minimum Inlet Air Temperature (°F) and Relative Humidity (%)	10°F / 30%
Design Discharge Pressure (psig)	9.50
Discharge Flange Size (ANSI 150 lb.) (in)	2 x 14
VFD-Rated Maximum Motor Horsepower (bhp)	2 x 350
Available Power Voltage	4160
Available Power Phase	3 phase
Maximum Noise at 3 Feet	80 ± 2 dBa
Allowable vibration level	< 4 mm/sec

- B. Blower will be evaluated based on the data in Table 1. Guaranteed wire power Table 1 must be supplied with the bid. Failure to complete and submit guaranteed wire power table with the bid will result in immediate rejection.

Table 1. Guaranteed Wire to Air Power									
Design Points	Number Of Blowers Operating	Blower Airflow Rate	Total System Airflow Rate	Discharge Pressure	Inlet Temperature	Inlet Pressure	Relative Humidity	Blower Wire to Air Power	Total System Wire to Air Power
		SCFM	SCFM	Psig	Deg.F	Psia	%	kW	kW
1	1	14000	14000	9.5	100	14.35	60	539	539

Note: Performance data is based on ASME PTC 10

- C. Bearings: Blower shall have a double-layer type bump foil air bearing and shall not require oils or lubricants for adequate operation. Bearing shall be manufacturer from Inconel alloy and be Teflon coated. Magnetic bearings, single-layer or leaf type air bearings are unacceptable and are cause for immediate rejection.
 - D. Flow Capacity: Blower shall be capable of variable speed operation with a minimum turndown of fifty percent (50%) from its maximum flow capacity and shall use integral variable frequency drives. Each blower shall be capable of operating continuously and satisfactorily at any point between the minimum and maximum flows without any surge, vibration, hunting, or excessive heating of bearings or motor.
 - E. Step-Down Transformer: The blower shall have an integrated 4160V/480V Step-Down Transformer that is integral to the blower package and receives one single power feed. Blowers requiring externally mounted Step-Down Transformers will not be accepted.
 - F. Master Control Panel: Blower shall be designed to operate with Manufacturer's supplied Master Control Panel to maximize overall system efficiency.
 - G. Safety: Complete blower package shall be UL & CSA Listed, with no exception. UL & CSA Listing nameplate to be on package exterior. UL & CSA listing must be for the complete package.
 - H. Testing: Blower shall be factory tested per ASME PTC-10 Performance test to verify flow and wire power at design conditions as well as blower maximum conditions.
 - I. Foundation: Neither special foundations nor anchoring shall be required for installation.
 - J. Elastomeric Couplings: All elastomeric materials for couplings, valves, etc., shall be rated for a minimum 250° F temperature.
- 2.2 HIGH SPEED TURBO BLOWER
- A. Blower shall be designed to maintain a minimum rise-to-surge of 3.0 psig at the maximum flow point and design pressure.
 - B. Impeller: Blower impeller shall be a single-stage backswept blade high efficiency configuration designed using CFD milled from forged aluminum alloy Type 7075 (cast impellers are not permitted), with first critical speed at least 120 percent of the maximum allowable operating speed. The impeller shall be mounted directly to the motor shaft and shall be dynamically balanced. The use of dual impellers is not permitted.

- C. Bearing Life: Bearings shall be sized for a minimum of expected ten (10) years between scheduled overhauls or inspections.
- D. Enclosure: Blower shall be supplied with a sound enclosure covering the entire blower package. The sound enclosure shall be designed for easy inspection and maintenance of all blower package components. Quick release panels shall provide easy and quick access for routine maintenance of the blower and the package components.
- E. Cooling:
 - 1. The currently designed blower system layout is based on blowers that do not require separate exhaust connections for ventilation of cooling air. Blower shall not allow heat caused by motor or electrical cooling to be exhausted into the blower room. Blower and integral VFD shall not require any external cooling devices such as cooling fans, ducting, or external glycol cooling. All heat to be discharged through the process air with no exception. Blowers rejecting heat into the blower room or via a duct to the outside will be immediately rejected.
 - 2. Blower shall be cooled by forced air convection and an internal closed loop water glycol system. No external cooling provisions shall be permitted.
- F. PLC: Integrated blower instrumentation and PLC programming shall enable measurement and display of shaft vibration, and temperatures in the motor windings and bearings.
- G. Vibration: Blower shall be supplied with blower core built in vibration isolating mounts. The blower Manufacturer shall be responsible for demonstrating the vibration of the blower core below the 4 mm/s design limit.
- H. Discharge Cone: Blower shall be supplied with a discharge cone that will be designed to reduce discharge flow speeds below 82 feet/sec, to minimize discharge piping noise and losses, and increase overall efficiency.
- I. Dual Core: Each blower package shall contain two blower cores in a "dual" core arrangement as indicated above. Dual core blowers shall function with either core out of service or with both cores in parallel operation. Blower turndown shall be smooth and continuous from maximum flow with two cores operating to minimum flow with one core operating.

2.3 SPARE PARTS

- A. Blower Furnish the following recommended spare parts with the blower:
 - 1. One (1) set of inlet air filter
- B. Furnish one set of special tools required for complete assembly or disassembly of blower system components, together with a storage box (or boxes) for the same. This tool kit shall be sufficiently complete to permit normal repair and maintenance of all equipment furnished under this project.

2.4 APPURTENANCES

- A. Blower shall be supplied with two (2) 14" EPDM expansion joints to be installed on the discharge piping prior to the main air header to mitigate the transmission of vibration to the discharge piping and allow for thermal expansion of the discharge components. The flexible connector shall be suitable for the maximum operating discharge flow temperature and pressure.
- B. Blower shall be supplied with two (2) 14" wafer style, dual plate check valves that

shall be installed on the discharge cones. Check valves shall be of iron body with aluminum internals and silicon seat.

- C. Blower shall be supplied with one (1) 30" EPDM inlet expansion joint to be installed on the inlet flange of the blower
- D. Blower shall be equipped with an integrated electro-pneumatic blow-off valve actuated by blower pressure and an open/closed status signal is available through the blower PLC.
- E. Blow-off valve discharge shall be supplied with a properly sized blow-off silencer for discharge noise levels not to exceed 90 dBA at 5 feet from blower at HMI height.
- F. Integrated blower dual filtration shall be comprised of a coarse pre-filter and a fine pleated filter media with 90% by weight per ASHRAE 52-76 with an 98% efficiency @ 10 microns (nom). Filter element shall be removable without disconnecting the inlet duct and shall be cleanable by maintenance personnel as a preventative maintenance procedure.
- G. Blower shall be equipped with the following Manufacturer's integrated instrumentation and display on blower HMI.
 - 1. Inlet differential pressure sensors for filter monitoring
 - 2. Discharge differential pressure sensor
 - 3. Inlet and discharge temperature sensors
 - 4. Bearing temperature sensor
 - 5. Motor temperature sensor
 - 6. Ambient pressure transducer
 - 7. Rotor Vibration sensor

2.5 MOTORS

- A. Blower shall be supplied with a high-speed PMSM operating on 460/480 Volts, 3 Phase, 60 Hertz input power to the VFD. Induction or Permanent Magnet Brushless DC Motors shall not be acceptable.
- B. The maximum allowable motor horsepower shall be as specified in paragraph 2.1 Equipment Performance.
- C. The motor shall have a 1.15 service factor.
- D. The Manufacturer shall provide phase monitoring to quickly open the blow off valve and protect the blower if a voltage spike greater than 110% occurs.

2.6 INVERTER/VFD

- A. Blower shall be equipped with a high efficiency UL listed VFD (Variable Frequency Drive) with 97% efficiency at full rated motor speed and power. VFD Manufacturer shall be KEB America or VACON. Proprietary or Non-UL listed VFDs shall not be accepted. If the blower Manufacturer does not use a VFD manufactured by a reputable frequency drive manufacturer in the USA or Canada, a design change must be made to accommodate it. No Substitutions or equal permitted.
- B. Each VFD shall have an operation in the USA or Canada for manufacturing, support, and provision of replacement parts.
- C. Each VFD shall be supplied with a passive harmonic filter that reduces the THD in compliance with IEEE 519 rating. The harmonic filters shall have built-in line input reactors and be supplied by MTE or Manufacturer approved equal. Harmonic filter shall be mounted inside the blower enclosure with no exception. Externally mounted Harmonic Filters will not be accepted and would be cause of immediate rejection.

- D. Each VFD shall have a sinusoidal filter on its output consisting of an L (inductor) and C (capacitor) filter.

2.7 INVERTER/VFD

A. General

1. All components in the control panel shall be completely factory wired and shall include all necessary controls for both the manual/local and automatic/remote operation as indicated on the Drawings and Specifications.
2. The incoming power provided to the panel shall be 480 volt, 3 phases. A suitable thermal-magnetic main circuit breaker sized no less than 125% greater than the connected load shall be provided along with all transformers, relays, etc. necessary to make the panel fully functional. SPDs shall be provided to protect the electrical and control components from excessive voltage and current: Type 1 SPD to protect the 480V loads (VFD) and Type 2 SPD to protect the 120V loads (PLC controller box). The SPD locations shall be strategically selected to have surge immunity and the MCOV shall be not less than 115% of nominal voltage.
3. Wiring shall comply with UL/CSA and the Canadian National Electrical Code.
4. All electrical connections to external devices and equipment shall be provided by the Contractor.
5. Equipment and controls furnished by other Manufacturers shall be provided in accordance with their instructions, where applicable.
6. The blower shall have an Allen Bradley CompactLogix L33 PLC for dual-core blower operation, adjustment, and monitoring. If the blower Manufacturer does not use a PLC based control system in the blower package, a design change must be implemented to accommodate it. No similar or equal shall be accepted.
7. The system shall have an Allen-Bradley PanelView 10" HMI touchscreen for the dual-core blower.

B. Miscellaneous electrical devices

1. A 120 VAC to 24 VDC power supply shall be provided to power the programmable controller inputs and other 24 VDC powered devices. The power supply shall be properly sized for the LCP total load.
2. Provide noise filter to provide clean, noise-free power to programmable controllers.

C. Operator Interface: Provide the following indicators on the operator interface:

1. Blower Status (RUN/STOPPED)
2. Operator Mode Selection
3. System pressure display
4. Blower Local / Remote Control
5. Blower Speed Indication Status
6. Blower Run Times (hours)
7. Blower Amp Draw (amps)
8. System Pressure
9. System Flow

D. Operator interface device

1. The device shall include the following displays:
 - a) History: displays history of sequential alarms with date and time of occurrence.
 - b) Status: One-touch access to display current system operating status.

When the system is running, the display shall show the set point pressure, actual pressure, flow, and speed (0-100%).

- c) Alarm Information: Last alarms recorded in memory are displayed with related detailed information on the alarm including time of occurrence, date, and blower's main operating parameters at the time of alarm and how to correct the alarm condition. Each log shall include individual blower run status, VFD mode, flow, and alarm type.
 - d) Alarm List: One-touch access to an Alarm List of all possible alarms and their current status.
 - e) Daily Log/Total: Displays the individual equipment run times and run times since last reset.
 - f) Scroll Key: Used to scroll up and down through data.
2. Provide Setup Menu system for adjusting all alarm set points, dead band, delays, etc. Display and adjust flow and pressure set points and time delays. Set equipment alternation to manual or automatic. Set the hour of the day for automatic alternation. Restore all factory defaults. Protect adjustable settings with a password.
- E. Alarm systems
1. Local indication of alarm conditions shall be provided on the face of the control panel via a general amber alarm light. Specific alarm messages shall be provided on the operator interface screen.
 2. All alarm conditions shall be displayed at the operator PanelView 10" HMI terminal and shall provide output capability to display all alarm conditions at future SCADA system. No other similar or equal HMI will be acceptable.
- F. SCADA System
1. The following outputs shall be provided to the plant PLC and SCADA system via Ethernet/IP communication.
 - a) All alarms
 - b) All equipment status (On/Off, In Remote/Not in Remote, Off)
 - c) All parameters displayed at the operator interface (blower PLC)
 - d) Motor speed
 - e) Airflow
 - f) Discharge pressure
 - g) Blower run: output
 - h) Blower stop: output
 - i) Blower fault: output
 - j) Remote on: output, enabled when touch screen is placed in remote
 2. The following inputs shall be provided from the plant PLC and SCADA system
 - a) Remote Command: 4-20 mA input for remote control of blower speed
 - b) Remote start: input
 - c) Remote stop: input
- G. System Function
1. Blower LCP shall consist of a PLC-based control system physically located inside the blower enclosure with the following:
 - a) True Programmable Logic Controller:
 - Allen Bradley CompactLogix L33 PLC with Multifunctional PanelView 10" touch screen display capability. If the blower Manufacturer does not use a PLC based control system in the blower package, a design

change must be made to accommodate it. No substitution or equal permitted.

- The PLC shall provide local and remote control, monitoring, and diagnostic capability.
- b) Blower controls shall provide real time monitoring of discharge pressure vs. suction air flow graph indicating current operating point and boundaries.
- c) Blower shall have the ability to be controlled in four different modes.
 - Speed (blower functions independently on speed control)
 - Pressure
 - Flow
 - Dissolved Oxygen
- d) The blower PLC shall have a minimum of 4 operating methods.
 - Local control
 - TCP/IP control
 - Remote Terminal Block control
 - Remote Terminal Block start/stop & Touch screen mode
- e) Blower PLC shall allow the blower to automatically restart, when operating in Terminal Block Mode, in the event of a power failure. The blower PLC shall automatically reset all faults and alarms in the PLC and restart the blower.
- f) Blower LCP shall perform dynamic speed changes when the blower operating point approaches the surge boundary. The PLC automatically increases the speed of the blower such that surge is avoided and the blower BOV is not engaged.
- g) Blower LCP shall automatically perform dynamic adjustments to the blower operating range during seasonal ambient temperature variations such that attainable maximum and minimum flow is always optimized. Dynamic adjustments shall not expose the blower to surge.
- h) Blower PLC shall be capable of time control blower synchronization based on pre-set, user defined settings for flow and speed. The user shall define pre-set operating schedule in the blower PLC. The blower PLC shall allow for a minimum of 6 daily set points for time control ability.
- i) Blower PLC shall allow for alternating operating schedules such that the service hours per blower is either 2:1, 3:1, 4:1 or 5:1 with respect to the standby unit. Ratio Alternation function permits the owner to balance the run time of all blowers or stagger the hours of use to facilitate maintenance scheduling.
- j) Blower PLC controls shall include intuitive, user-friendly fault menus for ease of monitoring diagnostics and troubleshooting.
- k) Blower shall include built in automatic surge protection.
- l) Blower controls shall include built in measurement or calculation for the following parameters:
 - Flow (calculated)
 - Speed (calculated)
 - Temperature (inlet and discharge air, motor, bearing)
 - Pressure

- m) Blower PLC shall be accessible through a touch screen control panel and shall control the blow-off valve for each blower.
- n) All integrated controls shall be enclosed in a sub-panel located inside the blower enclosure.
- o) Turbo Blower PLC shall be capable for communication through Ethernet/IP communication protocol.

2.8 SHOP PAINTING

- A. The blower enclosure shall be painted in Manufacturer's standard color. Painted carbon steel enclosures shall be Zinc primed and dual powder coated with a total dry film thickness of 4 mils dft.

2.9 FACTORY ACCEPTANCE TESTS

- A. All equipment shall be factory tested in accordance with a pre-approved Test Procedure by the Engineer during submittals approval.
- B. Tests shall be performed on the actual assembled unit being supplied for this project. Prototype model tests and calculated values based on previous model testing will not be acceptable.
 - 1. Functional Package Test: Blower shall be given a factory mechanical test to assure mechanical integrity. If the test indicates that adjustments are necessary to ensure conformance with specifications, such adjustments shall be made prior to shipment. Unless otherwise specified, a certified report of a mechanical test of each blower furnished shall be provided. The mechanical test shall consist of operating the units at or near design conditions for a minimum of one (1) hour. Test data shall include duration of the test, bearing temperatures, speed, brake horsepower, pressure and temperature rise and vibration level.
 - 2. Performance Test: A certified report of a performance test of the blowers furnished shall be submitted to the Engineer for review. The performance test shall be performed in accordance with the American Society of Mechanical Engineers (ASME-PTC10) Power Test Code for Displacement Compressors, Vacuum Pumps and Blowers and shall demonstrate the durability with the applicable performance criteria specified.
- C. In the event the blower fails to meet the performance requirements specified, the Engineer shall have the right to require the Manufacturer to modify or replace the blower to meet the performance requirements specified.
- D. Any subsequent tests as may be necessary to ensure compliance with these Specifications shall be performed at no additional cost to the Owner.
- E. Performance tests shall cover the design point 1 contained in paragraph 2.1.B – Table 1 of this specification.
- F. The Manufacturer/Contractor shall notify the Engineer and Owner at least 30 days prior to conducting the factory acceptance tests. The contractor, owner, and engineer shall confirm their decision and/or acceptance of the proposed date within five (5) days of receipt of the Manufacturer's notification.
- G. The Manufacturer shall complete production and acceptance testing of the product on a schedule pre-agreed to with the owner and contractor. Should there be a delay of more than fifteen (15) days for the owner and/or contractor to take delivery, the Manufacturer shall invoice the amount allocated for delivery on the order and store the product on their premises until delivery is approved.


PART 3 - EXECUTION

3.1 FACTORY ACCEPTANCE TESTS

- A. Install and adjust equipment in accordance with the Drawings, approved shop drawings and the Manufacturer's instructions. Do not operate the equipment until the installation is approved by the Manufacturer's representative.
- B. Assembly and Installation
 - 1. Do not drill, cut or weld any component to the blower enclosure or accessories. Only bolted connections will be allowed in the field.
 - 2. Manufacturer to certify installation readiness prior to start-up for conformance to Manufacturer's instructions.
- C. Manufacturer's Services:
 - 1. Provide the services of a qualified, factory-trained representative of the Manufacturer for review of each part of the installation before approval. The contractor shall provide a firm date for the required services with a minimum of four (4) weeks advanced notice. h
 - 2. Hold a Pre-Start-Up meeting with the Manufacturer to verify proper blower installation, Start-Up procedure and operating conditions.
 - 3. Each day shall consist of eight (8) hours at the project site excluding travel time and breaks.
Provide services at no additional cost to the Owner.
 - a) Equipment installation review – Four (4) days in one (1) trip
 - b) Training of Owner's personnel – One (1) day in one (1) trip
 - c) Operation review (6 months later) – Two (2) days in one (1) trip
 - 4. Prior to equipment start-up, the CONTRACTOR, with the assistance of the Manufacturer's representative, shall re-inspect all equipment for proper assembly, installation, and calibration:
 - i. All components shall operate without alarms or shutdowns, except as intended, for eight consecutive hours.
 - ii. Equipment shall operate through the design performance range consistent with available flows. Adjust, balance, calibrate and verify that the equipment, safety devices, controls and process system operate within the design conditions.
- D. Operator Training
 - a) Provide training sessions to instruct the Owner's personnel in the operation and maintenance of the system, in accordance with Section 01 79 00 - Training. Training of the Owner's personnel to be provided by an experienced factory engineer. Training to include a hands-on demonstration of all aspects of the operation and a simulation of all control and alarm functions.
 - b) General Contractor is responsible for overall coordination of training activities.
 - c) Supply Contractor to coordinate training activities with General Contractor and integrate with other training components if necessary. Provide training only after Engineer's acceptance of treatment facility Operating and Maintenance Manuals.

d) Owner to set training date. Supply Contractor to be given at least four (4) weeks' notice prior.

END OF SECTION 431111


	Water and Sewer Department Water Pollution Control - NSWWTP Lockout Tagout Procedure Blowers 1, 2, 3, 4, 5 Blower Building	Version No.	1
		Date Created	12/9/2019
		Date Revised	Click here to enter a date.
		Approved by	
		Control No.	NS-SOP-BLO01
		Section	Safety

LUCITY EQUIPMENT ID: N040-BLO1-BLO01,2,3,4,5	LOCATION (area): Blower Building	WRITTEN BY: Tom Moyes	LOTO DESCRIPTION: Prevent blower starting / air entry.
PURPOSE: To protect authorized employees against unexpected or unplanned entry of air & activation of equipment or energy while servicing equipment.			TRADE(S): <input checked="" type="checkbox"/> Electrical <input checked="" type="checkbox"/> Mechanical <input type="checkbox"/> Operations
SCOPE: Utilize this procedure for all scheduled PM shutdowns, any maintenance task that requires you to place your body in harm's way of the equipment, or if you must leave the area while the equipment is in service.			
4 LOTO POINTS		Failure to follow LOTO procedure may result in injury. Electrical Qualified Person must wear NFPA 70E ARC FLASH PPE before opening electrical cabinet doors.	

Lockout Tagout Application

1. Notify affected personnel. 2. Properly shut down machine. 3. Isolate all energy sources. 4. Apply lockout devices, locks, & tags. 5. Verify total de-energization of all sources. NOTE: (Steps in parenthesis) are: "As Required" or "Not Practical" or "Redundant."

Blowers 1,2,3,4,5	E1 Panel N040-BLO01,2,3,4,5 Depress LOCAL STOP for relevant blower. LOTO.	E2 MCC01 Soft start breaker for relevant blower, switch to OFF. Lock & tag.
		
(E3) Verify the soft start is off & powered down.	E4 Close inlet valve. Switch inlet valve breaker to OFF. LOTO.	M5 Discharge valve, close. Lock & tag chain. Don't rely on discharge check valve to hold.
		

 CITY OF Tulsa <i>A New Kind of Energy.</i>	Water and Sewer Department Water Pollution Control - NSWWTP Lockout Tagout Procedure Blowers 1, 2, 3, 4, 5 Blower Building	Version No.	1
		Date Created	12/9/2019
		Date Revised	Click here to enter a date.
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		Control No.	NS-SOP-BLO01
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#	Energy Source	Location of Energy	Method of LOTO	LOTO Device(s)
1	E1 Electrical	Panel N040-BLO01,2,3,4,5 Depress LOCAL STOP.	Lock the push-switch.	Lock & tag.
2	E2 Electrical	MCC01 Breaker soft start for relevant blower, switch to OFF.	Lock the breaker.	Lock & tag.
3	(E3 Electrical)	Verify the relevant soft start is off & powered down.	Switch soft start to OFF per E2.	Not necessary to lock out, redundant. Place tag.
4	E4 Electrical	Close inlet valve. Switch breaker for inlet valve to OFF.	Lock the breaker.	Lock & tag.
5	M5 Mechanical	Close discharge valve. CAUTION: Don't rely on discharge check valve to hold.	Lock discharge valve chain closed.	Lock & tag.

SHUTDOWN, LOCK, TAG, & TEST SOURCE


#	STEP	DESCRIPTION
1	Required PPE	LOTO equipment, Site specific required PPE, ELECTRICAL QUALIFIED PERSON MUST WEAR NFPA 70E PPE PER ARC FLASH TAG PRIOR TO OPENING CABINET DOORS, ETC.
2	Notify Employees	Notify affected personnel of LOTO equipment.
3	Review Lockout Tagout Procedure	Review LOTO details in NS-SOG-600.
4	Perform Equipment Stop	Operations to shut off equipment in SCADA as required.
5	Isolate Energy	Shut off equipment per Lockout Tagout Application Process.
6	Lockout Energy	Install all LOTO devices.
7	Dissipate Energy	Dissipate all stored energy.
8	Attempt Restart	Verify all electrical & mechanical devices in place to not allow a start.

Lockout Tagout Removal Process

1. Ensure all tools & items have been removed. 2. Confirm all employees are safely located. 3. Verify controls are in neutral. 4. Remove LOTO devices & tags, and reenergize machine. 5. Notify affected employees that servicing is complete. 6. Verify total energization of all sources.

RESTORE TO SERVICE SEQUENCE


#	STEP	DESCRIPTION
1	Check Equipment	Verify lubes, filters, coolants, all components, fasteners, & guards in place.
2	Check Area	Remove tools & slip/trip hazards.
3	Verify Equipment	Notify affected personnel LOTO will be removed.
4	Remove Lockout Tagout	Remove LOTO in reverse order.
5	Notify Employees	Have Operators check for proper SCADA operations as required.


	Water and Sewer Department Water Pollution Control - NSWWTP Lockout Tagout Procedure Blowers 1, 2, 3, 4, 5 Blower Building	Version No.	1
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