

PROJECT MANUAL
for the
**REAERATION BLOWERS AND AERATION
DIFFUSERS AT THE WASTEWATER TREATMENT
PLANT**

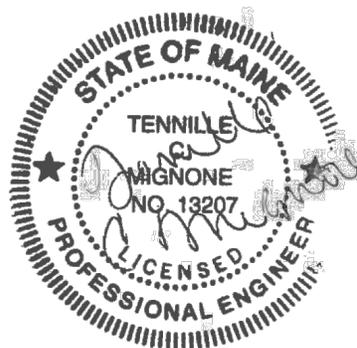


CITY OF BANGOR

AECOM

250 Apollo Drive
Chelmsford, MA 01824

JUNE 2025



CAROLLYNN LEAR
CITY MANAGER

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A. NOTICE TO CONTRACTORS

SECTION A

NOTICE TO CONTRACTORS

Bids are requested for the

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
WASTEWATER TREATMENT PLANT

The project includes replacing reaeration blowers and replacing the Aeration Diffusers, and appurtenances as shown on the drawings and as noted in the specifications.

All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion.

For consideration, the attached bid form sealed in an envelope, distinctly marked

“REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
WASTEWATER TREATMENT PLANT”

must be received at the Office of the City of Bangor Purchasing Coordinator by

2:00 PM, Wednesday, November 12, 2025.

at which time all proposals will be opened and read aloud.

A **Pre-Bid** meeting will be held on **Wednesday, October 16, 2025 at 1:00 P.M.** at the City of Bangor’s Wastewater Treatment Plant, 760 Main Street, Bangor, Maine 04401.

The City reserves the right to waive any informalities in or to reject any or all bids submitted, or to accept any proposal considered to be the most advantageous to the City.

Specifications may be obtained at the Engineering Department, City Hall, 73 Harlow Street, Bangor, Maine 04401, for a one-hundred dollar (\$100.00) charge. If plans need to be mailed, an additional fee of fifty (\$50.00) will be charged.

B. INFORMATION FOR BIDDERS

SECTION B

INFORMATION FOR BIDDERS

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT

The project includes replacing reaeration blowers and replacing the aeration diffusers, and appurtenances as shown on the drawings and as noted in the specifications.

All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion.

Description of Work

The work contemplated under the terms of this contract consists of the following general items:

- Remove and replace reaeration blowers
- Remove and replace Aeration Diffusers
- Remove and replace drain valves
- Perform other work as shown on plans
- Removal and reinstallation of all existing gratings, metal plates, railings and hardware necessary to complete the work
- Coordinate with other work at the WWTP and operation of the WWTP.

Definitions

The following terms or, in the case of Owner, Engineer, or Contractor, the singular, masculine pronouns used in their place, shall have the following meanings within the context of this Contract:

Owner - The City of Bangor, Maine acting through its duly authorized representatives

Engineer – AECOM Technical Services, Inc., 250 Apollo Drive, Chelmsford, MA, or its duly authorized representatives

Contractor - The individual, firm, or corporation to whom the contract has been awarded whether acting on his own or through subcontractors or employees

Contract - The Contract shall be deemed to include the Notice to Contractor, Information for Bidders, the Bid Form, the Contract Agreement, the Performance and Payment Bond(s), the Specifications and Plans, any addenda which may be issued to any of the foregoing, and all other provisions which may be required by law to be included in this contract whether actually included or not.

Withdrawal of Bids

The Owner may consider informal any bid not in accordance with the provisions hereof and may waive any informalities in, or reject, any or all bids. Any bidder may withdraw his bid prior to opening of the bids. Any bid received after the time and date specified will not be considered. No bidder may withdraw his bid within 30 days after the actual bid opening.

Bid Submitted

Bids must be submitted on the prescribed form and all blank spaces must be filled in, in ink, in both words and figures. The price quoted in the bid shall be for the total project, complete and shall include all labor, tools, materials, supplies, equipment, and all else necessary for or incidental thereto.

Qualified Bidder

The Owner may make such investigations as he may deem necessary to determine the ability of any bidder or bidders to perform the work, and the bidder(s) shall furnish to the Owner all such information and data pertinent to this investigation as the Owner may request. The Owner reserves the right to reject any bid after evidence submitted or investigation of the bidder fails to satisfy the Owner that such bidder is properly qualified to carry out the obligations of the Contract and to complete the work contemplated therein. Conditional bids will not be accepted.

Bidder's Obligation

At the time of the opening of the bids it will be presumed that each bidder will have inspected the site and will have thoroughly familiarized himself with the Contract documents, including the plans, specifications, and any addenda which may have been issued thereto. Failure of the bidder to receive and examine any form, instrument, or document, or to visit and examine the site itself will not in any way relieve the successful bidder from any obligation in respect to his bid or to the terms of this contract.

Performance Bond and Labor and Materials Bond

Simultaneously with his delivery of the Contract to the Owner, the successful bidder shall deliver to the Owner an executed Performance Bond and an executed Labor and Materials Bond, each in the amount of 100% of the total bid price, as security for the faithful performance of the Contract and for the payment of all persons performing labor or furnishing materials in connection therewith. These bonds shall be on the prescribed forms and shall be furnished by a surety company or companies listed on the current Circular 570 of the U.S. Treasury Department which company or companies shall also have a record of service satisfactory to the Owner, shall be authorized to do business in the State of Maine and shall be independent of the Contractor.

Work Under AECOM

All work under this project shall be under the direct supervision of AECOM. All decisions pertaining to the new construction shall be final and binding.

Questions During Bidding

No interpretation of the meaning of the plans, specifications or other Contract documents will be made to any bidder orally. Every request for such interpretation must be in writing and must be received no later than 4:30 p.m. on October **24**, 2025 at bids@bangormaine.gov, subject line: *REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT* Attn: Derrick Bellavance & Scott Paradis. The City will provide a response to all questions received by the deadline by 4:30 P.M. on Friday October 31, 2025. This response will be in the form of an addendum, accessible on the City's website. Notifications will be sent to those who have signed up to receive notifications at www.bangormaine.gov/bids through NotifyME. Notifications will be sent when new addenda are released.

Any and all such interpretations and any supplemental instructions will be written addenda to the specifications which, if issued, will be mailed by registered mail with return receipt requested to all prospective bidders at least three (3) working days prior to the bid opening date. Failure of any bidder to receive any addenda or interpretation thus mailed will not relieve the bidder of his obligation under the bid submitted. All addenda so issued will become an integral part of the Contract documents.

Terms and Conditions

The bidder is hereby notified that the construction terms and conditions set forth in the Contract documents will be rigidly enforced, that it is the intention of the Owner to maintain full time inspection during the period of construction, and that only first quality materials and workmanship will be accepted. Neither the fact of such inspection, nor the omission thereof,

will imply acceptance by the Owner of any or all of the work performed under this contract or relieve the Contractor of any responsibility for the successful completion of all the terms of this Contract subject to final inspection and review by the Owner.

The City of Bangor is a municipal corporation duly organized under the laws of the State of Maine and therefore is not required to file proof of exemption to the Maine State sales tax.

Time of Completion

All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion. After which time liquidated damages will be assessed at \$2,500.00 (two thousand five hundred dollars) per calendar day.

C. BID FORM

SECTION C

BID FORM

To the City of Bangor, Maine, herein called the Owner, acting through its City Manager for the construction of the REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT, together with all related work specified in the specifications, and any other work necessary or incidental thereto.

The undersigned, as Bidder, herein referred to as singular and masculine, declares that the only parties interested in the bid as principals are named herein; that this bid is made without collusion with any other person, firm, or corporation; that no officer or agent of the Owner is directly or indirectly interested in this bid; that he has carefully examined the location of the proposed work, the annexed form of contract, and the plans and specifications therein referred to and he proposes and agrees that if this bid is accepted he will contract with the Owner, in the form of the copy of the Contract Agreement deposited in the office of the Engineer and attached hereto, to provide all necessary machinery, tools, apparatus, and other means of construction and to do all the work and furnish all the materials specified in this contract in the manner and time therein prescribed, and according to the requirements of the Engineer as therein set forth and that he will take in full payment for the work thereof the following unit prices.

Item No.	Estimated Quantity	Brief Description; Unit or Lump Sum Price Bid In Both Words and Figures	Total Price In Figures
1.	1	Mobilization/Demobilization (not to exceed 5% of bid) the Lump Sum Price of _____ Dollars per lump sum (\$_____/LS	\$ _____
2.	1	Remove, Dispose, and Replace Reaeration Blowers at WWTP the Lump Sum price of _____ Dollars per lump sum (\$_____/LS	\$ _____
3.	1	Remove and Replace Aeration Diffusers at the WWTP the Lump Sum price of _____ Dollars per lump sum (\$_____/LS	\$ _____

Item No.	Estimated Quantity	Brief Description; Unit or Lump Sum Price Bid In Both Words and Figures	Total Price In Figures
4.	11	Remove, Dispose of, and Replace Drain Valves at the WWTP the unit price of _____ Dollars per valve (\$ _____)/LS	\$ _____
5.	1	Furnish and Install Knife Gate Valve at WWTP the Lump Sum price of _____ Dollars per lump sum (\$ _____)/LS	\$ _____

TOTAL BASE BID (IN FIGURES):\$ _____

TOTAL BASE BID (IN WORDS): _____

_____ Dollars
and _____ Cents

Amounts must be shown in both words and figures. In case of discrepancy, the amount in words will govern.

*I hereby acknowledge by my signature receipt of each numbered addendum:

Addendum Number 1. _____
Contractor's Signature

Addendum Number 2. _____
Contractor's Signature

*(Signature required to acknowledge receipt of each addendum as may be issued. Sign only upon receipt of written addendum.)

The foregoing prices shall include all labor, materials, equipment, overhead, profit, insurance, etc., to cover the finished work of the several kinds called for.

Business Name

Street Address

City, State, Zip Code Telephone

By: _____
Name (Printed or typed) Title

Residence Address

Signature Date

D. CONTRACT AGREEMENT

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
WASTEWATER TREATMENT PLANT

SECTION D

CONTRACT AGREEMENT

CITY OF BANGOR

This agreement is made this _____ day of _____, 20 by and between

(hereinafter referred to as the "Contractor"),

and the City of Bangor, hereinafter referred to as the "Owner,"),

WITNESSETH, that the Contractor and the Owner, for consideration stated herein mutually agree as follows:

ARTICLE 1 - Statement of the Work

The Contractor shall furnish the materials and perform the work for the Owner for the consideration set forth in the Bid and in strict accordance with the Contract, as the word "Contract" is hereinafter defined.

ARTICLE 2 - The Contract

The following shall be deemed to be part of this Contract:

- A. Notice to Contractor
- B. Information for Bidders
- C. Bid Form
- D. Contract Agreement
- E. Performance and Payment Bonds
- F. Specifications and Plans
- G. Addenda, if any, issued to any of the foregoing
- H. Any and all other provisions required by law to be included in this Contract, whether actually included or not.

All of the foregoing, taken as a whole, shall constitute the Contract document.
In case of conflict, the Articles of Section D will prevail.

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
WASTEWATER TREATMENT PLANT

ARTICLE 3 - Definitions

The following terms and/or the singular, masculine pronouns used in their place, shall have the following meanings within the context of this Contract:

- Owner - The City of Bangor, Maine acting through its duly authorized representatives.
- Engineer – AECOM, or its duly authorized representatives.
- Contractor - The individual, firm, or corporation to whom the contract has been awarded whether acting on his own or through subcontractors or employees.

ARTICLE 4 - Obligations and Liability of the Contractor

The Contractor shall furnish all labor, materials, tools and appliances, except as may be otherwise specified herein, and all else necessary for or incidental to the proper performance and completion of all work required by this Contract in the manner and within the time herein specified. He shall complete the entire work subject to the direction of the Engineer and to the Engineer's complete satisfaction in accordance with the specifications and plans which are a part hereof, at the prices herein agreed upon and fixed therefore.

The Contractor shall conduct his work in such manner as to interfere as little as possible with private business and/or public travel and to protect both life and property. He shall, at his own expense, provide all necessary fences, barricades, lights, watchmen, flagmen, traffic directors, etc. and shall take any and all such other precautionary measures as common sense might dictate or as may be required by the Engineer. Safe access to each property must be maintained. The Contractor will be held solely liable for any and all damages occasioned in any way by his act or failure to act, or by any such action or negligence on the part of his agents, employees, suppliers, or workmen.

The Contractor shall take full responsibility for the work done under this Contract, for the protection of all such work, and for the prevention of injuries to persons and/or damage to property, including utilities, on or about the work site. He shall under no circumstances be relieved of his responsibility by any right of the Engineer to give permission or issue orders relating to any part of the work, or by any such permission given, or by the failure of the Engineer to issue any such orders. The Contractor shall bear any and all losses resulting to him or to the Owner on account of the amount or character of the work, or because the nature of the land in or on which the work is done is different from what was estimated or expected, or on account of the weather, elements, acts of God, or any other causes whatsoever. The Contractor shall assume the defense of any and all claims of any nature whatsoever against the Contractor or the Owner, and shall indemnify, save harmless, and insure the Owner and Owner's officers and/or agents against all claims arising out of injury or damage to persons, corporations, or property whether such claims arise out of negligence or not, or whether said claims are for unavoidable damage or not, and from all claims relating to labor and /or materials furnished for the work. The Contractor will not be required to indemnify the Owner against damage or claims occasioned by acts of the Owner.

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
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ARTICLE 5 - Engineer's Authority

The Engineer will in all cases determine the amount, quality, acceptability and fitness of the several kinds of work and materials which are to be paid for under this contract. He will determine all questions in relation to said work and the construction thereof, and will in all cases decide every question of fact which may arise relative to the fulfillment of this contract on the part of the Owner and on the part of the Contractor. The estimate and decision will be final and conclusive upon all parties to this Contract.

Any differences or conflicts which may arise between the Contractor and other contractors of the Owner in regard to their work will be adjusted and determined by the Engineer.

The Engineer will make all necessary explanations as to the meaning and intent of the plans and specifications and will give all necessary orders and directions.

The order or sequence of execution of the work and the general conduct of the work will be subject to the approval of the Engineer and, should public necessity or welfare so require, to his direction. No such approval or direction will, however, in any way affect the responsibility of the Contractor in the conduct of the work.

ARTICLE 6 - Superintendence

The Contractor shall keep competent supervisory personnel at the site at all times during which work is in progress. He shall designate in writing, before commencement of work under this Contract, a project superintendent who shall be an employee of the Contractor and who shall have complete authority to represent and to act on behalf of the Contractor. The Engineer shall be notified in writing prior to any change in superintendent assignment.

The superintendent shall receive on behalf of the Contractor all communications from the Engineer. Communications of major importance will be confirmed in writing upon request from the Contractor.

ARTICLE 7 - Discrepancies, Errors and Omissions

The plans and specifications are intended to be explanatory of each other, but should any discrepancy appear or any misunderstanding arise as to the import of anything contained in either, the interpretation and decision of the Engineer will be final and binding on both parties to this contract.

Any correction of errors or omissions in plans and/or specifications may be made by the Engineer when such correction is necessary for the proper fulfillment of their intention as construed by him. Where said correction of errors or omissions, except as provided in the next two (2) paragraphs, adds to the amount of work to be done by the Contractor, compensation for said additional work will be made in accordance with ARTICLE 28 hereof regarding Extra Work except where the additional work may be classed under some item of work for which a unit price is included in the bid, in which case compensation will be made accordingly.

The fact that specific mention of a fixture, or of any part of the work, is omitted in the specifications, whether intentionally or otherwise, when the same is clearly shown or indicated on the plans or is

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
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- f. If any of the work performed under the contract includes blasting, excavating, pile driving or caisson work; moving, shoring, underpinning, razing or demolition of any structure or removal or rebuilding of any structural support thereof, or any subsurface or underground work, the Comprehensive General Liability Insurance policy shall include coverage for the explosion, collapse and underground hazards.

ARTICLE 9 - Patents

The Contractor shall indemnify and save harmless the Owner, and all persons acting for or on behalf of the Owner, from all claims and liability of any nature or kind including costs and expenses arising from or occasioned by any infringement or alleged infringement of patent rights on any invention, process, article or apparatus, or any part thereof, furnished and installed by said Contractor or arising from or occasioned by the use or manufacture thereof, including their use by the Owner.

ARTICLE 10 - Compliance with Laws

The Contractor shall keep himself fully informed of all existing and future state and national laws and municipal ordinances and all regulations in any manner affecting those engaged or employed in the work, or the materials used in the work, or in any way affecting the conduct of the work, and of all such orders and decrees of bodies or tribunals having any jurisdiction or authority over the same. If any discrepancy or inconsistency is discovered in the plans, specifications, or elsewhere in this Contract in relation to any such law, ordinance, regulation, order or decree, he shall forthwith report the same to the Engineer in writing. He shall at all times himself observe and comply with, and cause all his agents and employees to observe and comply with, all such existing and future laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Owner and all officers and agents of the Owner against any claim arising from or based upon violation of any such laws, ordinances, regulations, orders or decrees, whether by himself or his employees.

ARTICLE 11 - Permits

The Contractor shall, at his own expense, obtain all necessary permits from the county, municipal, and/or other public authorities; he shall give all notices required by law or ordinances; and he shall post all bonds and pay all fees and charges incident to the due and lawful prosecution of the work covered by this Contract.

ARTICLE 12 - Contractor Not to Sublet or Assign

The Contractor shall give his personal attention constantly to the faithful prosecution of the work, shall keep the same under his personal control, and shall not assign by power of attorney or otherwise, nor sublet the work or any part thereof without the previous written consent of the Owner, and shall not either legally or equitably assign any of the moneys payable under this agreement, or his claim thereto, unless by and with the like consent of the Owner and the surety on the bond(s).

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE
WASTEWATER TREATMENT PLANT

ARTICLE 13 - Time of Beginning Work

Except as herein provided, the Contractor shall commence work at such points as the Engineer may direct or approve. Such time of starting may be postponed but only by written agreement between the Owner and Contractor and then only because of expected delays in receipt of materials and equipment, or if the season be unsuitable for commencement of the work, or because of other contingency clearly beyond the control or responsibility of the Contractor.

ARTICLE 14 - Delay by Owner

The Owner may delay the beginning of the work or any part thereof if the necessary lands or rights-of-way for such work shall not have been obtained by the Owner or if necessary, materials or equipment to be furnished by the Owner are not delivered. The Contractor shall have no claim for damages on account of such delay, but shall be entitled to so much additional time wherein to perform and complete this contract as the Engineer shall certify in writing to be just.

ARTICLE 15 - Time of Completion

The rate of progress shall be such that the whole work shall be performed in accordance with the terms of this Contract within the number of calendar days stipulated in the bid unless and except as any part may be delayed under the provisions of this Contract. All work shall in any case be complete on or before any specific date of completion which may be specified elsewhere herein.

It is agreed that the rate of progress herein required has been purposely made low enough to allow for ordinary delays incident to construction work of this character. No extension of time will be made for ordinary delays, inclement weather and/or accidents and the occurrence of such will not relieve the Contractor from the necessity of maintaining this rate of progress.

If delays are caused by acts of God, acts of Government or State, strikes, extra work, floods or other contingencies clearly beyond the control or responsibility of the Contractor, the Contractor will be entitled to so much additional time wherein to complete this Contract as the Engineer shall certify in writing to be just.

The time in which work under this Contract is to be performed and completed is of the essence. All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion.

ARTICLE 16 - Liquidated Damages

In case the Contractor fails satisfactorily to complete the entire work, or any phase of the work, contemplated and provided for under this Contract on or before the date of completion determined as described elsewhere herein, the Owner shall deduct from the payments otherwise due the Contractor each month the sum of two thousand five hundred dollars (\$2,500.00) for each calendar day, excluding only Sundays and legal holidays, of delay, which sum is agreed upon not as a penalty but as fixed and liquidated damages for each day of such delay to be paid in full and subject to no deduction. If the payments otherwise due the Contractor are less than the amount of such liquidated damages,

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said damages shall be deducted from any other moneys due or to become due the Contractor, and in case such damages shall exceed the amount of all moneys due or to become due the Contractor then the Contractor or his surety shall pay the balance to the Owner.

ARTICLE 17 - Night and Sunday Work

No night work requiring the presence of the Engineer or inspector will be permitted except in the case of emergency and then only to such an extent as is absolutely necessary and with written permission of the Engineer. In the case of a regular gang organized specifically for regular and continuous night work this clause may be waived but only when so specified elsewhere herein or when such work shall be deemed necessary and/or beneficial to the Owner by the Engineer, provision for night time inspection and payment therefore has been made and agreed upon by the Contractor and the Engineer, and the foregoing has been certified in writing by the Engineer.

No Sunday work will be permitted except in the case of great emergency and then only with the written consent of the Engineer and only to such an extent as he may judge necessary. See Section E, Special Provisions for special night-time work hours.

ARTICLE 18 - Contractor to Employ Competent Workers

The Contractor shall employ only competent workers and whenever the Engineer shall notify the Contractor in writing that any person or persons employed under this Contract are, in his opinion, incompetent, unfaithful, disorderly, or in any other way unsatisfactory or not employed in accordance with the provisions of this Contract, then such person or persons shall be discharged from work under this Contract and shall not again be employed under this Contract except by written consent of the Engineer.

ARTICLE 19 - Contractor to Employ Sufficient Labor and Equipment

If, in the opinion of the Engineer, the Contractor is not employing sufficient labor or equipment to complete this Contract satisfactorily and within the time specified, the Engineer will so notify the Contractor in writing and the Contractor shall, immediately upon receipt of such notice, employ such additional labor and/or equipment as may be deemed necessary by the Engineer.

ARTICLE 20 - Intoxicating Substances

The Contractor shall neither permit on site nor suffer the introduction or use on site of alcoholic beverages, drugs, or other controlled substances which might in any way impair the judgment, alertness, or efficiency of any person or persons employed under this Contract or which might be used in violation of any State or Federal law or local ordinance.

ARTICLE 21 - Access to Work

The Owner, the Engineer, and their agents and employees shall be permitted access to all parts of the work site at all times throughout the duration of this Contract, and the Contractor shall at all times provide safe and proper facilities therefore.

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ARTICLE 22 - Examination of Work

The Engineer shall be furnished with every reasonable facility for ascertaining that all work is in accordance with the requirements and intent of this Contract, even to the extent of uncovering or taking down portions of finished work.

Should the work thus exposed or examined prove satisfactory, the uncovering or taking down and the replacement material and rebuilding of the work shall be considered as extra work, as defined and provided for elsewhere herein, unless the original work was done in the absence of the Engineer or his inspector without the Engineer's written authorization. In the latter case, and/or if unsatisfactory work should be so uncovered, then all such uncovering, taking down, replacement, and rebuilding, together with the repair or replacement of any and all such unsatisfactory work as may have been so uncovered, will be at the Contractor's sole cost and expense.

ARTICLE 23 - Defective Work

Inspection of the work by the Engineer and/or his agents shall neither imply that all such work will prove acceptable to the Owner nor will it relieve the Contractor from any obligations or responsibility whatsoever under the terms of this Contract. Any and all defective work and/or materials shall be replaced by the Contractor, at his sole expense, at any time prior to final acceptance of the work as such may be discovered, regardless of whether such work has previously been inspected and/or included in estimates for partial payment. Any material furnished by the Contractor which shall be judged by the Engineer, at any time, to be defective and/or not in conformance with the specifications shall be immediately removed from the site and replaced at the Contractor's sole cost and expense, as shall any materials or goods furnished by the Owner which have been, in the opinion of the Engineer, damaged by the Contractor, his agents or employees.

ARTICLE 24 - Protection Against Water and Storm

The Contractor shall take all necessary precautions to prevent damage to the work by storms or by water entering the work site directly or through the ground. In case of damage by storms or water, the Contractor shall make such repairs and/or replacements or rebuild such parts of the work as the Engineer may require in order that the finished work shall be completed in full accord with the plans and specifications.

The Engineer may prohibit the carrying out of any work at any time that, in his judgment, the conditions are not suitable or the proper precautions are not being taken, whatever the whether or season may be.

ARTICLE 25 - Mistakes of the Contractor

The Contractor shall pay to the Owner all expenses, losses, and/or damages, as determined by the Engineer, incurred in consequence of any defect, omission, or mistake of the Contractor, his agents or employees, or the making good thereof.

ARTICLE 26 - Right to Materials

REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT

Nothing in this Contract shall be construed as vesting in the Contractor any right of property in the materials used after they have been attached or affixed to the work or the soil, but all such materials shall, upon being so attached or affixed, become the property of the Owner.

ARTICLE 27 - Alterations

The Engineer may make alterations in the line, grade, plan, form, dimensions or materials of the work or any part thereof, either before or after the commencement of construction. If such alterations increase or diminish the quantity of work to be done, adjustment for such increase or decrease shall be made at the unit prices stipulated for such work under this contract, except that if unit prices are not stipulated for such work, compensation for increased work will be made under the provisions for Extra Work made elsewhere herein, and for decreased work the Contractor shall allow the Owner a reasonable credit as determined by the Engineer. If such alterations diminish the quantity of work to be done, they shall not warrant any claim for damages or for anticipated profits on the work that is dispensed with.

ARTICLE 28 - Extra Work

The Contractor shall do any work incidental to the proper completion of the Contract not otherwise provided for when and as so ordered, in writing, by the Engineer, either (a) at a price agreed upon before the work is commenced and named in the written order for the work, or (b) if the Engineer so elects, for the reasonable cost of said work, as determined by the Engineer, plus fifteen (15) percent of such cost. No extra work will be paid for unless specifically ordered as such by the Engineer in writing.

The Contractor shall, when so requested by the Engineer, furnish itemized statements of the cost of the work ordered, and shall give the Engineer access to the accounts, bills, and vouchers relating thereto.

The Engineer shall include in the cost of extra work under (b) above the reasonable cost to the Contractor of all materials used, of all labor common and skilled and of foremen, and the fair rental of all machinery used upon the extra work for the period of such use.

The fair rental for all machinery shall be based upon the most recent edition of "Compilation of Rental Rates for Construction Equipment" as published by the Associated Equipment Distributors, rental rates established by the Maine State Department of Transportation, or similar publication approved by the Engineer. Rental for machinery which was upon the work site immediately before, or which will be required by or used upon the work after the extra work is done, shall be based upon an appropriate fraction of the approved monthly rate schedule. If said work requires the use of machinery not upon the work site or otherwise to be used upon the work, then the cost of transportation, not exceeding a total round trip distance of 150 miles, of such machinery to and from the work shall be added to the fair rental as accepted by the Engineer.

The Engineer shall include in the cost of extra work the cost to the Contractor of additional premiums paid on the required insurance on account of such extra work, and the cost of Social Security and/or other direct assessment upon the Contractor's payroll by Federal or other properly authorized public agencies. The Engineer shall not include in the cost of extra work any cost or rental of small tools,

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buildings, or any portion of the time of the Contractor or his superintendent, or any allowance for use of capital or the premium on the bond as assessed upon the amount of extra work, these items being considered as being covered by the fifteen (15) percent added to the reasonable cost.

ARTICLE 29 - Extension of Time on Account of Extra Work

When extra work ordered at any time during the progress of the work is such as to require, in the opinion of the Engineer, an unavoidable increase in the amount of time necessary for completion of the Contract, then a suitable extension of time will be added to the completion date.

ARTICLE 30 - Changes not to Affect Bond

It is distinctly agreed and understood that any changes made in or to the plans and/or specifications, whether the amount of work to be done under this Contract should thereby be affected or not, or any change or changes in the manner or time of payments made by the Owner to the Contractor, shall in no wise annul, release, or affect the liability and/or surety on the bond or bonds provided by the Contractor.

ARTICLE 31 - Claims for Damages

If the Contractor claims compensation for any damages sustained by breach of Contract or otherwise, be the same based on claims that due and full credit has not been given the Contractor for work performed or materials furnished in accordance with the terms of the Contract or for any other cause, he shall, promptly after the sustaining of any such damage, make a written statement to the Engineer of the nature of the damage sustained and shall, on or before the fifteenth day of the month following that in which the damage shall have been sustained, file with the Engineer an itemized statement of the details and amount of such damage. Unless such statement is made in such time and manner as thus required his claim for compensation will be forfeited and invalidated and he will not be entitled to payment on account of any such damage.

ARTICLE 32 - Abandonment of Work

If the work to be done under this Contract shall be abandoned, or if this Contract or any part thereof shall be sublet without the previous written consent of the Owner, or if the Contract or any claim thereunder shall be assigned by the Contractor otherwise than as herein specified, or if at any time the Engineer shall be of the opinion, and shall so certify in writing, that the conditions herein specified as to the rate of progress of work under this Contract are not fulfilled, or that the work or any part thereof is unnecessarily or unreasonably delayed, or that the Contractor has violated any of the provisions of this Contract, the Owner may notify the Contractor by a written order with a copy to the home office of the surety to discontinue all work or any part thereof, and thereupon the Contractor shall discontinue such work or such part thereof as the Owner may designate, and the Owner may thereupon, by contract or otherwise, as the Owner may determine, complete the work or any part thereof, and charge the entire expense of completing such work or part thereof to the Contractor; and for such completion the Owner, or such contractors as the Owner may employ, may take possession of and use or cause to be used in the completion of the work or part thereof, any of such materials, equipment, machinery, implements and tools of every description as may be found at the location of said work.

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Any and all costs or expenses, including liquidated damages as specified elsewhere herein, incurred by the Owner under this article shall be deducted and paid out of any moneys then due or to become due the Contractor under this Contract, or any part thereof; and in such accounting the Owner shall not be held to obtain the lowest figures for the work of completing the Contract or any part thereof, or for insuring its proper completion, but all sums actually paid therefor shall be charged to the Contractor. If the aforementioned costs and expenses so incurred, coupled with payments already made to the Contractor, shall exceed the amount which would have been payable under this Contract if the same had been completed by the Contractor, then the Contractor or the Contractor's surety shall pay the full amount of any such excess to the Owner.

ARTICLE 33 - Prices for Work

The Owner will pay and the Contractor shall accept the prices stipulated in the bid as full and just compensation for everything furnished and done by the Contractor, and for any and all expenses of any nature incurred by the Contractor in completing properly and to the entire satisfaction of the Owner all work under this Contract, including any losses or damages incurred by the Contractor as a result of work under this Contract and excepting only such expenses, losses, etc. for which other provisions are specifically made elsewhere herein.

ARTICLE 34 - Money may be Retained

The Owner may keep any moneys which would otherwise be payable at any time hereunder, and may apply the same, or so much as may be necessary therefor, to the payment of expenses, losses or damages incurred by the Owner and determined as herein provided, and may retain, until all claims are settled, so much of such money as, in the Owner's opinion, will be required to settle all claims filed with the Owner relating to this Contract.

ARTICLE 35 - Progress Estimates

Except as hereinafter provided, the Engineer shall, once in each month, make an estimate in writing of the total amount of the work done to the first of the month, and the amount earned by the Contractor. The Owner will retain ten (10) percent of such estimated value as part security for fulfillment of this Contract by the Contractor and shall deduct from the balance all previous payments and all sums to be retained under this and/or other provisions of this Contract. The Owner shall pay to the Contractor each month the balance not retained as aforesaid, except that such monthly payment may be withheld at any time if the work, in the opinion of the Engineer, is not proceeding expeditiously and in accordance with the Contract. The Owner may, if it is deemed expedient to do so, cause estimates and payments to be made more frequently than once a month.

Estimates of lump sum items will be based on the Engineer's estimate of the percentage of each such item completed, each such percentage to be applied to the appropriate lump sum price as set forth on the Bid Form.

Payment for materials will not be made unless and until such materials have been satisfactorily installed or otherwise incorporated into the work.

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ARTICLE 36 - Final Estimate and Payment

The Engineer shall, as soon as practicable following the completion of work under this Contract, make a final estimate in writing of the total amounts of such work done under the various items contained in the bid and of the total amount of money due the Contractor for said work, and he shall also fix the date of substantial completion of such work and incorporate same into said final estimate.

The Owner will pay to the Contractor the entire sum so found to be due hereunder, including the ten (10) percent interim retainage withheld from previous payments, after deducting from said entire sum all previous payments, a retainage of two (2) percent as guaranty for a period of one year following the certified date of substantial completion unless said guaranty is specifically waived in writing by the Owner, and any and all other amounts as may be retained under the various provisions of this Contract. Such payment shall be made not later than fifteen (15) days after, but in no event before, the expiration of the time within which claims for labor performed and materials used or employed must be entered under the Lien Law, or if such time is not specified by law, the expiration of 30 days after the aforementioned date of substantial completion.

All prior progress estimates and payments shall be subject to correction in the final estimate and payment.

ARTICLE 37 - Liens

If, at any time before the expiration of the period within which claims must be entered under the Lien Law or, if not otherwise specified by law, within thirty (30) days after the certified date of substantial completion of all work under this Contract, any person, corporation, firm or other legal entity shall claim to have performed any of the work or to have furnished any of the materials under this Contract and shall file with the Owner suitable notice, the Owner will retain until discharge of such notice sufficient money to satisfy and discharge the amount claimed to be due in such notice together with the cost of any action or actions brought to enforce such lien created by the filing of such notice.

ARTICLE 38 - Waivers

Neither inspection by the Owner or any agents thereof, nor any orders, measurement or certificate by the Engineer, nor any order by the Owner for the payment of money, nor any payment for or acceptance of the whole or any part of the work performed under this Contract by the Owner, nor any extension of time nor any possession taken by Owner or agents thereof shall operate as a waiver of any provision of this Contract, or of any power herein reserved to the Owner, or any right to damages herein provided, nor shall any waiver of any breach of this Contract be held to be a waiver of any other or subsequent breach. Any remedy provided in this Contract shall be taken and construed as cumulative, that is, in addition to each and every other remedy herein provided, and in addition to all other suits, actions, or legal proceedings. The Owner shall also be entitled as of right to a writ of injunction against any breach of any of the provisions of this Contract.

ARTICLE 39 - Indemnification

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The Contractor shall indemnify, defend and hold harmless the Owner from and against all claims and actions, and all expenses incidental to such claims or actions, based upon or arising out of damage to property or injuries to persons or other tortious acts caused or contributed to by the Contractor or anyone acting under his direction or control or in his behalf in the course of his performance under this Contract, provided the Contractor's aforesaid indemnity and hold harmless agreement shall not be applicable to any liability based upon the sole negligence of the Owner.

The Contractor hereby expressly agrees that he will defend, indemnify and hold the Owner harmless from any and all claims made or asserted by the Contractor's agents, servants or employees arising out of the Contractor's activities under this Contract. For this purpose, the Contractor hereby expressly waives any and all immunity he may have under Maine's Workers Compensation Act in regard to such claims made or asserted by the Contractor's agents, servants or employees. The indemnification provided under this paragraph shall extend to and include any and all costs incurred by the Owner to answer, investigate, defend and settle all such claims, including but not limited to the Owner's costs for attorneys fees, expert and other witness fees, the cost of investigators, and payment in full of any and all judgments rendered in favor of the Contractor's agents, servants or employees against the Owner in regard to claims made or asserted by such agents, servants or employees.

ARTICLE 40 - Liability of Owner

No person, firm, corporation or other legal entity other than the Contractor now has any interest hereunder, and no claim shall be made or be valid, and neither the Owner nor any agent of the Owner shall be liable for or be held to pay any money except as herein provided. The acceptance by the Contractor of the payment of the final estimate shall operate as and shall be a release to the Owner, and every agent of the Owner, from all claim and liability to the Contractor for anything done or furnished for, or relating to the work performed under this Contract, and for any act or neglect of the Owner or of any person relating to or affecting said work except the claim against the Owner for the remainder, if any there be, of the amounts kept or retained as provided elsewhere herein.

ARTICLE 41 - Guaranty

The Contractor guarantees that the work to be done under this Contract and the materials to be furnished by him for use in the construction of same will be free from defects or flaws. This guaranty shall remain in effect for a period of one year from the certified date of substantial completion of all work under this Contract. It is agreed and understood, however, that this guaranty shall not include any repairs made necessary by any cause or causes other than defective work or materials furnished by the Contractor.

As surety of this guaranty the Owner will retain an amount equal to two (2) percent of the total final Contract amount at the time of payment of the final estimate. If at any time within said period of guaranty any part of the work constructed under this Contract shall require repairs because of, in the opinion of the Engineer, defective workmanship and/or materials, then the Owner may notify the Contractor in writing by certified mail, return receipt requested, of his obligation to make such repairs. Should the Contractor fail to make such repairs to the complete satisfaction of the Owner within ten (10) calendar days of receipt of such notice, then the Owner may elect to employ others to make said repairs and to pay for same out of the sum retained hereby for that purpose. Upon the expiration of the

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period of guaranty the Engineer will inspect the work, or cause same to be inspected, and upon his determination that the work is in good order the retainage, less any amount which may have been expended in the making of repairs, will be released upon receipt of invoice from the Contractor.

It is agreed and understood, however, that the Owner may keep the whole or any portion of the sum retained for settlement of any and all claims which may have arisen out of this Contract against the Owner or agents thereof, and for any and all expenses, losses, or damages incurred by the Owner by reason of said claims.

ARTICLE 42 - Legal Address of Contractor

Both the address given in the bid and the Contractor's temporary field office are hereby designated as places to which letters, notices and other communications to the Contractor may be mailed or delivered. The first named address may be changed at any time, in writing, by the Contractor.

ARTICLE 43 - Progress Schedule

The Contractor shall, within five (5) days of commencement of Work, prepare and submit to the Engineer for approval a practicable schedule showing the order in which the Contractor proposes to carry on the work, the date on which he will start the several salient features thereof, and the contemplated dates for completing the same. The schedule shall be in the form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled for completion at any time and shall be acceptable to the Engineer. If, in the opinion of the Engineer, the Contractor falls behind such schedule, the Contractor shall take any and all such steps as may be deemed necessary by the Engineer to improve his progress toward completion of the work and shall submit and maintain such supplemental schedules as the Engineer may deem necessary to demonstrate that all work under this Contract will be completed within the time and/or by such completion date as may be specified elsewhere herein. None of the foregoing shall result in any additional cost to the Owner.

ARTICLE 44 - Site Investigation

The Contractor acknowledges that he has satisfied himself as to the nature and location of the work, the general and local conditions including but not restricted to those bearing upon transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, river stages, tides or similar physical conditions at the site, the conformation and condition of the ground, and the character of equipment and facilities needed preliminary to and during prosecution of the work. The Contractor further acknowledges that he has satisfied himself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Owner as well as from information presented by the plans and specifications hereof. Any failure by the Contractor to acquaint himself with the available information will not relieve him from responsibility for estimating properly the difficulty or cost of successfully completing the work. The Owner assumes no responsibility for any conclusions or interpretations made by the Contractor on the basis of the information made available to him.

ARTICLE 45 - Protection of Existing Utilities

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Existing utilities, structures, or other works that may be shown on the plans, reasonably located or anticipated by a site investigation, or marked on the ground or in any other way by the Owner or by the respective utility companies shall be protected from damage by the Contractor during construction operations and, if damaged, shall be repaired by the Contractor at his sole expense. It will be the Contractor's sole responsibility to contact the Dig Safe Center at 1-800-225-4977 and to assure that any and all utility companies in the project area have been notified, furnished with sufficient information, and have located on the ground their respective underground utilities in any area(s) where excavation will occur, all prior to commencement of any such excavation.

Materials below existing utilities which are removed or disturbed during excavation shall be replaced and thoroughly compacted to prevent future settlement and damage to the utility. Utilities damaged due to subsequent settlement of the backfill or of any materials disturbed by the Contractor shall be repaired by the Contractor, or as otherwise required by the utility company, at the Contractor's sole expense.

The locations of certain existing subsurface pipes and utilities are indicated on the plans to the best of the Owner's knowledge but they are approximate only and no guarantee is made either to the accuracy or completeness thereof. It is the Contractor's absolute responsibility to determine to his best ability the existence and location of any and all underground utilities prior to commencement of excavation and to exercise such precautions during excavation as may be necessary to compensate for any incompleteness or inaccuracy of such determination. Should the scope of work under this contract be substantially altered because of the existence of subsurface utilities not shown on the plans or reasonably anticipated by the Contractor at the time of bidding hereon, then the contract price may be adjusted accordingly by the Owner but the mere fact of damage by the Contractor to an existing utility, whether shown on the plans or not, shall under no circumstances result in extra compensation to the Contractor by the Owner, and all necessary repairs together with any and all related costs, damages, and/or claims related thereto or arising therefrom will be the Contractor's sole responsibility and shall be made and/or otherwise satisfied at the Contractor's sole expense.

ARTICLE 46 - Temporary Power and Water

The Contractor shall make all necessary applications and arrangements and shall pay all fees and charges for electrical power, light and water necessary for proper completion of this Contract during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, piping, connections, meters and all else that may be required in this regard.

ARTICLE 47 - Temporary Field Office and Storage Facilities

The Contractor shall provide and maintain a suitable temporary field office at the project site for his own use and the use of the Engineer, if deemed necessary for the project. It shall be provided with adequate heat, electric lighting, telephone, and desk for plan references. It shall be located at a site acceptable to the Engineer, shall be relocated at any time during the course of construction under this Contract if and as deemed necessary by the Engineer, and shall be removed from the site immediately upon completion of said construction.

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The Contractor shall provide and maintain such additional offices, storage sheds, and/or other temporary buildings and/or trailers at the site as may be required for his own use, all subject to the Engineer's direction and approval.

ARTICLE 48 - Time of Completion

All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion.

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IN WITNESS WHEREOF, the City of Bangor, Owner, has caused this instrument to be signed by its Purchasing Agent or its City Manager, hereunto duly authorized, and the Contractor has hereunto set his hand and has caused this instrument to be signed by his (Officer) _____ hereunto duly authorized to execute this instrument as of the date first written above.

WITNESS:

CITY OF BANGOR, OWNER

By: _____

Ken Kinnear
Purchasing Coordinator

By : _____

Carollyn Lear
City Manager

CONTRACTOR

WITNESS:

Name of Individual, Firm or Corporation

By: _____

Name: _____

Printed or Typed

Title: _____

Printed or Typed

E. SPECIAL PROVISIONS

SECTION E

SPECIAL PROVISIONS

Working Hours

Normal working hours shall be from 6:00 A.M. until 4:30 P.M., Monday through Friday. Holidays are excluded from working hours unless Contractor receives approval from the City. The Contractor shall cease all activity within 1/2 hour of sunset unless otherwise directed.

Time and Material Payment

If, at any time during the construction of the project, a situation occurs where payment for work performed cannot be paid for under pay items in the Contract, then the Contractor may request payment on a time and materials basis. All labor and equipment rates, crew sizes, equipment and materials used, and other factors affecting the work shall be approved by the Resident Engineer before work commences. The Contractor and Engineer shall agree to and record hours worked, crew and equipment used, and all materials used at the end of each working day. Requests for time and materials payment after the fact may not be considered for payment if the Resident Engineer was not properly notified.

References

The apparent low Bidder shall furnish the Director of Water Quality with references from at least three similar projects within three working days of the bid opening date, if deemed necessary by the Director of Water Quality. References must be for projects similar in dollar value and scope of work to the project proposed herein. If, in the opinion of the Director of Water Quality, the Contractor does not have prior work experience in successfully completing projects of this scope, then the Director of Water Quality may recommend rejection of the bid and recommend award of the contract to the next qualified Bidder.

Housekeeping

At the conclusion of each working day, the contractor shall take necessary measures to leave the site in suitable condition, including but not limited to, sweeping, dust control, and removal of equipment or large construction debris that block normal access ways.

All open trenches located within the travel way shall be restored with a hard surface at the conclusion of each working week. Acceptable methods of restoration are to bring flowable fill up to finish grade or to install permanent pavement. Cold patch will not be considered an acceptable substitute.

Coordination with Other Work

The Contractor shall be required to coordinate work with other activities and operation of the

WWTP.

As-Built Drawings

The Contractor shall keep a set of "As-Built" drawings on the job site for the Resident Inspector's review that shall show all work up to one week prior to the date of inspection. The Resident Inspector may examine the drawings on a weekly or monthly basis at his own discretion. If the "As Built" drawings are not kept up to date as the work progresses, then the monthly payment requisition will not be processed for payment until the "As-Builts" have been brought up to date.

Time of Completion

All work is to be substantially completed in 365 calendar days from the date of the Notice to Proceed and final completion within 60 calendar days of substantial completion.

F. NOTICE OF AWARD

Notice of Award

Date: _____, 2023

Project: REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT

Owner: <u>The City of Bangor, Maine</u>	Owner's Contract No.:
Contract:	Engineer's Project No.:
Bidder:	
Bidder's Address:	

You are notified that your Bid dated _____ for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT

The Contract Price of your Contract is _____ Dollars and ____ Cents (\$ _____).

_ copies of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

0 sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within [15] days of the date you receive this Notice of Award.

1. Deliver to the Owner [6] fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20), General Conditions (Paragraph 5.01), and Supplementary Conditions (Paragraph SC-5.01).
3. Other conditions precedent:

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

City of Bangor, Maine
Owner
By: _____

Authorized Signature
City Manager

Title

Copy to Engineer

G. NOTICE TO PROCEED

Notice to Proceed

Date: _____

Project: REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER
TREATMENT PLANT

Owner: The City of Bangor

Owner's Contract No.: _____ 1

Contract:

Engineer's Project No.: _____ 1

Contractor:

Contractor's Address: [send Certified Mail, Return Receipt Requested]

You are notified that the Contract Times under the above Contract will commence to run on _____. On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with the Agreement, all work needs to be completed within 365 calendar days.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds and loss payees) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Also, before you may start any Work at the Site, you must:

_____ [add other requirements].

Owner

Given by:

Authorized Signature

Title

Date

Copy to Engineer

H. PERFORMANCE BOND

PERFORMANCE BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (*Name and Address*): SURETY (*Name, and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONTRACT

Effective Date of Agreement:

Amount:

Description (*Name and Location*):

BOND

Bond Number:

Date (*Not earlier than Effective Date of Agreement*):

Amount:

Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

SURETY

Contractor's Name and Corporate Seal

Surety's Name and Corporate Seal

By: _____
Signature

By: _____
Signature (Attach Power of Attorney)

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

Note: Provide execution by additional parties, such as joint venturers, if necessary.

Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

1. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 2.1.

2. If there is no Owner Default, Surety's obligation under this Bond shall arise after:

2.1 Owner has notified Contractor and Surety, at the addresses described in Paragraph 9 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor, and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

2.2 Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 2.1; and

2.3 Owner has agreed to pay the Balance of the Contract Price to:

1. Surety in accordance with the terms of the Contract; or
2. Another contractor selected pursuant to Paragraph 3.3 to perform the Contract.

3. When Owner has satisfied the conditions of Paragraph 2, Surety shall promptly, and at Surety's expense, take one of the following actions:

3.1 Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or

3.2 Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

3.3 Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 5 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or

3.4 Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or
2. Deny liability in whole or in part and notify Owner citing reasons therefor.

4. If Surety does not proceed as provided in Paragraph 3 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 3.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

5. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 3.1, 3.2, or 3.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To the limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

- 5.1 The responsibilities of Contractor for correction of defective Work and completion of the Contract;
- 5.2 Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions of or failure to act of Surety under Paragraph 3; and
- 5.3 Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

6. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

7. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

8. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located, and shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

9. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

10. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

11. Definitions.

- 11.1 Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.
- 11.2 Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.
- 11.3 Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.
- 11.4 Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or otherwise comply with the other terms thereof.

FOR INFORMATION ONLY – *(Name, Address and Telephone)*

Surety Agency or Broker:

Owner's Representative *(Engineer or other party)*:

I. PAYMENT BOND

PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (*Name and Address*):

SURETY (*Name, and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONTRACT

Effective Date of Agreement:

Amount:

Description (*Name and Location*):

BOND

Bond Number:

Date (*Not earlier than Effective Date of Agreement*):

Amount:

Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL

SURETY

Contractor's Name and Corporate Seal (Seal)

Surety's Name and Corporate Seal (Seal)

By: _____
Signature

By: _____
Signature (Attach Power of Attorney)

Print Name

Print Name

Title

Title

Attest: _____
Signature

Attest: _____
Signature

Title

Title

Note: Provide execution by additional parties, such as joint venturers, if necessary.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.
2. With respect to Owner, this obligation shall be null and void if Contractor:
 - 2.1 Promptly makes payment, directly or indirectly, for all sums due Claimants, and
 - 2.2 Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.
3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.
4. Surety shall have no obligation to Claimants under this Bond until:
 - 4.1 Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.
 - 4.2 Claimants who do not have a direct contract with Contractor:
 1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and
 2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and
 3. Not having been paid within the above 30 days, have sent a written notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.
5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.
6. When a Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at Surety's expense take the following actions:
 - 6.1 Send an answer to that Claimant, with a copy to Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.
 - 6.2 Pay or arrange for payment of any undisputed amounts.
7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.
8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders, and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions

15.1 Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

15.2 Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3 Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract, or to perform and complete or otherwise comply with the other terms thereof.

FOR INFORMATION ONLY – *(Name, Address, and Telephone)*

Surety Agency or Broker:

Owner's Representative *(Engineer or other)*:

J. APPLICATION FOR PAYMENT

Contractor's Application for Payment No.

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer):
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

Application For Payment Change Order Summary

Approved Change Orders		
Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

- 1. ORIGINAL CONTRACT PRICE..... \$ _____
- 2. Net change by Change Orders..... \$ _____
- 3. Current Contract Price (Line 1 ± 2)..... \$ _____
- 4. TOTAL COMPLETED AND STORED TO DATE
(Column F on Progress Estimate)..... \$ _____
- 5. RETAINAGE:
 - a. _____ Work Completed..... \$ _____
 - b. _____ Stored Material..... \$ _____
 - c. Total Retainage (Line 5a + Line 5b)..... \$ _____
- 6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c)..... \$ _____
- 7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application)..... \$ _____
- 8. AMOUNT DUE THIS APPLICATION..... \$ _____
- 9. BALANCE TO FINISH, PLUS RETAINAGE
(Column G on Progress Estimate + Line 5 above)..... \$ _____

Contractor's Certification	
The undersigned Contractor certifies that to the best of its knowledge: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.	
By: _____	Date: _____

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ (Engineer) _____ (Date)

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ (Owner) _____ (Date)

Approved by: _____ Funding Agency (if applicable) _____ (Date)

Stored Material Summary

Contractor's Application

For (contract):						Application Number:			
Application Period:						Application Date:			
A	B	C	D		E		F		G
Invoice No.	Shop Drawing Transmittal No.	Materials Description	Stored Previously		Stored this Month		Incorporated in Work		Materials Remaining in Storage (\$) (D + E - F)
			Date (Month/Year)	Amount (\$)	Amount (\$)	Subtotal	Date (Month/Year)	Amount (\$)	
Totals									

**Engineers Joint Documents Committee
Design and Construction Related Documents
Instructions and License Agreement**

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4. Also note the instruction in the License Agreement about the EJCDC copyright.

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The license is effective until terminated. You may terminate it at any time by destroying **EJCDC Design and Construction Related Documents** altogether with all copies, modifications and merged portions in any form. It will also terminate upon conditions set forth elsewhere in this Agreement or if you fail to comply with any term or condition of this Agreement. You agree upon such termination to destroy **EJCDC Design and Construction Related Documents** along with all copies, modifications and merged portions in any form.

Limited Warranty:

EJCDC warrants the CDs and diskettes on which **EJCDC Design and Construction Related Documents** is furnished to be free from defects in materials and workmanship under normal use for a period of ninety (90) days from the date of delivery to you as evidenced by a copy of your receipt.

There is no other warranty of any kind, either expressed or implied, including, but not limited to the implied warranties of merchantability and fitness for a particular purpose. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

EJCDC does not warrant that the functions contained in **EJCDC Design and Construction Related Documents** will meet your requirements or that the operation of **EJCDC Design and Construction Related Documents** will be uninterrupted or error free.

Limitations of Remedies:

EJCDC's entire liability and your exclusive remedy shall be:

1. the replacement of any document not meeting EJCDC's "Limited Warranty" which is returned to EJCDC's selling agent with a copy of your receipt, or
2. if EJCDC's selling agent is unable to deliver a replacement CD or diskette which is free of

defects in materials and workmanship, you may terminate this Agreement by returning EJCDC Document and your money will be refunded.

In no event will EJCDC be liable to you for any damages, including any lost profits, lost savings or other incidental or consequential damages arising out of the use or inability to use **EJCDC Design and Construction Related Documents** even if EJCDC has been advised of the possibility of such damages, or for any claim by any other party.

Some states do not allow the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to you.

General:

You may not sublicense, assign, or transfer this license except as expressly provided in this Agreement. Any attempt otherwise to sublicense, assign, or transfer any of the rights, duties, or obligations hereunder is void.

This Agreement shall be governed by the laws of the State of Virginia. Should you have any questions concerning this Agreement, you may contact EJCDC by writing to:

Arthur Schwartz, Esq.
General Counsel
National Society of Professional
Engineers
1420 King Street
Alexandria, VA 22314

Phone: (703) 684-2845
Fax: (703) 836-4875
e-mail: aschwartz@nspe.org

You acknowledge that you have read this agreement, understand it and agree to be bound by its terms and conditions. You further agree that it is the complete and exclusive statement of the agreement between us which supersedes any proposal or prior agreement, oral or written, and any other communications between us relating to the subject matter of this agreement.

K. CERTIFICATE OF SUBSTANTIAL COMPLETION

Certificate of Substantial Completion

Project: REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT

Owner:

Owner's Contract No.: 1

Contract:

Engineer's Project No.: 1

This [tentative] [definitive] Certificate of Substantial Completion applies to:

All Work under the Contract Documents: The following specified portions of the Work:

Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

A [tentative] [definitive] list of items to be completed or corrected is attached hereto. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:

Amended Responsibilities

Not Amended

Owner's Amended Responsibilities:

Contractor's Amended Responsibilities:

GENERAL SPECIFICATIONS

SUMMARY OF WORK

PART 1 - GENERAL

1.1 REQUIREMENT INCLUDED

- A. The work to be performed under this Contract consists of furnishing all tools, labor, equipment, materials providing startup services, and for furnishing all transportation and services, including fuel, power, water, and essential communications, and for the performance of all labor, or other operations required for the fulfillment of the Contract in strict accordance with the specifications, drawings, and other Contract Documents as herein before defined, all of which are made a part hereof; and including such detail sketches as may be furnished by the Engineer from time to time during construction in explanation of said Contract Documents. The work shall be complete, and all work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary for the complete and proper construction of the work in good faith shall be performed, furnished, and installed by the Contractor as though originally so specified or shown, at no increase in cost to the Owner.
- B. The Contractor shall be responsible for removal and reinstallation of all existing grating, metal plates, railings, hardware, and other incidental existing items necessary for completion of the work under this contract.
- C. The owner shall retain the services of Wright-Pierce to function as the System Integrator (SI) for this project. Wright-Pierce shall provide programming services based on the control requirement in the contract documents. The Contractor shall be responsible for all instrumentation and SCADA control system hardware and shall coordinate with the SI on system testing.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Contractor shall complete all Work as specified or indicated in the Contract Documents titled "REAERATION BLOWERS AND AERATION DIFFUSERS AT THE WASTEWATER TREATMENT PLANT". The project includes replacing reaeration blowers and replacing the Aeration Diffusers, replacing drain valves, and appurtenances as shown on the drawings and as noted in the specifications.

1.3 CONTRACT METHOD

- A. The work will be constructed under lump sum prices as indicated in the Bid Schedule.
- B. The Contractor shall include the General Conditions of the Contract as a part of all of its

subcontract agreements.

1.4 WORK SEQUENCE

- A. The Contractor shall construct work in phases or stages as required to accommodate Owner's occupancy requirements. The Contractor shall coordinate construction schedule and operations with Owner.

1.5 CONTRACTOR USE OF PROJECT SITE

- A. The Contractor's use of the project site shall be limited to its construction operations, including onsite storage of materials as needed for the immediate work, onsite fabrication facilities, and field offices.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 MAINTAIN EXISTING WORKS

- A. Existing Operations

- 1. The existing WWTP must remain operable at all times during construction.

- B. Maintain Operation

- 1. State and Federal regulations require that at all times during construction work under this Contract, existing utilities remain operational until the new utilities are accepted and on line.
- 2. The responsibility of the Contractor shall be to provide, maintain and operate all temporary facilities such as bypass wastewater pumping equipment, dams, sewers, conduits, valves and all other labor and equipment necessary to intercept the sewage flow before it reaches the points where it would interfere with his work, and carry it past his work such that essential transport of wastewater remains operational and effective.
- 3. The Contractor's operations shall not hinder the delivery, storage and use of materials and supplies, nor hinder staff duties, nor disrupt utility service.
- 4. The Owner must have access to the existing facilities at all times unless a specific exception is granted by the Owner.

- C. Minimize Interference

1. The Contractor shall conduct operations so as to interfere as little as possible with existing works. The Contractor shall develop a program, for review and approval by the Engineer and Owner, which shall provide for the construction and putting into service of the new works in the most orderly manner possible. This program shall be adhered to except as otherwise directed by Engineer.
2. It may be necessary to work outside of normal working hours to minimize interference. Work of connecting with, cutting into and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time and when the demands on the facilities best permit such interference. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.
3. When making interconnections to active lines, perform such work at low flow times and in a manner to maintain flows. The Contractor is responsible for providing temporary bypass pumping or other means as necessary to ensure continuous wastewater flow.

D. Existing Wastewater Flows

1. Existing flows vary significantly from hour to hour and season to season. Peak flows are influenced by rain events and groundwater depths. The Contractor shall conduct operations to be prepared for these variable flow conditions.

3.2 CONSTRUCTION SEQUENCE

- A. The Contractor shall submit to the Owner for review and acceptance, a complete schedule of proposed sequence of construction operations prior to commencing work.

END OF SECTION

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 MEASUREMENT AND PAYMENT

- A. The following subsections describe the measurement of and payment for the work to be done under the items listed in the BID.
- B. The Contractor shall become acquainted with all Work associated with each Payment Item and shall have no claim for additional compensation due to unfamiliarity with the Work required to complete each Item in accordance with the Contract Documents.
- C. No Payment will be made for any item of Work until all documentation required by the Contract Documents has been reviewed and accepted by the Engineer.
- D. No payment will be made for additional materials that are not installed on the Project.
- E. Each unit or lump sum, stated in the BID shall constitute full compensation as herein specified for each item of work completed in accordance with the drawings and specifications. Each allowance price stated in the BID shall constitute an estimate of full compensation as herein specified for each item of work completed in accordance with the drawings and specifications. Actual compensation for allowance price bid items shall be in accordance with the measurement payment for each item.
- F. The prices bid shall constitute payment for all work incidental thereto. Unless identified within the individual item description, the price shall not include work specifically identified for payment under other items.

1.02 PAYMENT ITEMS

<u>Item</u>	<u>Description</u>
1.	Mobilization/Demobilization
2.	Remove, Dispose, and Replace Reaeration Blowers at WWTP
3.	Remove and Replace Aeration and Reaeration Diffusers at the WWTP
4.	Remove, Dispose of, and Replace Drain Valves at the WWTP
5.	Furnish and Install Knife Gate Valve at the WWTP

1.03 THE MEASUREMENT AND PAYMENT FOR THE BID ITEMS 1 THROUGH 4 ARE AS FOLLOWS:

ITEM 1 MOBILIZATION / DEMOBILIZATION

- A. General. The lump sum price for Item 1 shall constitute full compensation for initiating the contract, obtaining all permits, bonds and insurance, exclusive of the cost of materials, for mobilizing all machinery, tools, for furnishing and installing erosion control measures, for site restoration upon completion of the work, and all other equipment to carry on and complete the work.
- B. Measurement. Measurement for mobilization/demobilization shall be made based on the lump sum amount bid as approved by the engineer
- C. Payment. Payment for mobilization/demobilization shall be made at the lump sum price under this Bid Item. The amount of this lump sum shall not exceed FIVE percent (5%) of the

Contract amount, excluding Item 1, and no payment shall be made in excess of this amount. An amount of seventy-five (75) percent of the amount bid under Item 1 (exclusive of normal Contract retainage) will be made when the Contractor has mobilized to the Project site(s) and is ready to start construction. The remaining twenty-five (25) percent (exclusive of normal Contract retainage) will be made following demobilization from the Project site.

ITEM 2 REMOVE, DISPOSE, AND REPLACE REAERATION BLOWERS AT WWTP

- A. General. The lump sum price for Item 2 shall constitute full compensation for all labor, equipment, tools, expenses, freight, delivery and handling of materials, and materials necessary to complete the Work as specified which shall include: removing and legally disposal of existing reaeration blowers, actuator valve and accessories, replacing with new reaeration blowers, all electrical demolition and legal disposal, and replacement of electrical connections as shown on the drawings, protection of surrounding processes from damage, including, but not limited to, existing pumps and valves, maintenance of flows, dust control, restoration of all areas disturbed by the Contractor's operations, all Work, as specified in the General Requirements, including Environmental protection. The Contractor shall be responsible for removal and reinstallation of all existing grating, metal plates, railings, hardware, and other incidental existing items necessary for completion of the work under this contract.
- B. Measurement. Measurement shall be based on the removal, legal disposal, and replacement of the reaeration blowers.
- C. Payment. Payment shall be made based the lump sum under this Bid Item. Seventy-five (75) percent of the price bid shall be paid upon installation of all reaeration blowers, the balance shall be withheld until such time as the reaeration blowers are tested and accepted by the Owner for incorporation into the existing treatment process.

ITEM 3 REMOVE AND REPLACE AERATION DIFFUSERS AT THE WWTP

- A. General. The lump sum price for Item 3 shall constitute full compensation for all labor, equipment, tools, expenses, freight, delivery and handling of materials, and materials necessary to complete the Work as specified which shall include: removing and legal disposal of the existing Aeration Diffusers and piping, replacing with new Aeration Diffusers, all pipe demolition and replacement of piping as shown on the drawings, protection of surrounding processes from damage, including, but not limited to existing pumps and valves, maintenance of flows, dust control, restoration of all areas disturbed by the Contractor's operations, all Work, as specified in the General Requirements, including Environmental protection. The Contractor shall be responsible for removal and reinstallation of all existing grating, metal plates, railings, hardware, and other incidental existing items necessary for completion of the work under this contract.
- B. Measurement. Measurement shall be based on the removal, legal disposal of, and replacement of the Aeration Diffusers.
- C. Payment. Payment shall be made based the lump sum under this bid item. Seventy-five (75) percent of the price bid shall be paid upon installation of the Aeration Diffusers, the balance shall be withheld until such time as the Aeration Diffusers are tested and accepted by the Owner for incorporation into the existing treatment process.

ITEM 4 REMOVE, DISPOSE OF, AND REPLACE DRAIN VALVES AT THE WWTP

- A. General. The per valve price for Item 4 shall constitute full compensation for all labor, equipment, tools, expenses, freight, delivery and handling of materials, and materials necessary to complete the Work as specified and shown on the drawings which shall include: excavation and backfill, removing and legal disposal of the existing valves and piping, replacing with new valves, furnishing and installing precast concrete manholes, manhole covers, all pipe demolition and replacement of piping as shown on the drawings, protection of surrounding processes from damage, including, but not limited to existing pumps and valves, maintenance of flows, dust control, restoration of all areas disturbed by the Contractor's operations, all Work, as specified in the General Requirements, including Environmental protection. The Contractor shall be responsible for removal and reinstallation of all existing grating, metal plates, railings, hardware, and other incidental existing items necessary for completion of the work under this contract.
- B. Measurement. Measurement shall be based on the removal, legal disposal of, and replacement of the drain valves.
- C. Payment. Payment shall be made based the lump sum under this bid item. Seventy-five (75) percent of the price bid shall be paid upon installation of the drain valves, the balance shall be withheld until such time as the valves are tested and accepted by the Owner for incorporation into the existing treatment process.

ITEM 5 FURNISH AND INSTALL KNIFE GATE VALVES AT THE WWTP

- A. General. The lump sum price for Item 5 shall constitute full compensation for all labor, equipment, tools, expenses, freight, delivery and handling of materials, and all materials necessary to complete the Work as specified and shown on the drawings which shall include: furnishing and installing new valve, saw cutting concrete, all pipe demolition and replacement of piping as shown on the drawings, protection of surrounding processes from damage, including, but not limited to existing pumps and valves, maintenance of flows, dust control, restoration of all areas disturbed by the Contractor's operations, all Work, as specified in the General Requirements, including Environmental protection. The Contractor shall be responsible for removal and reinstallation of all existing grating, metal plates, railings, hardware, and other incidental existing items necessary for completion of the work under this contract.
- B. Measurement. Measurement shall be based on the furnishing and installing of the knife gate valve.
- C. Payment. Payment shall be made based the lump sum under this bid item. Seventy-five (75) percent of the price bid shall be paid upon installation of the knife gate valve, the balance shall be withheld until such time as the valves are tested and accepted by the Owner for incorporation into the existing treatment process.

PART 2 PRODUCTS – Not Applicable

PART 3 EXECUTION – Not Applicable

END OF SECTION

SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submittal procedures.
- B. Construction progress schedules.
- C. Product Data.
- D. Shop Drawings.
- E. Design data.
- F. Test reports.
- G. Certificates.
- H. Manufacturer's instructions.

1.2 RELATED SECTIONS

- A. Section - Quality Control: Manufacturers' field services and reports.
- B. Section - Contract Closeout: Contract warranties, manufacturers' certificates, and closeout submittals.

1.3 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer accepted form.
- B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.
- D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- E. Schedule submittals to expedite the Project, and deliver to Engineer at business address.

Coordinate submission of related items.

- F. For each submittal for review, allow 14 days excluding delivery time to and from the contractor.
- G. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.
- H. Provide space for Contractor and Engineer review stamps.
- I. When revised for resubmission, identify all changes made since previous submission.
- J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- K. Submittals not requested will not be recognized or processed.

1.4 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial schedule in duplicate within 14 days after date of Owner-Contractor Agreement.
- B. Revise and resubmit as required.
- C. Submit revised schedules with each Application for Payment, identifying changes since previous version.
- D. Submit a horizontal bar chart with separate line for each major portion of Work or operation, identifying first work day of each week.
- E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.
- F. Indicate estimated percentage of completion for each item of Work at each submission.
- G. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and required by Allowances.

1.5 PRODUCT DATA

- A. Product Data For Review:
 - 1. Submitted to Engineer for review for the limited purpose of checking for

conformance with information given and the design concept expressed in the contract documents.

2. After review, provide copies and distribute in accordance with this Section and for record documents purposes described in Section - Contract Closeout.

B. Product Data For Information:

1. Submitted for the Engineer's knowledge as contract administrator or for the Owner.

C. Product Data For Project Close-out:

1. Submitted for the Owner's benefit during and after project completion.

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

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

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

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

1.6 SHOP DRAWINGS

A. Shop Drawings For Review:

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

B. Shop Drawings For Information:

1. Submitted for the Engineer's knowledge as contract administrator or for the Owner.

C. Shop Drawings For Project Close-out:

1. Submitted for the Owner's benefit during and after project completion.

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

E. Submit the number of opaque reproductions which Contractor requires, plus two copies which will be retained by Engineer.

1.9 DESIGN DATA

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

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

1.10 TEST REPORTS

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

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

1.11 CERTIFICATES

A. When specified in individual specification sections, submit certification by the manufacturer, installation/application subcontractor, or the Contractor to Engineer, in quantities specified for Product Data.

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

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

1.12 MANUFACTURER'S INSTRUCTIONS

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

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

C. Refer to Section - Quality Control, Manufacturers' Field Services article.

1.13 ERECTION DRAWINGS

- A. Submit drawings for the Engineer's benefit as contract administrator or for the Owner.
- B. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
- C. Data indicating inappropriate or unacceptable Work may be subject to action by the Engineer or Owner.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

END OF SECTION

QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality assurance and control of installation.
- B. References.
- C. Inspection and testing laboratory services.

1.2 QUALITY ASSURANCE/CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply fully with manufacturers' instructions, including each step in sequence.
- C. Comply fully with manufacturers' instructions. If in conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce workmanship of specified quality.
- F. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.3 REFERENCES

- A. Conform to reference standard by date of issue current on date of Contract Documents.
- B. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or interference otherwise in any reference documents.

END OF SECTION

MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Products.
- B. Transportation and handling.
- B. Storage and protection.
- D. Product options.
- E. Substitutions.

1.2 RELATED SECTIONS

- A. None.

1.3 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

1.4 TRANSPORTATION AND HANDLING

- A. Transport and handle Products in accordance with manufacturers' instructions.
- B. Promptly inspect shipments to assure that Products comply with requirements, quantities are correct, and Products are undamaged.
- C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

- A. Store and protect Products in accordance with manufacturers' instructions, with seals and labels intact and legible. Store sensitive Products in weathertight, climate controlled enclosures.

- B. For exterior storage of fabricated Products, place on sloped supports, above ground.
- C. Provide off-site storage and protection when site does not permit onsite storage or protection.
- D. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.
- E. Store loose granular materials on solid flat surfaces in a well-drained area. Avoid mixing with foreign matter.
- F. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.
- G. Arrange storage of Products to permit access for inspection. Periodically inspect to assure Products are undamaged and are maintained under specified conditions.

1.6 PRODUCT OPTIONS

- A. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

1.7 SUBSTITUTIONS

- A. Engineer will consider requests for Substitutions only within 14 days after date established in Notice to Proceed.
- B. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.
- C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- D. A request constitutes a representation that the Contractor:
 1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
 2. Will provide the same warranty for the Substitution as for the specified Product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- F. Substitution Submittal Procedure:
1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
 2. Submit shop drawings, Product data, and certified test results attesting to the proposed Product equivalence.
 3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

END OF SECTION

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Closeout Procedures.
- B. Final Cleaning.

1.2 RELATED SECTIONS

- A. None.

1.3 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Submit record drawings including all ties and elevation information recorded for underground facilities.

1.4 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean interior and exterior surfaces exposed to view; remove temporary labels, stains and foreign substances.
- C. Clean site; sweep paved areas, rake clean landscaped surfaces.
- D. Remove waste and surplus materials, rubbish, and construction facilities from the site.

END OF SECTION

TECHNICAL
SPECIFICATIONS

SECTION 01110

ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The work covered by this Section consists of furnishing all labor materials and equipment and performing all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B. The control of environmental pollution requires consideration of air, water, and land, and involves management of noise and solid waste, as well as other pollutants.
- C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, staked hay bales, seeding, mulching, or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area. Specific requirements for erosion and sedimentation controls are specified in Section 01568.
- D. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Maine Department of Environmental Protection.
- F. Schedule and conduct all work in a manner that will minimize the level of noise escaping the site, especially at night and on weekends.

1.02 APPLICABLE REGULATIONS

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

1.03 NOTIFICATIONS

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

1.04 IMPLEMENTATION

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

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EROSION CONTROL

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

3.02 PROTECTION OF STREAMS, WETLANDS, AND SURFACE WATER

- A. Care shall be taken to prevent or reduce to a minimum any damage to any stream, drainage ditch, storm drain or sewer from pollution by debris, sediment, or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream or separated storm drain system. Such water will be diverted through a settling basin or filter before being directed into the streams. Sediment must be handled according to the VRAP Soils Management Plan.
- B. The Contractor shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water, or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels. Sediment must be handled according to the VRAP Soils Management Plan. Dewatering must be in accordance with the Dewatering Plan as described in Section 02140.
- C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, the City and Maine DEP must be notified. Prompt remedial action shall be taken in accordance with a contingency action drawing or plan approved by the Maine Department of Environmental Protection. Contractor shall submit to copies of approved contingency drawings or plans to the Engineer.

3.03 PROTECTION OF LAND RESOURCES

- A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the project. Confine all construction activities to areas shown on the Drawings.
- B. Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly before beginning operations near them.

- D. Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition. The Engineer will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.
- E. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1-in. in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
- F. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed and replaced.
- G. The locations of the Contractor's storage, and other construction building, required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Drawings and shall require written approval of the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.
- H. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess of waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling, and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in Section 01568, or as approved by the Engineer.
- I. All debris and excess material will be disposed of according to VRAP Soils Management Plan.

3.04 PROTECTION OF AIR QUALITY

- A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B. Dust Control. The Contractor will be required to maintain all excavations, embankments, stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.

- C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of chlorides may be permitted with approval from the Engineer.
- D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

3.05 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

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

3.06 NOISE CONTROL

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

END OF SECTION

SECTION 01250

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes administrative and procedural requirements for substitutions.

1.02 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

1.03 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01300.
- B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use Form 01250-1 to request substitution.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Justification for use of the proposed equivalent item(s), including evidence, as applicable, that Contract specified material, product or equipment is unobtainable or unobtainable within an acceptable time for Contract completion.
 - b. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable. If the Contractor is proposing the substitution because of unavailability of the product, submit a letter from the manufacturer stating the product is unavailable with an explanation of why it is unavailable with the form 01250-1

- c. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
- d. Detailed comparison of qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, electrical characteristics, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated and specified. Indicate deviations, if any, from the Work specified.
- e. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- f. Samples, where applicable or requested.
- g. Certificates and qualification data, where applicable or requested.
- h. List of similar installations for completed projects with project names and addresses and names, telephone numbers and addresses of engineers and owners.
- i. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
- j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
- k. Cost information, including a proposal of change, if any, in the Contract Sum.
- l. A prediction of any effects the proposed change will have on operation and maintenance costs, where applicable.
- m. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is intended for applications indicated.
- n. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.04 ACCEPTABLE EQUIVALENT PRODUCTS, MATERIALS AND EQUIPMENT

- A. Any other product the contractor wants to substitute must follow the requirements of this Section.
- B. The Contractor may choose equipment from a manufacturer of an acceptable equivalent product, however, this will be treated as a substitution and the Contractor must follow the requirements of this Section. Any additional costs or time required to accommodate such equipment shall be made without a change in the Contract Price or Contract Time.

1.05 MATERIAL AND WORKMANSHIP

- A. Whenever a material, article, system or sub-system is specified or described by using the name and/or model of a proprietary product or trademark or the name of the manufacturer or vendor, the specified item shall establish the type, function, and quality required; it shall be understood that the words "or approved equivalent" are implied whether or not they follow the proprietary enumeration.
- B. The Engineer reserves the right to determine when proprietary items have no equivalency, and when uniformity of operations, interchangeability of parts, standard parts inventory, etc., are in Owner's best interest.
- C. Requests for review of equivalency will be considered upon submission of sufficient information as described herein, to allow complete review.
- D. Such requests will not be accepted from anyone other than the Contractor. Such submission must be made prior to purchase, fabrication, manufacture or use of the equivalent items under consideration.
- E. The Contractor is responsible for all delays caused by its failure to submit complete and accurate information with any request for approval of any material, article, system or subsystem, as an equivalent.

1. Contractor Risk:
 - a. If the Contractor includes in his bid or later proposes any material, product or equipment that he considers equivalent to that specified, the Contractor assumes all risk of any sort associated with acceptance or rejection of proposed equivalent items.
 - b. The Contractor shall have no right to make claim based upon his bid that includes a proposed equivalent item(s) of work which resulted in a lower bid amount for said item(s) or lower total bid.
2. Equivalency:
 - a. An item will be considered equivalent to the item specified if:
 - (1) It is equal or better in design and strength in all subparts, quality, reliability and durability, operation, maintenance and serviceability, as applicable; and
 - (2) It is equal or better in specified parameters in performance in all respects for the specific function(s) indicated in the contract.
3. Supplemental Requirements:
 - a. The time associated with equivalency review will be paid by the Contractor.
 - b. Any tests required by the Engineer to establish quality and performance standards shall be promptly conducted by or through the Contractor at no additional cost to the Owner.
 - c. The Contractor shall submit any additional data requested by the Engineer for the equivalency review.
 - d. The Contractor shall satisfactorily accomplish all changes, including any engineering associated with use of equivalent items, at no additional cost to the Owner.
 - e. The Contractor shall have no right of appeal to any decision rejecting the equivalency of any item.

1.06 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01400.
- B. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers at no cost to the Engineer or Owner.

1.07 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

- 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution is consistent with the Contract Documents and will produce specified and indicated results.
- b. Substitution request is fully documented and properly submitted.
- c. Requested substitution will not negatively affect Contractor's construction schedule.
- d. Requested substitution has received necessary approvals of authorities having jurisdiction.
- e. Requested substitution is compatible with other portions of the Work.
- f. Requested substitution has been coordinated with other portions of the Work.
- g. Requested substitution provides specified warranty.
- h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

- B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.

- 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied,

Engineer will return requests without action, except to record noncompliance with these requirements:

- a. Requested substitution offers Owner an advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
- b. Requested substitution does not require revisions to the Contract Documents.
- c. Requested substitution is consistent with the Contract Documents and will produce specified and indicated results.
- d. Substitution request is fully documented and properly submitted.
- e. Requested substitution will not affect Contractor's construction schedule.
- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
- g. Requested substitution is compatible with other portions of the Work.
- h. Requested substitution has been coordinated with other portions of the Work.
- i. Requested substitution provides specified warranty.
- j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 - EXECUTION

3.01 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

Form 01250-1
SUBSTITUTION REQUEST

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to design, including Engineer design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

Engineer REVIEW AND ACTION

- Substitution approved – Make submittals in accordance with Specification Section 01 25 00.
- Substitution approved as noted – Make submittals in accordance with Specification Section 01 25 00.
- Substitution rejected – Use specified materials.
- Substitution Request received too late – Use specified materials.

Signed by: _____ Date: _____

Additional Comments: Contractor Subcontractor Supplier Manufacturer Engineer Other: _____

Form 01250-1 (Continued)
SUBSTITUTION REQUEST

Project: _____ Substitution Request Number: _____

From: _____

To: _____ Date: _____

Engineer Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No. _____

Installer: _____ Address: _____ Phone: _____

History: New product 1-4 years old 5-10 years More than 10 years old

Differences between proposed substitution and specified product: _____

Point-by-point comparative data attached – REQUIRED BY Engineer

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Engineer/Architect: _____

Address: _____ Owner: _____

Date Installed: _____

Proposed substitution affects other part of Work: No Yes, explain _____

Savings to Owner for accepting substitution: _____

Proposed substitution changes Contract Time: No Yes [Add] [Deduct] _____ days.

Supporting Data Attached: Drawings Product Data Samples Tests Reports _____

END OF SECTION

SECTION 01600

CONTROL OF MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

1. Section Includes:

- a. Definitions.
- b. Submittals.
- c. Spare parts.
- d. Quality assurance.
- e. Delivery, storage and handling.
- f. Warranty.
- g. Products.
- h. Substitution and "Or Equal" items.
- i. Manufacturer's instructions.
- j. Special tools.
- k. Lubrication.
- l. Nameplates.
- m. Loads and seismic forces.
- n. General material and equipment requirements.
- o. Materials and Equipment.
- p. Field Quality Control; Installation, and Instructional Services.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)

- B. American Society for Testing and Materials International (ASTM):

1. A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

1.03 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and accepted through Section 01250 or submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

1.04 SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Comply with the requirements of Section 01300.
 - 2. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 - 3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Engineer will notify Contractor of acceptance or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Acceptance: As specified in Section 01300.
 - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.

1.05 SPARE PARTS

- A. Provide spare parts for Products as specified in the individual technical specification sections. Comply with the requirements specified in Section 01610.
- B. Pack spare parts to protect them during storage. Tag spare parts and containers to clearly identify them in accordance with Contractor's parts numbering system as

reviewed by the Engineer. All parts shall be cross-referenced to their applicable the Specification Section.

1.06 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01400.
- B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.07 DELIVERY STORAGE AND HANDLING

- A. Arrange deliveries of materials and equipment in accordance with construction Progress Schedule, coordinate to avoid conflict with Work and conditions at site.
- B. Comply with the requirements of Section 01610.
- C. Provide equipment and personnel to handle materials and equipment by methods recommended by manufacturer to prevent soiling or damage to materials or equipment, or their packaging.
- D. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- E. Owner assumes no responsibility for damage or loss due to storage of materials and equipment.
- F. Interior Storage:
 - 1. Store with seals and labels intact and legible.
 - 2. Store materials and equipment subject to damage by elements in weathertight enclosures.
 - 3. Maintain temperature and humidity within ranges required by manufacturer's instructions.
- G. Exterior Storage:
 - 1. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment subject to deterioration with impervious sheet coverings. Provide ventilation to avoid condensation.
 - 2. Store loose granular materials in well-drained area on solid surfaces to prevent mixing with foreign matter.

3. Store materials such as pipe, reinforcing steel, structural steel, and equipment on pallets or racks, off ground.

H. Inspection and Maintenance:

1. Arrange storage to provide easy access for inspection, maintenance, and inventory.
2. Make periodic inspections of stored materials and equipment to ensure materials and equipment maintained under specified conditions are free from damage or deterioration, and coverings are in-place and in condition to provide required protection.
3. Perform maintenance on stored material and equipment in accordance with manufacturer's written instructions and in presence of Owner or Engineer.
 - a. Notify Engineer 24 hrs before performance of maintenance.
 - b. Submit report of completed maintenance and condition of coverings to Engineer with each Application for Payment.
 - c. Failure to perform maintenance, to notify Engineer of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

I. Assume responsibility for protection of completed construction and repair and restore damage to completed Work equal to original condition.

J. Wheeling of loads over finished floors, with or without plank protection, is not permitted in anything except rubber-tired wheelbarrows, buggies, trucks or dollies. This applies to finished floors and exposed concrete floors, as well as those covered with composition tile or other applied surfacing.

K. Where structural concrete is also finished surface, avoid marking or damaging surface.

1.08 WARRANTY

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. **Manufacturer's Warranty:** Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
2. **Special Warranty:** Written warranty required by the Contract Documents to provide specific rights for Owner.

- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01740.

1.09 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.10 SUBSTITUTION AND "OR EQUAL" ITEMS

- A. Follow the procedures in Section 01250.

1.11 ACCEPTANCE OF MATERIALS

- A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Engineer. No material shall be delivered to the work without prior acceptance of the Engineer.
- B. As specified in Section 01300, the Contractor shall submit to the Engineer, data relating to materials and equipment he proposes to furnish for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.
- C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, the Contractor shall submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the specifications. Such samples shall be furnished, stored, packed, and shipped at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.
- D. Any delay of acceptance resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.

- E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes, and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.
- F. The materials and equipment used on the work shall correspond to the accepted samples or other data.

1.12 MANUFACTURER'S INSTRUCTIONS:

- A. Installation of equipment and materials shall comply with manufacturer's instructions. Obtain and distribute printed copies of such instructions to parties involved in installation, including 2 copies to Engineer.
 - 1. Maintain one set of complete instructions at Site during installation and until completion of Work.
- B. Handle, store, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformance with Specifications.
 - 1. If Site conditions or specified requirements conflict with manufacturer's instructions, consult Engineer for further instructions. Do not proceed with Work without written instructions.

1.13 SPECIAL TOOLS

- A. For each type of equipment furnished, the Contractor shall provide a complete set of all special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, maintenance, and disassembly of such equipment. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever type.
- B. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment.
- C. Pack items to protect them during storage. Tag items and containers to clearly identify them in accordance with Contractor's part system, as reviewed by the Engineer. Cross-reference all items to their applicable Specification Section.
- D. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the work, at which time they shall be delivered to the Owner.
- E. The Contractor shall furnish and erect one or more steel wall cases with flat key locks and clips or hooks to hold each tool in arrangement.

1.14 LUBRICATION

- A. Where lubrication is required for proper operation of equipment, incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.
- B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for 24 hr period.
- C. Provide adequate and, as far as practicable, automatic means of lubrication for working parts. Arrange lubrication grease nipples, grease boxes and other lubrication devices so that they are readily accessible for routing greasing using grease nipples and Type 316 stainless steel extensions where required. Secure nipples and tubing to the equipment at appropriate locations. Indicate on the working drawings submitted, the types of lubricants to be used. Use grease nipples of a consistent type, Alemite button head type or equivalent. Provide grease gun(s) of the appropriate size(s) and pressure(s).
- D. Provide a one (1) year supply of all lubricants necessary for the routine, daily operation of the equipment. Provide a complete schedule of all the lubricant including the manufacturer name, type, name and local address and phone number of where each lubricant can be purchased for each piece of equipment.

1.15 NAMEPLATES

- A. With the exceptions mentioned below, each piece of equipment shall be provided with a Type 316 stainless steel nameplate, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model number or type designation, serial number, principal rated capacities, size, electrical or other power characteristics, and similar information.
- B. This requirement shall not apply to standard, manually operated hydrants or to gate, globe check and plug valves.
- C. Each process valve shall be provided with a Type 316 stainless steel tag securely fastened in place and inscribed with an identification number in conformance with the Valve Identification Schedule indicated and specified or furnished later by the Engineer.

1.16 LOADS AND SEISMIC FORCES

- A. Provide anchorage and supports for products, including equipment, assemblies, and pipe, designed to resist the following loads and seismic forces.
 - 1. Horizontal forces: 100 percent of dead and live loads acting in any direction in the horizontal plane applied to the center of gravity of the load.
 - 2. Vertical forces: 50 percent of the dead and live load, acting either upward or downward applied at the center of gravity of the load.

3. Cantilevered anchorages/supports: 100 percent of the dead and live loads acting in any direction applied at the center of gravity of the load.
- B. Seismic force determination: Maximum dead and live loads conditions while operating.
- C. Products, including equipment and assemblies, in normal submerged condition operation: analysis of seismic forces in both submerged/dry condition.
- D. Analysis of loads and seismic force: Performed by a registered Maine structural Engineer.
- E. Furnish copies of analysis with submittals for equipment, assemblies, and pipe.

1.17 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

- A. The requirements of this Paragraph shall constitute the standards for the material and equipment specified herein. Should these requirements conflict with the Supplier's recommendations or in any way be less stringent than the Supplier's requirements, they shall be superseded by the Supplier's requirements.
- B. Bolts, Anchor Rods and Nuts:
 1. All necessary bolts, anchor rods, nuts, washers, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith. Anchor rods shall have washers and hexagonal nuts.
 2. All anchor rods, nuts, washers, plates, and bolt sleeves: Type 316 stainless steel unless otherwise indicated or specified.
 3. Unless otherwise specified, stud, tap, and machine bolts, and nuts shall conform to the requirements of ASTM Standard Specification for Stainless Steel Externally and Internally Threaded Standard Fasteners, Designation A325. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to ANSI Standard B1.1 for Unified Inch Screw Threads (UN and UNR Thread Form).
 4. Bolts, anchor rods, nuts, and washers: Type 316 stainless steel ASTM F593.
 5. Bolts, anchor rods, nuts, and washers specified to be stainless steel shall be Type 316 stainless steel, as indicated.
 6. Anchor rods shall be set accurately. They shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and set in the concrete forms with suitable pipe sleeves, or both. If anchors are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and

care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.

C. Grease Fittings:

1. Provide extension fittings and tubing on all grease fittings that are installed in an inaccessible location. The extension is to be located so that equipment can be lubricated from the operating level without the use of ladders, staging or shutting down the equipment. Tubing: Type 316 stainless steel.

D. Concrete Inserts For Hangers:

1. Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be Type 316 stainless steel.

E. Equipment Foundations, Installation and Grouting:

1. The Contractor shall furnish the necessary materials and construct suitable concrete foundations for all equipment installed by him, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.
2. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.
3. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 inch for grout under the equipment bases. Shims used to level and adjust the bases shall be Type 316 stainless steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-metallic, non-shrink grout.
4. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.
5. Where such procedure is impracticable, the method of placing grout shall be as accepted by the Engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an accepted manner and given a burlap-rubbed finish.

F. Equipment Drive Guards:

1. All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism. Guards shall be constructed of Type 316 stainless steel (12 gage minimum) or or Type 316 stainless steel expanded metal set in a frame of Type 316L stainless steel members. Guards shall be secured in position by Type 316 stainless steel braces or straps which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.
2. Hardware: Type 316 stainless steel.
3. Provide access covers for shaft speed measurements.

G. Sleeves:

1. Unless otherwise indicated on the drawings, or specified, form openings for the passage of pipes, conduits, and circular ducts through floors and walls using sleeves of Schedule 40 pipe. Provide sleeves of ample diameter to pass the pipe, pipe joint and its insulation, if any, and to permit expansion as may occur. Provide sleeves that are flush at the walls and at the bottom of slabs and project 4 inches above the finished floor surface. Threaded nipples shall not be used as sleeves.
2. Sleeves in exterior walls below ground or in walls that have liquids on one or both sides, shall have a 2-inch annular fin of 1/8-inch plate welded with a continuous weld completely around the sleeve at mid-length. Sleeves shall be set accurately before the concrete is placed or shall be built in accurately as the masonry is being built.
3. Sleeve materials, provide material type as indicated and specified:
 - a. Type 316L stainless steel.
 - b. Carbon steel with fusion bonded polymer powder 10 to 15 mils thick, applied to oven heated sleeves via spraying method.
 - c. HDPE with integrated waster stop, 2-in thru 25-inch.

H. Protection Against Electrolysis:

1. Where dissimilar metals are used in conjunction with each other, provide insulation between adjoining surfaces to eliminate direct contact and any resultant electrolysis. Provide bituminous insulation, heavy bituminous coatings, flange isolating gasket kits, nonmettalic separators or washers, impregnated felt, or other means to provide insulation.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Material and Equipment Incorporated into Work:
 - 1. Conform to applicable specifications and standards.
 - 2. Comply with size, make, type, and quality specified or as accepted by Submittal.
- B. Manufactured and Fabricated Materials and Equipment:
 - 1. Design, fabricate, and assemble in accordance with engineering and shop practices standard with industry.
 - 2. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.
 - 3. Two or more items of same kind shall be identical, by same manufacturer.
 - 4. Material and equipment shall be suitable for service conditions specified and indicated.
 - 5. Equipment capabilities, sizes, and dimensions indicated or specified shall be adhered to, unless variations are specifically submitted and accepted, in writing.
 - 6. Provide parts and components designed for stresses occurring during continuous or intermittent operation as specified and indicated, and for stresses occurring during fabrication, shipping, handling and installation.
 - 7. Design so working parts are accessible for inspection and repair, can be duplicated, and replaced.
 - 8. Design structural members of equipment for shock and vibratory loads.
 - 9. Design machinery such that working parts are accessible for inspection and repair, and that each part is suitable for the service specified and indicated.
- C. Do not use material or equipment for purpose other than for which it is designed or specified.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL; INSTALLATION, AND INSTRUCTIONAL SERVICES

- A. General:

1. Provide on-site services of Supplier's representatives for equipment provided by Contractor during construction, installation, equipment startup, and training of Owner's personnel for equipment or plant operation as specifically required in Specification section for equipment or system.
2. Include and pay costs for Supplier's services.
3. Work day is defined as 8 hour period during Owner's or Contractor's typical calendar day. Work day for purposes of this section does not include travel to or from Site.
4. Specifications include minimum mandays to provide basis for bidding. If additional time is required to perform services Contractor shall include that time in Contract Price.

B. Installation Services:

1. Where installation services are called for in Specifications, provide competent and experienced technical representatives of manufacturers of material or equipment and systems to resolve assembly or installation procedures attributable to, or associated with, equipment furnished.
2. After equipment is installed, representatives shall perform initial equipment and system adjustment and calibration to conform to Specifications and manufacturer's requirements and instructions.
3. Provide "Certificate of Installation Services" stating proper adjustments have been made to equipment or system and equipment or system is ready for startup and system demonstration.

C. Training:

1. Do not start training until Installation Services have been completed.
2. Where training is called for in Specifications, provide competent and experienced technical representative of Supplier to provide detailed instructions to Owner's personnel for operation of equipment. Training services shall include operation and maintenance of instrumentation and equipment in classroom and on-site. Training shall include electrical, mechanical, and safety aspects of equipment.
3. Submit documentation identifying name of specific representative, factory authorization, and background of named individual(s) to conduct training. Submit information 30 days before scheduled training period for review and acceptance by Engineer.
4. Coordinate training periods with Engineer and Owner and Supplier's representatives.

- a. No training shall be conducted unless instructor has been accepted by Engineer.
 - b. Notify Engineer at least 48 hrs before training sessions are to begin so Engineer can make arrangements with Owner's operating personnel.
 - c. Reschedule canceled training sessions 48 hrs in advance.
 - d. Failure of Supplier's or manufacturer's representative to appear for scheduled training, failure to notify Engineer 24 hrs in advance of need to cancel scheduled training or failure to arrive within 30 min of start of scheduled training shall result in reimbursement to Owner for time lost by Owner's personnel in waiting for arrival of manufacturer's representative. Except in case of failure to arrive on time, time will not exceed 1 hr for each employee scheduled to receive training. Failure to arrive on time will be reimbursed by actual time late, up to 1 hr, after 1 hr training will be rescheduled. Failure of Supplier's or manufacturer's representative to appear for scheduled training, failure to notify Engineer 24 hrs in advance of need to cancel scheduled training or failure to arrive within 30 min of start of scheduled training shall result in reimbursement to Owner for expenses and time incurred by Engineer in traveling and time spent on-site. Minimum time billed shall be 8 hrs.
5. Similar types of equipment differing in model, size or manufacturer shall require equal service time as stated in specific Specification section.
 6. O&M data shall constitute basis of instruction.
 - a. Review data contents with personnel in full detail to explain aspects of operations and maintenance.
 7. Provide "Certificate of Instructional Services", cosigned by Owner and Supplier's representative, verifying training has been accomplished to satisfaction of each party.

3.02 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01700.

FORM 01600-1-1
EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION SERVICES

Owner - City of Bangor

Project - Reaeration Blowers and Aeration Diffusers

Contract No. _____

AECOM No. 60699402

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

conforms to the requirements of the Contract and is ready for permanent operation and that
nothing in the installation will render the manufacturer's warranty null and void.
on

Date: _____ Time: _____

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

FORM 01600-1-2
EQUIPMENT MANUFACTURER'S CERTIFICATE OF POST STARTUP SERVICES

Owner - City of Bangor

Project - Reaeration Blowers and Aeration Diffusers

Contract No. _____

AECOM No. 60699402

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

Post Startup Services for the subject project (has) (have) been performed in a satisfactory manner, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date: _____ Time: _____

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF POST STARTUP SERVICES

(I) (We) the undersigned, authorized representatives of the Owner and/or Plant Operating Personnel have received Post Startup Services for the equipment as required by the contract on:

_____ Date: _____

SECTION 01610

DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 GENERAL:

- A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY:

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

1.03 STORAGE AND PROTECTION:

- A. Store and protect products and equipment in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces

of equipment.

- B. Arrange storage of products and equipment to permit access for inspection. Periodically inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
- C. Provide protective maintenance during storage consisting of manually exercising equipment, inspecting mechanical surfaces for signs or corrosion or other damage, lubricating, applying any coatings as recommended by the equipment manufacturer necessary for its protection and all other precautions to assure proper protection of all equipment stored and for compliance with manufacturers' requirements related to warranties.
- D. Store loose granular materials on solid flat surface in a well-drained area. Prevent mixing with foreign matter.
- E. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulation of dirt or grease, and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in manner to reduce breakage, cracking and spalling to a minimum.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Submit record drawings including all ties and elevation information recorded for underground facilities.

1.02 FINAL CLEANING

- A. During its progress, the work and the adjacent areas affected thereby shall be cleaned up and all rubbish, surplus materials, and unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.
- B. Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the work, be left in a clean and neat condition.
- C. On or before the completion of the work, the Contractor shall, unless otherwise especially directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by him; shall remove all rubbish from any grounds which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.

- D. The Contractor shall thoroughly clean all materials and equipment installed by him and his sub-contractors, and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.

- E. The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, walk, and landscaping work. Suitable materials, equipment, and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the contract period.

END OF SECTION

SECTION 01730
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section includes procedural requirements for providing, compiling and submitting operation and maintenance data required for this Project.

1.02 SUMMARY:

- A. This section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. General contents of data.
 - 2. Specific data for each equipment and system.
 - 3. Manual for materials and finishes.
 - 4. Assembly.

1.03 DEFINITIONS:

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 SUBMITTALS:

- A. O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized as specified in this Specification section.
 - 1. Engineer will comment on whether content of operations and maintenance submittals are acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Initial O&M Manual: Submit draft copy of each O&M Manual to Engineer. Engineer will comment on whether general scope and content of each O&M Manual is acceptable.
- C. Pre-Final Manual Submittal: Submit two (2) copies of each O&M Manual in final form prior to requesting inspection for Substantial Completion. Engineer will return one (1) copy with comments.
 - 1. Contractor to correct or revise each manual to comply with Engineer's comments.
- D. Submit three (3) copies of each corrected manual as a final manual within 15 days of receipt of Engineer's comments and prior to commencing startup, commissioning, and/or training.

1.05 FORMAT:

- A. Submit a pdf electronic file and the number of paper copies indicated in paragraph 1.04 of the O&M Manual.
- B. Prepare data in the form of an O&M instructional manual.
- C. Binders: Commercial quality, 8 1/2 inch by 11 inch three ring “D” binders with hardback, 3 inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings.
- D. Arrange contents by Specification section numbers and sequence of Table of Contents of this Project Manual.
- E. Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.
- F. Text: Manufacturer’s printed data, or typewritten data on 20 pound paper.
- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three ring “D” binders.

1.06 QUALITY ASSURANCE:

- A. Preparation of data shall be performed by personnel:
 - 1. Trained and experienced in O&M of described equipment.
 - 2. Familiar with requirements of this section.
 - 3. Skilled as technical writers to the extent required to communicate the essential data to the Reader.
 - 4. Skilled as drafters competent to prepare any required drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL CONTENTS OF DATA:

- A. Each individual manual shall contain equipment data pertaining to not more than one Specification section number as indicated in the Contract Documents unless otherwise approved by Engineer. For example, Engineer will consider combining individual Specification sections under Division 16.
 - 1. Completed Form 01730-1, Contractor’s Submittal Form. An electronic copy of Form 01730-1 will be provided to Contractor.
- B. Title Sheet: First page in data listing following:
 - 1. Title: “OPERATION AND MAINTENANCE INSTRUCTIONS”.
 - 2. Title of Project: As shown on Contract Documents.
 - 3. Name(s) of applicable building(s) or structure(s) in which equipment is located.

4. Name of equipment as described in Contract Documents.
 5. Contractor's name, address, and telephone number.
 6. Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.
 7. Contractor's or Subcontractor's purchase order number, manufacturer's shop order number or other such numbers required for parts and service ordering.
 8. Manufacturer's name, address, and telephone number.
 9. Name, address, and telephone number for local source of supply for parts and service.
- C. Equipment List: Immediately following title sheet containing the following:
1. Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.
 2. Tabbed Dividers: Insert tabbed section dividers between each major section
 - a. Provide title of section on each tab.
 - b. Provide table of contents for each tabbed section, arranged in systematic order.
 3. Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).
 4. Text:
 - a. Include only those sheets applicable to the Project.
 - b. Each sheet shall:
 - (1) Identify specific equipment or part installed.
 - (2) Identify text applicable to equipment or part installed.
 - (3) Do not include inapplicable information or neatly strike it out.
 5. Drawings:
 - a. Supplement text with drawings to clearly illustrate following:
 - (1) Equipment and components.
 - (2) Relations of component parts of equipment and systems.
 - (3) Control and flow diagrams.
 - b. Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation for this Contract.
 6. Specially written information, as required to supplement text for particular installation.

- a. Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.
- b. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.
- c. Provide glossary of any special terms used by the manufacturer if applicable.
- d. Organize in consistent format under separate headings for different O&M procedures.
- e. Provide logical sequence of instructions in order of O&M action required for each procedure.

3.02 SPECIFIC DATA FOR EACH ITEM OF EQUIPMENT AND/OR SYSTEM:

A. For each item of equipment and system include:

1. Completed Equipment Data Form typewritten on copy of Form 01730-2 to Section 01730. An electronic copy of Form 01730-2 will be provided to Contractor.
2. Description of equipment and component parts:
 - a. Function
 - b. Normal operating characteristics
 - c. Limiting conditions.
 - d. Performance curves
 - e. Engineering data
 - f. Test as applicable.
 - g. Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.
 - h. Complete nameplate data.
 - i. Owner's tag (or asset) numbers for equipment as indicated on the Contract Drawings.
3. Operating Procedures:
 - a. Startup and break-in.
 - b. Normal operating instructions.
 - c. Regulation and control
 - d. Stopping and shutdown,
 - e. Emergency instructions.
 - f. Summer and winter operating instructions, as applicable.
 - g. Special operating instructions.
4. Maintenance Procedures:
 - a. Routine maintenance operations.

- b. Guide to troubleshooting.
 - c. Disassembly, repair, and reassembly instructions.
 - d. Alignment, adjusting, and checking instructions.
 5. Servicing and Lubrication Schedule:
 - a. List of lubricants required and quantity to be applied.
 - b. Schedule of lubrication.
 - c. Schedule for other routine maintenance.
 6. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.
 7. Description of sequence of operation of controls.
 8. Assembly drawings and diagrams required for maintenance.
 9. Manufacturer's parts list and illustrations
 - a. Predicted life of parts subject to wear.
 - b. Items recommended to be stocked by the Owner as spare parts and quantities of same.
 10. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.
 11. Bill of material.
 12. Other data as required under applicable Specification sections.
- B. Each electric and electronic system, as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include:
1. Description of System and Component Parts:
 - a. Function
 - b. Normal operating characteristics
 - c. Limiting conditions.
 - d. Performance curves
 - e. Engineering data
 - f. Rating tables
 - g. Tests, as applicable.
 - h. Complete nomenclature and model number of replaceable parts.
 - i. Complete nameplate data.
 - j. Owner's Tag (asset) numbers for equipment as indicated on the Contract Drawings.

2. Circuit Directories of Panel Boards:
 - a. Electrical service.
 - b. Controls.
 - c. Communications.
 3. Complete instrumentation
 - a. Loop diagrams
 - b. Tabulated listing of components in each control circuit or loop.
 4. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Sequences required.
 - c. Special operating instructions.
 5. Maintenance Procedures:
 - a. Routine maintenance operations.
 - b. Guide to troubleshooting.
 - c. Disassembly, repair, and reassembly instructions.
 - d. Adjustment and checking instructions.
 6. Manufacturer's printed instructions regarding safety precautions for both:
 - a. Protection of personnel operating equipment and systems.
 - b. Prevention of damage to equipment and systems.
 7. List of all the manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by the Owner.
 8. Other data as required under pertinent sections of Specifications.
- C. Prepare and include additional data when need for such data becomes apparent during instruction of Owner's personnel. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

3.03 MANUAL FOR MATERIALS AND FINISHES:

- A. Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. 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.
- C. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

- D. Additional Requirements: As specified in individual product Specification sections.
- E. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.04 ASSEMBLY:

- A. Assemble in four (4) sets.
- B. Remove bindings of individual manuals.
- C. Insert index tabs labeled with the respective piece of equipment to separate individual manuals.
- D. Provide a Table of Contents at the front of each volume showing the equipment items in the order in which they appear in the volume. Each equipment items shall include the functional name, applicable specifications section, and the plan listing, if any.
- E. The preventive maintenance schedule shall be bound in the front of each section immediately following the index tab sheet. The schedule shall be identified with respect to the piece of equipment it is referring to.
- F. Sheet Size: 8 1/2 inch by 11 inch sheets.
- G. Drawings may be on 11 inch by 17 inch sheets folded to 8 1/2 by 11 inches.
- H. Engrave on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, Engineer's Project number, date of Contract, and volume number with subject matter of contents, and Engineer's name.

CONTRACTOR SUBMITTAL FORM

TO: (Engineer) (Address) (City, State, Zip) (Attn:)		DATE:	
		SPECIFICATION SECTION TITLE:	
		SECTION NO.:	
		MANUFACTURER/ VENDOR:	
FROM: (Contractor) (Address) (City, State, Zip)		NO. OF COPIES SUBMITTED TO ENGINEER:	
		SIGNATURE OF CONTRACTOR:	
<p>GENTLEMEN:</p> <p>We have checked the O&M manual submittal dated _____, 20__, and have found it to be in accordance with the requirements of Specification Section 01730 as noted below.</p>			
<p>FORMAT</p> <p>Size: 8-1/2 x 11 or 11 x 17</p> <p>Paper: 20-lb minimum</p> <p>Text: Printed data/neatly typed</p> <p>Drawings: Standard size bound in text; in text size labeled envelopes</p> <p>Tabbed Section Dividers</p> <p>Cover Label: Title</p> <p>Project name</p> <p>Building/Structure ID</p> <p>Equipment Name</p> <p>Specification Section</p> <p>Binders: 3-ring</p>			

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			A. Section number - one specification only
			B. Title Page
			1. Title
			2. Project title
			3. Building/structure ID
			4. Equipment name
			5. Contractor ID
			6. Subcontractor ID
			7. Purchase order data
			8. Manufacturer ID
			9. Service/parts supplier ID
			C. Product List
			D. Table of Contents
			E. Tabbed Sections
			F. Pertinent data sheets
			1. Annotated as needed
			G. Text
			1. Pertinent to project
			2. Annotated
			H. Drawings
			1. Supplement text
			a. Illustrate product and components
			b. Relations of equipment systems
			c. Control and flow diagrams
			2. Actual drawing of project equipment

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.01 GENERAL CONTENTS			
			I. Special Information
			1. Interrelationships of equipment and components
			2. Instructions and procedures provided
			3. Instructions organized in consistent format
			4. Instructions in logical sequence
			5. Glossary
			J. Warranty, Bond, Service Contract
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			A. For each item of equipment
			1. Complete Form 2 to Section 01 78 23
			2. Description of Unit and Components
			a. Equipment functions
			b. Normal operating characteristics
			c. Limiting conditions
			d. Performance curves
			e. Engineering data
			f. Test data
			g. Replaceable parts list (with numbers)
			h. Nameplate data
			i. P&ID numbers
			3. Operating Procedures
			a. Startup, break-in
			b. Routine/normal operation
			c. Regulation and control
			d. Stopping and shutdown
			e. Emergency

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			3. Operating Procedures (continued)
			f. Seasonal operation
			g. Special instructions
			4. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/repair/assembly
			d. Alignment, adjusting and checking instructions
			5. Servicing and Lubrication
			a. List of lubricants
			b. Lubrication schedule
			c. Maintenance schedule
			6. Safety Precautions/Features
			7. Sequence of Operation of Controls
			8. Assembly Drawings
			9. Parts List and Illustrations
			a. Predicted life
			b. Spare parts list
			10. Control Diagrams/Schematics
			11. Bill of Materials
			12. Other Data as Required

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
3.02 SPECIFIC CONTENTS (EQUIPMENT/SYSTEMS ONLY)			
			B. Each electrical and electronic system
			1. Description
			a. Equipment functions
			b. Normal operating characteristics
			c. Performance curves
			d. Engineering data
			e. Test data
			f. Replaceable parts list (with numbers)
			g. Nameplate data
			h. P&ID numbers
			2. Circuit and Panel Board Directories
			a. Electrical
			b. Controls
			c. Communications
			3. Instrumentation
			a. Loop Diagrams
			b. Components list each circuit/loop
			4. Operation Procedures
			a. Routine/normal operating instructions
			b. Sequences required
			c. Special operating instruction
			5. Maintenance Procedures
			a. Routine/normal instructions
			b. Troubleshooting guide
			c. Disassembly/reassembly
			d. Adjusting and checking
			6. Safety Precautions/Features
			7. Spare Parts List
			8. Additional Data

EQUIPMENT DATA FORM

PROJECT NAME			
CONTRACT NO.			
CONTRACTOR			
EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	
LOCATION			
MANUFACTURER			
PURCHASED FROM			
VENDOR ORDER NO.		PURCHASE \$	
DATE OF PURCHASE			
LOCAL SUPPLIER			
ADDRESS			
PHONE NO.			
MODEL NO.			
NO. OF UNITS		SERIAL NOS.	
*By Owner			

EQUIPMENT DATA FORM

NAMEPLATE DATA			
ELECTRIC MOTOR		PUMP/HVAC UNIT	
MANUFACTURER		MANUFACTURER	
TYPE	[] AC [] DC	TYPE	
HORSEPOWER		SIZE	
RPM		CAPACITY	
VOLTAGE		PRESSURE	
AMPERAGE		ROTATION	
PHASE		IMPELLER SIZE	
FRAME		IMPELLER MATERIAL	
DRIVE/REDUCER		OTHER (I&C)	
MANUFACTURER		MANUFACTURER	
TYPE	[] GEAR	TYPE	
	[] V-BELT		
	[] CHAIN	SIZE	
	[] VARIDRIVE		
SERVICE FACTOR		CAPACITY	
RATIO		RANGE	

EQUIPMENT DATA FORM

LUBRICANT/RECOMMENDED SPARE PARTS LIST

EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	

LUBRICANT LIST

REFERENCE SYMBOL	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUBRICANT AND MANUFACTURER
List symbols in "Maintenance Operation" (Page 3).	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer.

RECOMMENDED SPARE PARTS LIST

PART NO. **	DESCRIPTION	UNIT	QUANTITY	UNIT COST

ADDITIONAL DATA AND REMARKS

* By Owner
 ** Identify parts provided by this contract with two asterisks.
 Note: Attach additional sheets if necessary; identify each sheet at top with equipment number and description.

END OF SECTION

SECTION 01740

WARRANTIES AND BONDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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

1.02 RELATED WORK

- A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.
- B. General closeout requirements are included in Section 01700, Contract Closeout.
- C. Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of Division 2 through 16.
- D. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

1.03 SUBMITTALS

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

- D. Refer to individual Sections of Divisions 2 through 16 for specific content requirements, and particular requirements for submittal of special warranties.
- E. At Final Completion, compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- F. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-in. by 11-in. paper.
- G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification Section in which specified, and the name of the product or work item.
- H. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer, supplier, and manufacturer.
- I. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name, address, and telephone numbers of the Contractor and equipment supplier.
- J. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.
- K. Schedule of Special Warranties

Special Warranties are listed within the Technical Specification Sections.

1.04 WARRANTY REQUIREMENT

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

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

1.05 DEFINITION

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

PART 2 - PRODUCTS

NOT USED

PART 3 – EXECUTION

NOT USED

END OF SECTION

SECTION 01750

TRAINING

PART 1 - GENERAL

1.01 SUMMARY:

- A. Section includes administrative and procedural requirements for instructing the Owner's personnel, including the following:
 - 1. Instructor manual.
 - 2. Trainee manual.
 - 3. Facilities for training.
 - 4. Schedule.
 - 5. Preparation.
 - 6. Instruction.
 - 7. Training contents.
 - 8. Demonstration and training video recordings.
 - 9. Field quality control.
 - 10. Training documentation.
- B. Payment for work covered by this section shall be included in the lump sum cost of the Project.

1.02 SUBMITTALS:

- A. Submit the following in accordance with Section 01300:
 - 1. Submit two copies of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - a. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of the live instructional module.
 - b. Draft and final training outlines.

- (1) Draft outline will be reviewed by the Engineer and comments returned to the Contractor.
 - c. Student notes and instructor guides.
2. Qualification Data for **instructor**.
 - a. Submit resumes, including two outside references, for each instructor proposed for training program. The qualifications of the instructor shall include:
 - (1) Type of training instructor has received for the specific equipment the training module will cover, including dates and who provided the training.
 - (2) Training Work experience including the employers name and address, dates of employment and type of training provided and to whom.
 - (3) A minimum of two training references including: project name, project location, Contact person's name. contact person's telephone number, contact persons role during the project, dates of training and type of training provided.
3. Within 7 days after each training module, submit list of participants and length of instruction time.
4. Submit electronic copy of each training module within seven calendar days following the delivery of each training module.
 - a. On each copy, provide an applied label with the following information:
 - (1) Name of Project.
 - (2) Training Session Name.
 - (3) Name and address of videographer.
 - (4) Name of Engineer.
 - (5) Name of Contractor.
 - (6) Date of video recording.
 - b. Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.

- c. At completion of training, submit complete training manual(s) for Owner's use in PDF electronic file format on compact disc.

1.03 QUALITY ASSURANCE:

A. Instructor Qualifications:

1. A factory-authorized service representative experienced in operation and maintenance procedures and in providing training for the products and systems installed under this Contract.

B. Videographer Qualifications:

1. A professional videographer who is experienced photographing demonstration and training events similar to those required under this contract.

C. Preinstruction Conference:

1. Conduct conference at the Project site to review methods and procedures related to the demonstration and training. The participants in this Preinstruction Conference shall include the Contractor, Engineer, and Owner.
 - a. Inspect and discuss classroom locations and other facilities required for instruction.
 - b. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed in order to facilitate the execution of the scheduled training in a timely manner.
 - c. Review required content of instruction.
 - d. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.04 COORDINATION:

- A. Contractor to coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of the Owner's personnel.
- B. Contractor to coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Contractor to coordinate content of training modules with content of accepted emergency, operation, and maintenance manuals. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01730 has been reviewed and accepted.

PART 2 - PRODUCTS

2.01 INSTRUCTOR MANUAL:

- A. Prepare an Instructor Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanical specialists and instrument technicians, and for wastewater treatment plant operators, or other disciplines, depending upon the target audience.
- B. The Instructor Manual shall be consistent with the nomenclature and contents of the accepted Contractor's O&M Manuals required in Specification Section 01730. The O&M Manuals cannot be substituted as the Instructor Manual.
- C. The purpose of the Instructor Manual is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The Instructor Manual is designed to provide specific guidance to the Instructor regarding all aspects of the training program. The Instructor Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics.
 - 3. Safety procedures.
 - 4. Startup checks and procedures.
 - 5. Overview of routine operation, including startup and shutdown and operating parameters, tailored to the intermittent, wet weather-related operation of this specific application.
 - 6. Routine, preventive, and corrective maintenance procedures.
 - 7. Lubrication (schedule and type).
 - 8. Assembly and disassembly procedures.
 - 9. Troubleshooting procedures.
 - 10. Parts list.
 - 11. Special maintenance practices.
 - 12. Emergency shutdown.
- D. All manuals shall be presented in electronic format. All equipment shall be cross-referenced to the equipment tag identification numbers shown on drawings and/or used in technical specifications.

- E. Each Instructor Manual shall contain:
1. Instructor Manual cover page.
 2. Instructor Manual table of contents.
 3. Lesson Plan which shall include:
 - a. Lesson Plan cover page.
 - b. Lesson Plan summary.
 - c. Lesson Plan text, including:
 - (1) Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.).
 - (2) Length of the training program and each topic to be covered.
 - (3) Performance and/or training objectives.
 - (4) Outline of the material to be covered.
 - (5) Training strategies to be used and interaction with the trainees.
 - (6) Audio visual and/or support materials required, and when used or referred to during instruction.
 - (7) A list of resource and/or reference materials.
 4. A copy of all training aids, including electronic files.
 5. A copy of trainee materials (handouts, reference materials, etc.) in electronic format.
- F. The Contractor shall submit the equipment manufacturer's lesson plans for acceptance by the Engineer no less than 45 days prior to the date that the training is to take place.
- G. With the exception of cutaway models or other items expressly exempted by the Engineer, all training aids and trainee materials contained in the Instructor Manual or used in the delivery of training shall become the property of the Owner and may be duplicated by the Owner for its own use.
- H. The Contractor shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the Contractor so that the materials can be reproduced by the Owner.
- I. The Contractor shall provide Instructor Manuals bound in 3 hole D-ring binders.

1. Utilize commercial quality 3 hole D-ring binders, maximum ring size 3-inches, with durable and cleanable plastic covers. Binders shall include title pockets for holding notes. Binders shall not be filled to more than 75 percent capacity.
2. When multiple binders are used for one device or system, correlate the information into related consistent groupings and list the contents of all volumes in the Table of Contents.

2.02 TRAINEE MANUAL:

A. Program Structure:

1. Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required in the individual Specification Sections.

B. Training Manuals:

1. The Contractor shall submit a Trainee Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanic specialists and instrument technicians, and for wastewater treatment plant operators, or other disciplines, depending upon the target audience.
2. The Trainee Manual shall be consistent with the nomenclature and content of the accepted Contractor O&M Manuals required in Specification Section 01730. The O&M Manual cannot be substituted for the Instructor Manual or Trainee Manual.
3. The purpose of the Trainee Manual is to provide an organized package of information for use by trainees during the training sessions and as reference material for operation and maintenance in the future. The Trainee Manual shall include:
 - a. Description of the equipment.
 - b. Parts and equipment graphics including “exploded” views.
 - c. Safety procedures.
 - d. Pre-startup checks.
 - e. Startup procedures.
 - f. Operation and monitoring procedures including normal operating parameters, and the operating limits of the equipment, tailored to the intermittent, wet weather-related operation of this specific application.
 - g. Shutdown procedures.

- h. Troubleshooting procedures.
 - i. Non-routine emergency procedures.
 - j. Safety/Protective equipment required by Trainees.
4. All manuals shall be presented in electronic format. All equipment shall be cross-referenced to the equipment tag identification numbers.
5. The Contractor shall provide one copy of each Trainee Manual for each trainee plus an additional five (5) copies for Owner's future use, bound in 3 hole D-ring binders.
6. Training Manual Format:
- a. Size: 8-1/2 inch by 11 inch.
 - b. Paper: 20-lb minimum, white, for typed pages.
 - c. Text: Manufacturer's printed data, or neatly typewritten, including:
 - (1) Table of Contents.
 - (2) Pretest.
 - (3) Learning Objectives.
 - (4) General Operations.
 - (5) Theory.
 - (6) Specific Equipment Information.
 - d. Drawings:
 - (1) Provide reinforced, punched binder tab, bind in with text.
 - (2) Reduce larger Drawings by folding to the size of 8-1/2 inch by 11 inch text pages. Drawings larger than 11 inch x 17 inch shall be folded and inserted into 8 1/2 inch by 11 inch clear vinyl pockets suitable for placing into 3 hole D-ring binders.
 - e. Cover: Identify each volume with typed or printed title "Training Manual".
 - (1) Title of Project.
 - (2) Identify separate structure or system as applicable.
 - (3) Identify general subject matter covered in Manual.

7. Binders:

- a. Utilize commercial quality 3 hole D-ring binders, maximum ring size 3-inches, with durable and cleanable plastic covers. Binders shall include title pockets for holding notes. Binders shall not be filled to more than 75 percent capacity.
- b. When multiple binders are used for one device or system, correlate the information into related consistent groupings and list the contents of all volumes in the Table of Contents.

C. Training Modules:

1. Develop a learning objective and teaching outline for each module. Include a description of the specific skills and knowledge that each participant is expected to master.
2. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - a. Basis of System Design, Operational Requirements, and Criteria: Include the following, tailored to the intermittent, wet weather-related operation of this specific application:
 - (1) System, subsystem, and equipment descriptions.
 - (2) Performance and design criteria if the training provider is delegated design responsibility.
 - (3) Operating standards.
 - (4) Regulatory requirements.
 - (5) Equipment function.
 - (6) Operating characteristics.
 - (7) Limiting conditions.
 - (8) Performance curves.
 - b. Documentation: Review the following items in detail:
 - (1) Emergency manuals.
 - (2) Operations manuals.
 - (3) Maintenance manuals.

- (4) Project record documents.
 - (5) Identification systems.
 - (6) Warranties and bonds.
 - (7) Maintenance service agreements and similar continuing commitments.
- c. Emergencies: Include the following, as applicable:
- (1) Instructions on meaning of warnings, trouble indications, and error messages.
 - (2) Instructions on shutdown.
 - (3) Shutdown instructions for each type of emergency.
 - (4) Operating instructions for conditions outside of normal operating limits.
 - (5) Sequences for electric or electronic systems.
 - (6) Special operating instructions and procedures.
- d. Operations: Include the following, as applicable, tailored to the intermittent, wet weather-related operation of this specific application:
- (1) Start-up procedures.
 - (2) Equipment or system break-in procedures.
 - (3) Routine and normal operating instructions.
 - (4) Regulation and control procedures.
 - (5) Control sequences.
 - (6) Safety procedures.
 - (7) Instructions on stopping.
 - (8) Normal shutdown instructions.
 - (9) Operating procedures for emergencies.
 - (10) Operating procedures for system, subsystem, or equipment failure.
 - (11) Seasonal and unattended operating instructions.

- (12) Required sequences for electric or electronic systems.
- (13) Special operating instructions and procedures.
- e. Adjustments: Include the following:
 - (1) Alignments.
 - (2) Checking adjustments.
 - (3) Noise and vibration adjustments.
 - (4) Economy and efficiency adjustments.
- f. Troubleshooting: Include the following:
 - (1) Diagnostic instructions.
 - (2) Test and inspection procedures.
- g. Maintenance: Include 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) List of lubrication products, procedures, and intervals.
 - (5) Procedures for routine cleaning
 - (6) Procedures for preventive maintenance.
 - (7) Procedures for routine maintenance.
 - (8) Instruction on use of special tools.
- h. Repairs: Include the following:
 - (1) Diagnosis instructions.
 - (2) Repair instructions.
 - (3) Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - (4) Instructions for identifying parts and components.

- (5) Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.01 FACILITIES FOR TRAINING:

- A. Use Owner's designated training facilities for specified field training programs.
- B. Facilities include installation sites, which shall be used for hands-on training programs.
- C. Coordinate use of Owner's facilities with Owner and Engineer.

3.02 SCHEDULE:

- A. Coordinate training periods with Owner, Engineer, and Supplier's representatives.
 - 1. Training shall be limited to no more than three days per week. No training shall be conducted on Mondays or Fridays unless requested or allowed by Owner.
 - 2. Separate training sessions shall be conducted for the Owner's operational personnel, mechanical and maintenance personnel, and electronic and electrical maintenance personnel.
 - 3. The Contractor shall coordinate the manufacturer's training services with the Owner and the Engineer, providing a minimum of fourteen (14) days prior notice of training, subject to the acceptance of the Engineer and the Owner.
 - 4. In order to provide training for an adequate number of Owner personnel, a minimum of two 8-hour training days, broken into training sessions as appropriate, shall be provided for each item of equipment at the site, unless otherwise specified.
 - 5. The Contractor shall deliver all training material to the Engineer and the Owner a minimum of fourteen (14) days prior to the scheduled training.
 - 6. The Contractor shall maintain a calendar of training events which defines each submission for each vendor training curriculum. Calendar shall be updated as required.
 - 7. Reschedule canceled training sessions 7 calendar days in advance.
 - 8. Failure of supplier's or manufacturer's representative to appear for scheduled training, failure to notify Owner and Engineer 48 hours in advance of need to cancel scheduled training, or failure to arrive within 30 minutes of start of scheduled training shall result in reimbursement of Owner for time lost by Owner's operating personnel and Engineer in waiting for arrival of manufacturer's representative. Time will not exceed 1 hour for each Owner's employee scheduled to receive training and actual cost to Owner by the Engineer.

B. Training Procedures:

1. The instructor shall arrive at the training site at least one hour before training is scheduled to be delivered in order to review the Instructor Manual with the Engineer and Owner and complete final preparations for presentation of the training session. The instruction shall comply with all safety requirements, including wearing a hard hat, safety shoes, and other safety and/or personal protective equipment.
 - a. Information presented in the training program shall be based on the Instructor and Trainee Manuals.
 - b. The Engineer and Owner will monitor and evaluate the performance of the instructor and the quality of the training session. Unacceptable sessions are those where the accepted lesson plan was not presented, where inadequate time was taken to present lesson plan or the training was not understood by the trainees. The adequacy of the training shall be determined solely by the Owner. Contractor shall repeat any training sessions deemed unacceptable, at no additional cost to the Owner.
 - c. A safety briefing shall be conducted by the instructor prior to use of any equipment.

C. Factory training programs, if required, shall be completed prior to start-up of Owner's system and shall use equipment similar to Owner's equipment.

D. Training shall be completed minimum of 7 days before performance testing on each piece of equipment or unit process begins.

E. Owner's personnel will require training, both for operating and maintenance functions. These individuals shall be trained in small groups at times and dates agreed upon by the Owner.

3.03 PREPARATION:

A. Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a training manual organized in coordination with requirements of this Section and in Section 01730 - Operations and Maintenance Data.

B. Set up instructional equipment at instruction location.

3.04 INSTRUCTION:

A. Prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.

- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish the Contractor with names and positions of participants after the final course outline is accepted.
- C. Manufacturer's Training Location and Reference Material:
 - 1. Conduct training on-site in the completed and fully operational facility using the actual equipment in-place.
 - 2. Conduct training using final operation and maintenance data submittals as training aides.
- D. At conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- E. Cleanup:
 - 1. Collect used and leftover educational materials and remove from the Project site if unwanted by the Owner.
 - 2. Remove instructional equipment.
 - 3. Restore systems and equipment to condition existing before initial training use.

3.05 TRAINING CONTENT:

- A. Maintenance of Instrumentation:
 - 1. Training requirements:
 - a. Describe overall function of each instrument and control loop installed under this Contract.
 - b. Locating probable source of malfunction in instrumentation equipment determining symptoms of trouble, establishing probable cause and effecting solution.
 - c. Taking appropriate preventive and corrective maintenance procedures necessary to keep instrumentation system in proper operating condition, including calibration and testing, tailored to the intermittent, wet weather-related operation of this specific application.
 - 2. Course Materials:
 - a. Pertinent portions of submittals specified in Specifications such as calibration data and maintenance instructions.

- b. Detailed course outlines and troubleshooting guides for field use. Troubleshooting guides shall include symptoms, probable causes and solutions for all cases of trouble described during training program.
 3. Training program shall not include any time specified for system start-up instruction or acceptance testing.

B. Maintenance of Process Equipment:

1. Training requirements:
 - a. Describe functions of process equipment.
 - b. Component preventive and corrective maintenance activities required to keep unit equipment in good operating conditions, tailored to the intermittent, wet weather-related operation of this specific application.
 - c. Instruct trainees in locating probable source of equipment malfunctions, determining symptoms of trouble, establishing probable cause, and effecting solution.
2. Course materials:
 - a. Pertinent portions of operation and maintenance manuals as well as alignment tolerances, lubrication schedules, vibration analysis instructions and parameters, and special calibration test and procedures.
 - b. Detailed course outlines and trouble-shooting guides for each piece of equipment. Trouble-shooting guides shall include symptoms, probable causes, and solutions for trouble described during training program.
3. Method of training maintenance personnel shall include Contractor using Owner's equipment to demonstrate trouble-shooting, preventive and corrective maintenance procedures.

C. Operation of Process Equipment:

1. Training requirements:
 - a. Being able to implement start-up and shutdown procedures for each piece of equipment individually, as well as start-up and shutdown of systems comprising equipment. This instruction shall include normal operation, alternative operations, and emergency operations, tailored to the intermittent, wet weather-related operation of this specific application.
 - b. Understand functions of instrumentation, describing individual components and how each component is used in monitoring and controlling equipment and processes for the instrumentation supplied by the manufacturer.

- c. Understand operating modes possible as result of modifications and installations.
 - d. Locating probable source of system inefficiency, determining symptoms, establishing probable cause, and re-stabilizing system efficiency for systems.
 - e. Precautions for safe operation of equipment, instrumentation, and control system.
 - f. Emergency procedures for equipment and systems during malfunction or other extreme conditions.
2. Course materials:
- a. Pertinent portions of Operations and Maintenance Manuals, including start-up and shutdown procedures; descriptions of equipment and instrumentation functions and modes of operations, control, and monitoring; troubleshooting instructions and process control instructions.
 - b. Detailed course outlines and operations guides for equipment and processes for field use. Operations guides shall include general operating procedures, start-up and shutdown procedures, optimization procedures, and emergency operating procedures.
3. Methods of training Owner's operations personnel shall include field training program at Owner's site consisting of classrooms and hands-on training using Owner's equipment and systems.

3.06 DEMONSTRATION AND TRAINING VIDEO RECORDINGS:

A. General:

- 1. Engage a qualified commercial videographer to record demonstration and training video recordings.
- 2. Record each training module separately. This includes classroom and field training.
- 3. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
- 4. At beginning of each training module, record each chart containing learning objective and lesson outline.

- B. Video: Provide minimum 640 x 480 video resolution converted to format file type acceptable to Owner, on electronic media.

1. Electronic Media: Read-only format compact disc acceptable to Owner, with commercial-grade graphic label.
 2. File Hierarchy: Organize folder structure and file locations according to project manual table of contents. Provide complete screen-based menu.
 3. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
 4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project, arranged according to Project table of contents:
 - a. Name of Contractor/Installer.
 - b. Business address.
 - c. Business phone number.
 - d. Point of contact.
 - e. E-mail address.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.
- D. Light Levels: Verify light levels are adequate to properly light equipment and overall training session. Verify equipment markings are clearly visible prior to recording.
1. Furnish additional portable lighting as required.
- E. Narration: Describe scenes on video recording by audio narration by microphone while on-site and/or dubbing audio narration off-site after video is recorded. Include description of items being viewed.
- F. Transcript: Provide a transcript of the narration. Display images and running time captured from electronic media opposite the corresponding narration segment.
- G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.
- 3.07 FIELD QUALITY CONTROL:
- A. Manufacturer's Training Effectiveness:

1. Instructor audio and class participant questions/answers shall be clear and audible on the electronic media or the sessions will need to be redone at no additional cost to the Owner.
2. Effectiveness of training operations personnel shall be assessed through written and in-the-field skills evaluation of trainees. Evaluations shall be designed to determine trainees' ability to control processes, as well as their ability to operate or maintain equipment.
3. Performance of each trainee shall be classified as "Satisfactory-Operations" (demonstrates basic knowledge and performance of Standard Operating Procedures) or "Unsatisfactory-Operations" (demonstrates basic knowledge and performance or process control strategies) or "Unsatisfactory-Process" (requires more training to demonstrate basic knowledge and performance of process control strategies).
4. Unsatisfactory evaluations shall include recommendations for corrective action and the training session must be given again at no cost to the Owner.

3.08 TRAINING DOCUMENTATION:

- A. On completion of training, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer a complete signed Form 01750-1 demonstrating training is complete.
- B. If the Owner approves the training, the acceptance will be documented in a completed Form 01750-2.
- C. Differences between the equipment O&M manual and the manufacturers training session shall result in the training and/or O&M Manual being corrected.

END OF SECTION

FORM 01750-1
EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION

Owner - _____

Project - _____

Contract No. _____

AECOM No. _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

installed for the subject project (has) (have) been installed in a satisfactory manner, (has) (have) been satisfactorily tested, (is) (are) ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date: _____ Time: _____

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

FORM 01750-2

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

(I) (We) the undersigned, authorized representatives of the _____
and/or Plant Operating Personnel have received classroom and hands-on instruction on the
operation, lubrication, and maintenance of the subject equipment and (am) (are) trained to assume
normal operational and maintenance responsibility for the equipment:

_____ Date: _____

_____ Date: _____

_____ Date: _____

SECTION 01900

SEISMIC AND WIND REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. This section establishes the minimum seismic and wind loading design requirements for architectural, mechanical, electrical and non-structural components.
- B. The Contractor shall be responsible for compliance with the seismic and wind requirements specified including conformance by all Subcontractors, manufacturers and Suppliers.

1.02 REFERENCES:

- A. American Society of Civil Engineers (ASCE):
 - 1. ASCE/SEI 7: Minimum Design Loads for Buildings and Other Structures
- B. American Society of Mechanical Engineers (ASME):
 - 1. B31: Code for Pressure Piping
- C. International Code Council (ICC):
 - 1. International Building Code
- D. Manufacturers Standardization Society of the Valve and Fitting Industry:
 - 1. SP-58: Pipe Hangers and Supports - Materials, Design and Manufacture
- E. National Fire Protection Association (NFPA):
 - 1. Standard for the Installation of Sprinkler Systems

1.03 DEFINITIONS:

- A. Components are defined as systems, equipment, parts, or other elements, including supporting structures and attachments.
- B. The reference Building Code is the building code cited on the structural drawings or specified herein for the design of the basic structure.
- C. The specified seismic criteria is defined as the seismic criteria cited on the structural drawings or specified herein for the design of the basic structure.

- D. The specified wind criteria is defined as the wind criteria cited on the structural drawings or specified herein for the design of the basic structure.

1.04 SEISMIC AND WIND DESIGN REQUIREMENTS:

- A. Refer to structural drawings for project specific seismic and wind requirements and also conform to the requirements specified herein.
- B. Seismic and wind design shall conform to the International Building Code and ASCE/SEI 7.
- C. Architectural, mechanical, electrical and non-structural components shall be designed and constructed to resist the seismic and wind forces and displacements based upon ASCE/SEI 7, the reference building code, and the specified seismic and wind criteria. In the case of conflict the more stringent requirements shall govern.
- D. The interrelationship of components and their effect on each other shall be such that the failure of one component shall not cause the failure of any other component.
- E. Components shall be anchored to the building structure to transfer seismic and wind forces. Connections shall be bolted, welded or otherwise positively anchored to the structure. Anchorage shall not rely on friction for force transfer.
- F. Post-installed anchors in concrete shall be prequalified for seismic applications in accordance with ACI 355.2, ICC-ES AC-193, or ICC-ES AC-308. Drop-in anchors are prohibited for concrete anchorage.
- G. Post-installed anchors in masonry shall be prequalified for seismic applications in accordance with ICC-ES AC-01, or ICC-ES AC-58. Drop-in anchors are prohibited for masonry anchorage.
- H. Exceptions: Exemption from the requirements for seismic and wind analysis and design are permitted only to the extent permitted by applicable codes and standards.

1.05 SUBMITTALS:

- A. Submit the following shop drawings in accordance with the General Specifications.
- B. Submit the following support data:
 - 1. Certification, signed and sealed by a Professional Structural Engineer registered in the jurisdiction in which the project is located stating that all systems, equipment, and other elements, including supporting structures, attachments and connections are designed to withstand the required seismic and wind forces and displacements.
 - 2. Codes and specifications to which structural design conforms.

1.06 SPECIFIC COMPONENTS:

- A. Compound Equipment: Connecting elements for equipment combinations such as pumps and motors, valves and operators, engines and generators, etc. which are not capable of transferring seismic and/or wind loads or accommodating seismic and wind displacements shall be protected by appropriate design.
- B. Piping Systems: Support and bracing of piping systems shall account for the weight and hydrodynamic effects of the contents.
- C. General Supports: Pipe, duct, raceways and cable tray supports and bracing shall conform to the AISC Manual of Steel Construction and MSS SP-58 in addition to the force and displacement requirements of the reference code.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 02012

PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Protecting existing underground utilities.
 - 1. Removing and plugging abandoned lines.
 - 2. Compaction.

1.02 DEFINITIONS

- A. Class C Concrete: Refer to Section 03300.

1.03 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01300.
 - 1. Record drawings to include record survey coordinates and elevations.
 - 2. Proposed locations for test pits.

1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01400.

1.05 PROJECT/SITE CONDITIONS

- A. Pipelines will be indicated on the drawings, but the right is reserved to the Owner, acting through the Engineer, to make such modifications in location as may be found desirable to avoid interference with existing utilities.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Except as indicated, or as specifically authorized by the Engineer, where existing utilities to remain must be removed, reconstruct utilities with new material of the same size, type, and quality as that removed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Comply with the requirements in Section 01046.
- C. Notify Dig Safe, the City, and Bangor Water District at least 72 hours before digging operations are scheduled to begin.
- D. Test Pits: Excavate test pits to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

3.02 PREPARATION

- A. Where utilities are parallel to or cross work, but do not conflict with work, notify the utility owner at least 48 hours in advance of construction at the crossing. Coordinate the construction schedule with the utility owner.

3.03 PROCEDURES

- A. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.
- B. Damage to Utilities to Remain: If existing utilities to remain are damaged, immediately notify utility owner, and repair to Owner's satisfaction at no additional cost to the Owner.

3.04 COMPACTION

- A. Protecting Existing Utilities:
 - 1. Backfill and compact under and around utilities. Compaction shall conform to Section 02210.
 - 2. Where compaction cannot adequately be performed around utility due to the presence of encroaching existing utilities, utilize controlled low strength fill.

3.05 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02140

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater, and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to:
 - 1. Lower the groundwater level.
 - 2. Prevent surface water from entering the excavation during construction.
 - 3. Implement erosion control measures for disposing of discharge water.
- B. Groundwater within the excavation area shall be lowered to at least 2 feet below the lowest excavation levels as specified and as indicated.
- C. Common dewatering methods include, but are not limited to, sump pumping, deep wells, well points, vacuum well points or combinations thereof.
- D. Common groundwater recharge methods include, but are not limited to, deep wells, large sumps or combination thereof.

1.02 REFERENCES

- A. Code of Federal Regulations, Title 40 – Protection of Environment (CFR):
 - 1. 40 CFR Part 122: EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.
- B. Code of Federal Regulations, 61 FR 19284: National Pollutant Discharge Elimination System (NPDES).

1.03 QUALITY ASSURANCE

- A. The contractor will be responsible for managing any groundwater encountered.
- B. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Engineer, stabilize the subgrade, and modify the system to perform as specified.

- C. Notify the Engineer immediately if settlement or movement is detected on structures. If the settlement or movement is deemed by the Engineer to be related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the Engineer within 24 hours. Implement the modified plan and repair damage incurred to adjacent structures at no additional cost to the Owner.
- D. Immediately notify the Engineer if oil or other hazardous materials are encountered after dewatering begins.

1.04 HYDRAULIC UPLIFT OF STRUCTURES

- A. The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the Owner.
- B. In this regard, the Contractor is advised that all structures when completed are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings when the structure is completed. The concrete slab bottoms shall be placed in the dry as specified.

1.05 PRECAUTIONS AGAINST HYDROSTATIC UPLIFT DURING CONSTRUCTION

- A. The Contractor shall maintain a low groundwater elevation in the vicinity of the structures until they are complete. In case of extremely high water during construction of the structures, it may be necessary to flood the structures to maintain stable conditions.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide casings, well screens, piping, fittings, pumps, power, and other items required for dewatering system.
- B. Provide and maintain erosion and sedimentation control devices as indicated or specified and in accordance with the dewatering plan.
- C. Provide temporary pipes, hoses, flumes, or channels for the transport of discharge water to the recharge location.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Execution of earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed and the geotechnical instrumentation has been installed.

- B. Provide and maintain dewatering system in accordance with the dewatering plan.
 - C. Carry out dewatering program in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.
 - D. Unless otherwise specified, continue dewatering uninterrupted until all structures, pipes, and appurtenances below groundwater level have been completed such that they will not be floated or otherwise damaged by an increase in groundwater elevation.
 - E. Discontinue open pumping from sumps and ditches when such pumping results in boils, loss of fines, softening of the ground, or instability of the slopes. Modify dewatering plan and submit revised plan to the Engineer for acceptance.
 - F. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 02210 at no additional cost to the Owner.
 - G. Dewatering Discharge:
 - 1. Transport pumped or drained water to discharge location without interference to other work, damage to pavement, other surfaces, or property.
 - 2. Immediately notify the Engineer if suspected contaminated groundwater is encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.
 - H. Install and maintain erosion/sedimentation control devices at the point of discharge as indicated or specified and in accordance with the dewatering plan.
 - I. Removal:
 - 1. Do not remove dewatering system without written acceptance from the Engineer.
 - 2. Backfill and compact sumps or ditches with screened gravel or crushed stone wrapped with geotextile fabric in accordance with Section 02210.
- 3.02 CLOSEOUT ACTIVITIES
- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02210

EARTH EXCAVATION, BACKFILL, FILL AND GRADING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Perform the following earth excavation, backfill, fill and grading as indicated or specified:
- B. Make excavations to accommodate piping, conduits, foundations and other structures.
- C. Provide materials for backfilling excavations and fills as indicated and specified.
- D. Grade surfaces to meet finished grades indicated.
- E. Immediately notify the Engineer if suspected hazardous materials are encountered and cease operations in that part of work.
- F. Remove boulders within the excavation limits.

1.02 RELATED WORK

- A. Section 02140: Dewatering
- B. Section 02223: Screened Gravel
- C. Section 02224: Bank-run Gravel
- D. Section 02435: Crushed Stone

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. C33: Specification for Concrete Aggregates.
 - 2. C136: Sieve Analysis of Fine and Coarse Aggregates.
 - 3. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.
 - 4. D422: Test Method for Particle-Size Analysis of Soils.

5. D1140: Test Method for Amount of Material in Soils Finer than the No. 200 (75 μm) Sieve.
6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
7. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (600 kN-m/m³)).
8. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
9. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
10. D4718: Practice for Correction of Unit Weight and Water Content for Soils Containing Oversized Particles.
11. D4944: Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Pressure Tester Method.
12. D4959: Test Method for Field Determination of Water (Moisture) Content of Soil by Direct Heating Method.
13. D5080: Test Method for Rapid Determination of Percent Compaction.
14. D6938: Standard Test method for In-Place Density and Water Content of Soil and Soil-Aggregate by nuclear Methods (Shallow Depth)

- B. Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29: Subpart P - Excavations, Trenching and Shoring.

1.04 DEFINITIONS

- A. Percentage of compaction is defined as the ratio of the field dry density, as determined by ASTM D1556 to the maximum dry density determined by ASTM D1557 Procedure C, multiplied by 100.
- B. Proof Roll: Compaction with a minimum of 4 passes of a vibratory steel drum or rubber tire roller. Vibratory plate compactors shall be used in small areas where vibratory steel drum or rubber tire roller cannot be used.
- C. Acceptable Material: Material which does not contain organic silt or organic clay, peat, vegetation, wood or roots, stones or rock fragments over 6-inch in diameter, porous biodegradable matter, loose or soft fill, excavated pavement, construction debris, or refuse. Stones or rock fragments shall not exceed 40 percent by weight of the backfill material.

- D. Unacceptable Materials: Materials that do not comply with the requirements for the acceptable material or which cannot be compacted to the specified or indicated density.

1.05 SUBMITTALS

- A. Submit the following in accordance with Section 01300:

1. Qualifications of the Contractor's Independent Testing Laboratory as specified in Paragraph 1.06 I, four (4) weeks prior to the execution of any earth excavation, backfilling, filling, or compaction process.
2. Submit an excavation, backfilling, and filling plan at least two weeks prior to start of any earth moving activities. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include, but not be limited to the following items:
 - a. Detailed sequence of work.
 - b. General description of construction methods.
 - c. Numbers, types, and sizes of equipment proposed to perform excavation and compaction.
 - d. Details of dust control measures.
 - e. Proposed locations of stockpiled excavation and/or backfill materials.
 - f. Proposed surplus excavated material off-site disposal areas and required permits.
 - g. Details of erosion and sedimentation control measures which will prevent erosion and sedimentation during the earth moving activities.
3. The following material submittals shall be submitted to the Engineer prior to backfilling and filling:
 - a. Screened Gravel: As specified in Section 02223.
 - b. Bank-run Gravel: As specified in Section 02224.
 - c. Crushed Stone: As specified in Section 02435.

- d. Other Acceptable Materials: Laboratory testing results of gradation and moisture-density relationship. Submittal shall include specific location of the source and the date when sample was taken.
- 4. During Construction, submit written confirmation of fill lift thickness, in-place soil moisture content, and percentage of compaction to the Engineer before placing the next lift or constructing foundations.

1.06 QUALITY ASSURANCE AND CONTROL

- A. Provide in accordance with Section 01400 and as specified.
- B. Dewatering and Groundwater Control: Provide and maintain as specified in Section 02140.
- C. Excavations shall be performed in the dry, and kept free from water, snow and ice during construction. Bedding and backfill material shall not be placed in water. Water shall not be allowed to rise upon or flow over the bedding and backfill material.
- D. The Contractor shall be solely responsible for making all excavations in a safe manner. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P) and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.
- E. Do not excavate, or fill until all the required submittals have been reviewed by the Engineer.
- F. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.
- G. Employ an independent testing laboratory to perform particle size and gradation analyses in accordance with ASTM D422, and to determine compactibility in accordance with ASTM D1557 for all the proposed backfill and fill materials, and monitoring field compaction operations. The Contractor's independent testing laboratory shall have the following qualifications:
 - H. Be accredited by the American Associates of State Highway and Transportation Officials (AASHTO) Accreditation Program.
 - I. Have three (3) years experience in sampling, testing and analysis of soil and aggregates, and monitoring field compaction operations.
 - J. Able to provide three (3) references from previous work.

- K. Field Testing and Inspections:
- L. By Contractor's independent testing laboratory, acceptable to the Engineer, at Contractor's expense as specified in Paragraph 1.06 K.
- M. Location of tests mutually acceptable to testing laboratory and the Engineer or as directed by the Engineer.
- N. In the event compacted material does not meet specified in-place density, recompact material and retest this area until specified results are obtained at no additional to the Owner.
- O. Contractor's testing laboratory to perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.
- P. Owner may retain the services of an independent testing laboratory to conduct confirmatory testing and inspection.
- Q. Methods of Field Testing:
- R. In-Place Density: ASTM D1556, ASTM D2167, or ASTM D6938.
- S. In-Place Moisture Content: ASTM D6938, ASTM D4944, or ASTM D4959.
- T. Material Testing Frequency: The following testing frequencies are minimum required for all structural and non-structural fill, grading and embankment.
- U. Field In-Place Density and Moisture Content - Screened gravel and crushed stone shall be compacted as specified and indicated. For other backfill and fill materials, minimum test frequency shall be as follows, and no less than one test per:
 - V. Trenches under structures, foundation preparation, or roadways subbase: Every 1000 lin. ft. per lift.
 - W. Trenches in areas without structures or roadways: Every 1000 lin. ft. per alternate lift.
 - X. Paved Roadways: Every 200 lin. ft. per lift.
 - Y. Paved Areas: 3,500 sq. ft. per lift.
 - Z. Under Structure: 1,000 sq. ft. per lift.
 - AA. Around Structures: 1,500 sq. ft. per lift.
 - BB. Embankment Fills: 10,000 sq. ft. per lift.

- CC. Moisture Density - One per source, except for screened gravel and crushed stone. Repeat the moisture density test for every 5,000 cubic yard of material use, and whenever visual inspection indicates a change in material gradation as determined by the Engineer.
- DD. Gradation Analysis - A minimum of one per source and for each moisture density test and whenever visual inspection indicates a change in material gradation.
- EE. Liquid Limit, Plastic Limit and Plasticity Index - Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.
- FF. Construction Tolerances:
- GG. Construct finished surfaces to plus or minus 1 inch of the elevations indicated.
- HH. Grade, cut and fill areas to plus or minus 0.20 foot of the grades indicated.
- II. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.
- JJ. Provide the Engineer with adequate survey information to verify compliance with above tolerances.
- KK. Cut pavement with a saw or pneumatic tools to prevent damage to remaining pavement without extra compensation. Where pavement is removed in large pieces, dispose of pieces before proceeding with excavation.
- LL. Pipes, drains, and other utilities may exist in certain locations not indicated on drawings. No attempt has been made to show all services. Completeness or accuracy of information given is not guaranteed.
- MM. Dig test pits considered as incidental to the normal excavation as indicated and specified in this Section, at no additional compensation.
- NN. Carefully support and protect from damage, existing pipes, poles, wires, fences, curbing, property line markers, and other structures which the Engineer determines must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore without compensation therefore, to at least as good condition as that in which they were found immediately before the work was begun.
- OO. Whenever certain existing structures, as described below, are encountered, and the Engineer so directs, change the location, remove and later restore, or replace such structures, or assist the Owner in doing so. Such work to be paid for under applicable items of work, otherwise as Extra Work.

- PP. In removing existing pipes or other structures, include for payment only those new materials which are necessary to replace those unavoidably damaged as determined by the Engineer.
- QQ. The preceding two paragraphs apply to pipes, wires, and other structures which meet the following: (a) are not indicated on the drawings or otherwise provided for, (b) encroach upon or are encountered near and substantially parallel to the edge of the excavation, and (c) in the opinion of the Engineer, will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.
- RR. Restore existing property or structures as promptly as practicable.
- SS. If material unacceptable for foundation (in the opinion of the Engineer) is found at or below the grade to which excavation would normally be carried in accordance with the drawings and/or specifications, remove such material to the required width and depth as directed by the Engineer and replace it with screened gravel, select borrow, or concrete.
- TT. Do not remove excavation materials from the site of the work or dispose of except as directed or permitted by the Engineer.
- UU. Haul away and dispose of surplus excavated materials at locations directed by the Engineer at no additional cost to the Owner.
- VV. During progress of work, conduct earth moving operations and maintain work site so as to minimize the creation and dispersion of dust. Furnish and spread calcium chloride if the Engineer decides that it is necessary for more effective dust control.
- WW. Provide suitable and safe bridges and other crossings where required for accommodation of travel, and to provide access to private property during construction, and remove said structures thereafter.

1.07 SITE CONDITIONS

- A. Subsurface Conditions: Refer to Attachment A.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Use only acceptable materials from excavations or borrows.
- B. Provide 1,500 psi concrete, screened gravel, bank-run gravel, fine aggregate, select borrow, and crushed stone.
- C. Provide Fine Aggregate conforming to ASTM C33.

- D. Provide erosion/sedimentation control devices as indicated, including geotextile fabric in accordance with Section 01568 and Section 02273.
- E. Provide geotextile fabric as indicated, meeting the requirements, and conforming to Section 02273.

2.02 EQUIPMENT

- A. The compaction equipment shall be selected by the Contractor, and shall be capable of consistently achieving the specified compaction requirements. The selected compaction equipment shall meet the following minimum requirements:
 - 1. Manually operated vibratory plate compactors weighing no less than 200 pounds with vibration frequency no less than 1600 cycles per minute.
 - 2. Vibratory steel drum or rubber tire roller weighing at least 12,000 pounds.

PART 3 - EXECUTION

3.01 SITE MAINTENANCE

- A. Roadway and Site Leveling: Grade roadway and site as to maintain them in a level unrutted condition and to eliminate puddling of surface and subsurface water.

3.02 EXCAVATION

- A. Execution of any earth excavation shall not commence until the related backfill and fill materials submittals are reviewed by the Engineer and all Engineer's comments satisfactorily addressed.
- B. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or of work previously completed under this contract.
- C. Excavate to widths that give suitable room for building structures or laying and jointing piping.
- D. Do not plow, scrape or dig by machinery near to finished subgrade in a manner that would result in disturbance of subgrade.
- E. Excavate to lines and grades indicated in an orderly and continuous program.
- F. Excavate to elevations indicated, or deeper, as directed by the Engineer, to remove unacceptable bottom material.

- G. Exercise care to preserve material below and beyond the lines of excavations.
- H. Place excavated material at the approved stockpile locations and in no case closer than 3 feet from edge of excavations to prevent cave-ins of bank slides.
- I. Regard small, less than two cubic yards, boulders, rock fragments, and concrete encountered during excavation as a normal part of in-place soils and not included for payment as rock.

3.03 SEPARATION OF EXCAVATED MATERIALS FOR REUSE

- A. Remove only existing pavement that is necessary for prosecution of work.
- B. Carefully remove loam and topsoil from excavated areas. Store separately for further use or furnish equivalent loam and topsoil as directed.
- C. Carefully remove acceptable material from excavated areas and store separately for further use as backfill material.

3.04 TRENCH EXCAVATION

- A. When pipe is to be laid in gravel bedding or concrete cradle, excavate trench by machinery to, or just below designated subgrade. If material remaining at bottom of trench is disturbed, recompaction shall be required.
- B. When pipe is to be laid directly on bottom of trench, do not excavate lower part of trenches by machinery to subgrade. Remove remainder of material to be excavated just before placing of pipe by use of hand tools. Form a flat or shaped bottom, true to grade, so pipe will have a uniform and continuous bearing. Support on firm and undisturbed material between joints, except for limited areas where use of pipe slings have disturbed bottom.

3.05 DEPTH OF TRENCH

- A. Excavate trenches to depths so as to permit pipe to be laid at elevations, slopes, or depths of cover indicated on drawings, and at uniform slopes between indicated elevations.

3.06 WIDTH OF TRENCH

- A. Make pipe trenches as narrow as practicable and do not widen by scraping or loosening materials from the sides. Make every effort to maintain sides of trenches firm and undisturbed until backfilling has been placed and compacted.
- B. Excavate trenches with approximately vertical sides between springline of pipe and elevation 1 ft. above top of pipe.

3.07 TRENCH EXCAVATION IN FILL

- A. Place and compact material to top of fill or to a minimum height of 1 ft. above top of pipe, whichever is less, when pipe is to be laid in embankment or other recently filled material. Take particular care to ensure maximum consolidation of material under pipe location. Excavate pipe trench as though in undisturbed material.

3.08 EXCAVATION NEAR EXISTING STRUCTURES

- A. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.
- B. Excavate test pits when determination of exact location of pipe or other underground structure is necessary for doing work properly.

3.09 REMOVAL OF SUBSURFACE OBSTRUCTIONS

- A. Remove indicated subsurface structures and related obstructions to extent shown.
- B. Promptly notify the Engineer when any unexpected subsurface facilities are encountered during excavation such as utility lines and appurtenances, walls and foundations.

3.10 UNAUTHORIZED EXCAVATION

- A. When the bottom of any excavation for structures is taken out beyond limits indicated or specified, backfill with screened gravel and crushed stone wrapped with non-woven geotextile fabric.

3.11 REUSE AND DISPOSAL OF SURPLUS EXCAVATED MATERIALS

- A. Reuse surplus acceptable excavated materials for backfill; deposit neatly and grade so as to make or widen fills, flatten side slopes, or fill depressions; or legally dispose off-site; all as directed or permitted and without additional compensation.

3.12 SUBGRADE PREPARATION AND PROTECTION

- A. As directed by the Engineer, overexcavate unacceptable materials below the foundation subgrade. Backfill the overexcavation with compacted screened gravel or crushed stone wrapped with nonwoven geotextile fabric. In no case shall the screened gravel be placed directly on the exposed subgrade prior to placing the geotextile fabric.
- B. Proof roll the foundation subgrade prior to backfilling and filling operation, or placing foundation concrete.

- C. Proof roll the pipe trench foundation subgrade prior to backfilling and filling operation, or placing soil-supported pipeline.
- D. Utilize excavating equipment equipped with a toothless or smooth edged, excavating bucket to expose the pipe trench foundation subgrade to avoid disturbance of the bearing surface. Tamp the exposed subgrade with the excavating bucket prior to backfilling and filling operation, or placing soil-supported pipeline.

3.13 CARE AND RESTORATION OF PROPERTY

- A. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces when their treads or wheels of which are so shaped as to cut or otherwise damage such surfaces.
- B. Restore surfaces damaged by the Contractor's operations to a condition at least equal to that in which they were found immediately before work commenced at no additional cost to the Owner. Use suitable materials and methods for such restoration.

3.14 BACKFILLING - GENERAL

- A. Do not place frozen materials in backfill or place backfill upon frozen material. Remove previously frozen material or treat before new backfill is placed.
- B. Do not place, spread, roll or compact fill material during unfavorable weather conditions. If interrupted by heavy rain or other unfavorable conditions, do not resume until ascertaining that the moisture content and density of the previously placed soil are as specified.
- C. Do not use puddling, ponding or flooding as a means of compaction.

3.15 MATERIAL PLACEMENT AND COMPACTION REQUIREMENTS

- A. Select Borrow, and Fine Aggregate:
 - 1. Dump and spread in layers not to exceed 8-in. uncompacted thickness.
 - 2. Compact, fill and backfill under structure and bedding for pipes (from below pipe to spring line) as indicated but to not less than 95 percent. Compact to not less than 90 percent in other areas unless otherwise indicated.
- B. Screened Gravel and Crushed Stone:
- C. Dump and spread in layers not to exceed 8-in. uncompacted thickness.

- D. Compact using self propelled vibratory steel drum or rubber tire rollers with a minimum of 4 passes in directions perpendicular to one another in open areas. In small areas, use manually operated vibratory plate compactors with a minimum of 4 passes.
- E. Bank-run Gravel and Acceptable materials for use as non-structural fill:
- F. Dump and spread in layers not to exceed 12-in. uncompacted thickness.
- G. Compact to not less than 90 percent unless otherwise indicated.
- H. Backfilling and filling operation shall be suspended in areas where tests are being made until tests are completed and the testing laboratory has advised the Engineer that adequate densities are obtained.

3.16 STRUCTURAL FILL AND BACKFILL UNDER STRUCTURES

- A. Compact fill and backfill under structures and pavements with screened gravel, crushed stone, select borrow, or fine aggregate as specified and indicated.

3.17 NON-STRUCTURAL BACKFILL AROUND STRUCTURES

- A. Use acceptable materials for non-structural backfill around structures and compacted as specified and indicated.
- B. Conduct hydraulic testing as soon as practicable after structures are constructed and other necessary work has been done. Start backfilling promptly after completion of tests.
- C. Deposit material evenly around structure to avoid unequal soil pressure.
- D. Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking, or other damage.

3.18 BACKFILLING PIPE TRENCHES

- A. General:
 - 1. Begin backfilling and proceed until completed after: the pipes and conduits have been laid, joints have acquired maximum degree of hardness, pipelines and conduits have successfully passed tests and inspections as required in the Specifications, and concrete or masonry structures within the trench have reached their design strength to support all loads.
 - 2. Backfill and compact indicated material under, around, and above pipes, conduits, and other structures to the indicated or specified compaction density requirement. Utilize compaction devices which will not damage the pipe, conduit, or structure

within the trench.

3. Do not drop backfill material into trench from a height of more than 5 ft., or in a manner which will damage the pipe, conduit, or other structure within trench.
- B. From below pipe to 1 ft. above top of pipe: Use screened gravel, or crushed stone, unless otherwise indicated.
- C. One foot above top of pipe to finished grade or to pavement subbase: Use bank-run gravel or acceptable materials, unless otherwise indicated.
- D. Compacting Around Pipes: Compact material around circumference of pipe and the area between the trench wall and the pipe by hand tamping in 6 inches layers.
- E. Compacting Above Pipe: Compact material by hand tamping. If trench width is wide enough to accommodate power tools and the compacted material over the pipe will support the load of the power tools without damage to the pipe, use rollers or other powered compaction equipment able to more readily achieve compaction requirements.

3.19 COMPACTION CONTROL OF BACKFILL, FILL, AND EMBANKMENT

- A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified or if not specified, at a level slightly lower than optimum.
- B. Moisture control may be required either at the stockpile area, pits, or on embankment or backfill. Increase moisture content when material is too dry by sprinkling or other means of wetting uniformly. Reduce moisture content when material is too wet by using ditches, pumps, drainage wells, or other devices and by exposing the greatest possible area to sun and air in conjunction with harrowing, plowing, spreading of material or any other effective methods.

3.20 ALLOWANCE FOR SHRINKAGE

- A. Build embankments or backfill to a height above finished grade which will, in the opinion of the Engineer, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.
- B. Supply specified materials and build up low places as directed, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.21 ROADWAY SUBBASE FINE GRADING

A. EXAMINATION

1. Verify site conditions.
2. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.
3. Verify existing conditions before starting work.

B. PREPARATION

1. Temporary and permanent erosion control shall be installed and maintained in accordance with the current Maine DEP Best Management Practices Manual for Erosion and Sedimentation Control before construction shall begin.
2. Identify required lines, levels, contours, and datum.
3. Stake and flag locations of known utilities.
4. Locate, identify, and protect utilities indicated to remain, from damage.
5. Notify utility company before removing or relocating utilities.
6. Protect above and below grade utilities indicated to remain.
7. Protect plant life, lawns, and other features remaining as portion of final landscaping.
8. Protect benchmarks, survey control point, property pins, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

C. SUBSOIL EXCAVATION

1. Excavate subsoil from marked areas.
2. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.
3. When excavating through roots, perform Work by hand and cut roots with sharp axe or saw.
4. Remove excess subsoil not intended for reuse, from site.
5. Stability: Replace damaged or displaced subsoil as specified for fill.

D. FILLING

1. Install work in accordance with current version of the State of Maine, Department of Transportation, Standard Specifications - Highways and Bridges.
2. Fill areas to contours and elevations with unfrozen materials.
3. Place fill material on continuous layers and compact in accordance with schedule in Backfilling
4. Maintain optimum moisture content of fill materials to attain required compaction density.
5. Slope grade away from building minimum ¼" inch per foot, unless noted otherwise.
6. Make grade changes gradual. Blend slope into level areas.
7. Remove surplus fill materials from site.
8. Verify site conditions.
9. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.
10. Verify existing conditions before starting work.

3.22 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02223
SCREENED GRAVEL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Provide and compact screened gravel as indicated and specified.

1.02 RELATED WORK

- A. Section 02210: Earth Excavation, Backfill, Fill and Grading

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:

- 1. C33: Specification for Concrete Aggregates
- 2. D422: Test Method for Particle-Size Analysis of Soils.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300:

- 1. Gradation test result from the soil testing laboratory, at least two (2) weeks prior to hauling material, for the Engineer's acceptance.
- 2. Submit a 20-lb. sample of the material when requested by the Engineer.

1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified.
- B. Qualifications of the independent soil testing laboratory as specified in Section 02210.
- C. Maximum particle size and gradation analyses shall be performed in accordance with ASTM D422.
- D. Material testing frequency and requirements as specified in Section 02210.

PART 2 – PRODUCTS

2.01 MATERIAL

- A. Screened gravel: Gradation and physical property requirements of screened gravel shall conform to ASTM C33, Coarse Aggregate number 67.
- B. Screened gravel shall be free from roots, leaves, and other organic materials, and free of ice, snow, frost and frozen soil particles.
- C. Crushed rock of equivalent size and grading may be used instead of screened gravel.

PART 3 – EXECUTION

3.01 PLACEMENT AND COMPACTION

- A. Specified in Section 02210 and as indicated on the drawings.

3.02 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02224

BANK-RUN GRAVEL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Provide and compact bank-run gravel as indicated and specified.

1.02 RELATED WORK

- A. Section 02210: Earth Excavation, Backfill, Fill and Grading

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. D422: Test Method for Particle-Size Analysis of Soils.
 - 2. D1140: Test Method for Amount of Material in Soils Finer than the No. 200 (75 μ m) Sieve.
 - 3. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300:
 - 1. Gradation and compaction test results from the soil testing laboratory, at least two (2) weeks prior to hauling material, for the Engineer's acceptance.
 - 2. Submit a 20-lb. sample of the material when requested by the Engineer.

1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified.
- B. Qualifications of the independent soil testing laboratory as specified in Section 02210.
- C. Maximum particle size and gradation analyses shall be performed in accordance with ASTM D422. Soil compaction test shall be performed in accordance with ASTM D1557 Procedure C.

D. Material testing frequency and requirements as specified in Section 02210.

PART 2 – PRODUCTS

2.01 MATERIAL

- A. Bank-run gravel shall be obtained from approved natural deposits and unprocessed except for the removal of deleterious materials and stones larger than the maximum size permitted.
- B. Bank-run gravel shall be unfrozen and substantially free from vegetation, roots, loam and other organic matter, clay, snow, frozen particles and other fine or harmful substances.
- C. Bank-run gravel: Inorganic granular material meeting the following gradation:

<u>Sieve</u> <u>Designation</u>	<u>Percentage by Weight Passing</u> <u>Square Mesh Sieves</u>
6 in.	100
2 in.	80 - 100
No. 4	20 - 65
No. 200	0 - 12

PART 3 – EXECUTION

3.01 PLACEMENT AND COMPACTION

- A. Specified in Section 02210 and where indicated on the drawings.

3.02 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02435
CRUSHED STONE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide and compact crushed stone as indicated and specified.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. C33: Specification for Concrete Aggregates
 - 2. D422: Test Method for Particle-Size Analysis of Soils.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01300:
 - 1. Gradation test result from the soil testing laboratory, at least two (2) weeks prior to hauling material, for the Engineer's acceptance.
 - 2. Submit a 20-lb. sample of the material when requested by the Engineer.

1.04 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified.
- B. Qualifications of the independent soil testing laboratory as specified in Section 02210.
- C. Maximum particle size and gradation analyses shall be performed in accordance with ASTM D422.
- D. Material testing frequency and requirements as specified in Section 02210.

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Crushed Stone: Gradation and physical property requirements of crushed stone shall conform to ASTM C33, Coarse Aggregate number 67.
- B. Crushed stone shall be free from roots, leaves, and other organic materials, and free of ice, snow or frost and frozen soil particles.

PART 3 - EXECUTION

3.01 PLACEMENT AND COMPACTION

- A. Specified in Section 02210 and as indicated on the drawings.

3.02 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 02500

PAVING, SURFACING AND CURBING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide permanent and temporary paving of all roadway and parking areas; damaged and/or removed during Contractor's operation.

1. Furnish and place process stone for base course.
2. Construct temporary and permanent bituminous concrete binder course pavement on prepared aggregate base course. Where required construct temporary and permanent bituminous concrete trench pavement as indicated.
3. Maintain temporary and permanent pavement, sidewalks, driveways and curbs during guarantee period.
4. Furnish materials, equipment and incidentals required to remove, dispose and clean-up road pavement by cold planning in accordance with these specifications or as ordered by the ENGINEER.
5. Contractor is to complete work on City roads to the satisfaction of the City of Bangor DPW Director and City Engineer.

B. Related Sections:

1. Section 02110 Earth Excavation, Backfill, Fill, and Grading

1.02 REFERENCES

A. Maine Department of Transportation Standard Specifications Highway and Bridges, latest edition and supplementals.

1.03 QUALITY ASSURANCE

A. Perform Work in accordance with Maine Department of Transportation Standards Specification – Highway and Bridges.

B. Mixing Plant: Conform to State of Maine Department of Transportation Standards.

C. Obtain materials from same source throughout.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Do not place asphalt when aggregate base surface temperature is less than 35 degrees F for Bituminous Concrete Binder and 50 degrees F for Bituminous Concrete Surface, or when surface is wet or frozen.
- B. Apply bituminous prime and tack coats prior to placing asphalt.
- C. Do not place surface pavement when the binder surface is wet or contains an excess of moisture, which would prevent uniform distribution and the required penetration.

PART 2 – PRODUCTS

2.01 AGGREGATE SUBBASE

- A. As specified in Section 02210 Earth Excavation, Backfill, Fill, and Grading.

2.02 AGGREGATE BASE

- A. As specified in Section 02210 Earth Excavation, Backfill, Fill, and Grading.

2.03 BITUMINOUS CONCRETE BASE COURSE

- A. MDOT Specification, Section 401.
- B. As shown on plans.

2.04 BITUMINOUS TACK COAT

- A. MDOT Specification, Section 409.
- B. Type MS-2, Emulsified Asphalt, Mixing.

2.05 BITUMINOUS CONCRETE SURFACE COURSE

- A. MDOT Specification, Section 401.
- B. As shown on plans.

2.06 SIDEWALKS/CROSSWALKS

- A. MDOT Specification, Section 401.
- B. As shown on plans.

2.07 TEMPORARY PATCHING

- A. Hot or cold, as approved by the Engineer.

2.08 ACCESSORIES

- A. Tack Coat: Homogeneous, medium curing, liquid asphalt, in accordance with Maine Department of Transportation Specifications.

PART 3 – EXECUTION

3.01 AGGREGATE SUBBASE

- A. As specified in Section 02210 Earth Excavation, Backfill, Fill, and Grading.

3.02 AGGREGATE BASE

- A. As specified in Section 02210 Earth Excavation, Backfill, Fill, and Grading.

3.03 BITUMINOUS CONCRETE BASE COURSE

- A. MDOT Specification, Section 401.

3.04 BITUMINOUS TACK COAT

- A. Apply emulsified asphalt tack coat to gutters and pavement if required by the Engineer to promote adequate bond.
- B. Apply at a rate of 0.03 to 0.05 gallons/square yard; excess coating and/or fat spots will not be permitted.

3.05 BITUMINOUS CONCRETE SURFACE COURSE

- A. MDOT Specification, Section 401.

3.06 SIDEWALKS/CROSSWALKS

- A. MDOT Specification, Section 401.

3.07 COMPACTION

- A. Bituminous compaction shall take place at as high a temperature as possible without the mix bulging excessively in front of the rolls. For most dense graded mix this is between 260 degrees F and 2285 degrees F. At no time shall the pavement be allowed to fall below 185 degrees F without compaction.
- B. Pavement compacted at temperatures below 185 degrees may be removed if deemed

unsatisfactory by the Engineer.

3.08 TOLERANCES

- A. Flatness: Maximum variation of ¼ inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within ¼ inch.
- C. Variation from True Elevation: Within ½ inch.

3.09 FIELD QUALITY CONTROL

- A. Field quality control testing shall be performed by the Contractor.

3.10 FIELD QUALITY ASSURANCE

- A. Field quality assurance testing shall be performed by an independent testing agency provided by the Engineer.

3.11 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 3 days.

END OF SECTION

SECTION 02601

MANHOLES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and construct manholes as indicated and specified.
- B. Base: Precast Concrete. Tops accurately shaped by ring forms to suit riser sections.
- C. Walls (Risers and Cones): Precast Concrete
- D. Top of Cone: Brickwork for adjusting frame to match finished surface (not to exceed 11 in.).
- E. Frames and Covers: Cast-iron

1.02 REFERENCES:

- A. American Society for Testing and Materials (ASTM) Publications:
 - 1. A48: Specification for Gray Iron Casting.
 - 2. C32: Specification for Sewer and Manhole Brick (Made for Clay or Shale).
 - 3. C150: Specification for Portland Cement.
 - 4. C207: Specification for Hydrated Lime for Masonry Purposes.
 - 5. C478: Specification for Precast Reinforced Concrete Manhole Sections.
 - 6. C923: Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and pipes.
 - 7. D4101: Specification for Propylene Plastic Injection and Extrusion Materials.
- B. AASHTO M198: Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gasket.

1.03 SUBMITTALS:

- A. Submit the following:
 - 1. Submit manufacturer's specifications and product data for all items specified.
 - 2. Submit manufacturer's written instruction for installing resilient connector.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Portland Cement: ASTM C150, Type II
- B. Hydrated Lime: ASTM C207, Type S
- C. Sand: Fine Aggregate, for mortar, but passes No. 8 Sieve.
- D. Brick: ASTM C32, Grade SS, but mean of five tests for absorption not to exceed 8 percent by weight.

- E. Frames and Covers: Cast Iron minimum Class 30 conforming to ASTM A48, and as follows:
 - 1. Castings to be free from scale, lumps, blisters and sandholes.
 - 2. Machine contact surfaces to prevent rocking.
 - 3. Thoroughly clean and hammer inspect.
 - 4. Capable of withstanding AASHTO H-20 loading unless otherwise indicated or specified.
 - 5. The frame will have a clear opening of twenty-four (24) inches. They shall be East Jordan Castings model No. 2114Z, and shall be installed in accordance with the manufacturer's instructions.
- F. Protective Coating.
 - 1. H.B. Tnemecol 46-465, by Tnemec Company.
 - 2. Amercoat 78HB, by Ameron International.
 - 3. Bitumastic Super Service Black, by Carboline.
 - 4. Or acceptable equivalent product.
- G. Plastic Coated Steel Steps. Minimum dimensions: Step width 14 inches, distance from manhole wall 5 inches after installation. Equal to: PS2-PF-SL Manhole Steps made by M.A. Industries, Inc., Peachtree City, GA.
 - 1. Part number is for steps to be driven into preformed holes; for steps to be driven into embedded plastic inserts, shape of exposed parts to be like part number, but other ends to suit inserts.
 - 2. The copolymer polypropylene conforming to ASTM D4101-82 PP200B33454 with a minimum carbon black content of 1/2% by weight or other demonstrated equivalent sunlight protection system.
- H. Steps capable of resisting following loads without loosening or damaging:
 - 1. Minimum horizontal pull out load 1600 pounds (800 pounds per leg).
 - 2. Minimum vertical load 800 pounds.

2.02 PRECAST CONCRETE SECTIONS:

- A. ASTM C478 and following modifications:
 - 1. Wall thickness: as indicated.
 - 2. Cement: ASTM C150, Type II, otherwise as directed by Engineer.
 - 3. Joints between sections: Butyl rubber-based sealants.
 - 4. Cure by subjecting to saturated steam at temperature between 100 and 130 degrees F. for 12 hours or more.
 - 5. Cast or drill only two lift holes in each section.

6. Clearly mark date of manufacture and name or trademark of manufacturer on insides of walls on all sections.
 7. Accept on basis of material tests and product inspection.
- B. Cones and Conical Transitions similar in design and construction to riser sections. Use flat slab tops only where indicated.
- C. Cast and build into bases during manufacture:
1. Resilient connectors for pipe connections
 2. Holes for future pipe connections
- D. Set steps accurately as indicated.
- 2.03 JOINTS:
- A. Between precast sections: Butyl rubber-based sealants per Type B, AASHTO M198, but no bitumen content.
- B. Resilient connectors for pipes to precast sections: ASTM C923, and to manufacturer's standards. Do not use connectors using castings and bolts with non-resilient bearing.
- C. Rubber ring waterstops for use in pipe-to-manhole joints: Rings of resilient material that will fit snugly over pipes, held firmly against pipe surface by means of a mechanical take-up device which when tightened will compress resilient material or by a stretch fit. Waterstop designed and installed so that leakage between pipe and manhole is minimized. 6-inch wide butyl wrap is required at all outside joints.
1. Materials and manufacture of waterstops: ASTM C923.
- D. Non-shrink mortar for pipe connections to existing manholes:
1. Masterflow 713 Grout made by Master Builders, Cleveland, OH.
 2. Five Star Grout made by U.S. Grout Corp., Old Greenwich, CT.
 3. Upcon made by Upco Co., Cleveland, OH.
 4. Or acceptable equivalent product.

2.04 MIXES:

- A. Mortar:
1. For Brickwork: Mix portland cement, hydrated lime and sand in proportion by volume of 1: 1/2: 4-1/2. Use sufficient water to form workable mixture to make mortar damp, just short of "balling".
 2. For Plugging lift holes: Mix portland cement and sand in proportion by volume of 1: 1-1/2, with sufficient water.

PART 3 - EXECUTION

3.01 SETTING PRECAST SECTIONS:

- A. Set verticals with sections and steps in alignment. Set bases true to line and elevation.
- B. Install Butyl rubber-based sealants in joints between sections.

- C. Plug holes for handling with mortar. Hammer mortar into hole until dense and excess of paste appears, then smooth flush with adjoining surface.
- 3.02 LAYING BRICKWORK AND GRADING RINGS:
- A. Moisten bricks, before laying. Moistening grading rings NOT PERMITTED.
 - B. Lay bricks and grading rings in full bed and joint of mortar without subsequent grouting, flushing or filling; bond thoroughly.
- 3.03 PLASTERING AND CURING BRICK MASONRY:
- A. Plaster outside faces with mortar for brick: 1/4 in. to 3/8 in. thick.
 - B. Moisten brick masonry before application of mortar.
 - C. Spread and trowel plaster carefully.
 - D. Check after hardening by tapping for bond and soundness.
 - E. Remove and replace unbonded and unsound plaster.
 - F. Protect from too rapid drying by moist burlap or as approved.
 - G. Protect from weather and frost.
- 3.04 JOINTING AND CONNECTIONS:
- A. Use pre-molded electrometric sealed joints, A-lok, Res-Seal, Kor-n-Seal or equal, between pipes and precast sections conforming to related standards and manufacturer's instruction.
 - B. Hold rubber ring water stops for pipe-to-manhole firmly against pipe surface by mechanical take-up device to compress resilient material when tightened. Install to minimize leakage.
 - C. Apply non-shrink mortar according to manufacturer's instruction.
 - D. Close openings for future connection with brick masonry bulkhead.
- 3.05 PROTECTIVE COATING:
- A. Apply two coats of protective coating material (min. 10 mils dft per coat) to exterior surfaces, by brush or spray according to manufacturer's printed instructions.
- 3.06 SETTING FRAMES AND COVERS:
- A. Set frames with top conforming to finished ground or pavement surface as indicated.
 - B. Set circular frames concentric with top of masonry.
 - C. Set frames in full bed of mortar to fill and make watertight the space between masonry top and bottom flange of frame.
 - D. Place thick ring of mortar extending to outer edge of masonry, around bottom flange. Finish mortar smoothly and give a slight slope to shed water away from frame.
 - E. Place concrete collar around frame when placing permanent pavement.
 - F. Place covers in frames on completion of work.

3.07 LEAKAGE TESTS:

- A. Inspect for visible leakage after backfill with ground water at normal level.
- B. Locate visible leakage inside manhole.
- C. Repair leaks.
- D. Each manhole shall undergo a vacuum test as specified below.
 - 1. Each manhole shall be vacuum tested immediately after assembly and prior to backfilling.
 - 2. All lift holes shall be plugged with an approved non-shrink grout.
 - 3. Stub-outs, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.
 - 4. Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.
 - 5. A vacuum of 10 inches Hg (4.9 psi) shall be drawn and the vacuum pump shut off. The test shall pass if the vacuum remains at 10-inches of Hg or drops to 9 inches Hg (4.4 psi) in a time greater than one minute.
 - 6. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test.

END OF SECTION

SECTION 02615

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test buried ductile iron pipe, fittings and appurtenances as indicated and in compliance with Contract Documents.
- B. Options:
 - 1. For buried exterior pipelines provide push-on joint pipe.
 - a. Provide restrained push-on pipe as specified
 - b. Provide either restrained push-on joint fittings as specified and indicated or provide mechanical joint fittings with restraint system as specified herein
 - 2. Cast iron pipe and fittings are not acceptable.

1.02 REFERENCES”

- A. American Society of Mechanical Engineers (AMSE):
 - 1. B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- B. ASTM International (ASTM):
 - 1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
 - 2. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - 3. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
 - 4. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 - 5. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
- C. American Water Works Association (AWWA):
 - 1. A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. A21.10: Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.
3. A21.11: Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings.
4. A21.50: Thickness Design of Ductile-Iron Pipe.
5. A21.51: Ductile-Iron Pipe, Centrifugally Cast in Metal Molds, or Sand-Lined Molds, for Water or Other Liquids.
6. A21.53: Ductile-Iron Compact Fittings, 3-in through 16-in. for Water and Other Liquids.

1.03 SUBMITTALS:

A. Submit the following in accordance with the General Specifications :

1. Pipe manufacturer's technical specification and product data.
2. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.
 - a. Pipe layouts in full detail.
 - b. Location of hangers and supports.
 - c. Location and type of anchors.
 - d. Location of couplings and expansion joints.
 - e. 1/2-inch = 1 foot-0 inch scale details of all wall penetrations and special fittings.
 - f. Schedules of pipe, fittings, special castings, couplings, expansion joints and other appurtenances.
3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed.
4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports and other accessories.
5. Brochures and technical data on coatings and linings and proposed method of application.
6. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.

B. Material Certification:

1. Provide certification from the pipe and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
 - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with the General Specifications and as specified.
- B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.
- C. Inspect and test at foundry according to applicable standard specifications.

- D. Owner reserves right to inspect and test by independent service at manufacturer's plant or elsewhere at his own expense.
- E. Visually inspect before installation.
- F. Job Conditions:
 - 1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps and equipment to be installed in the piping systems.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section .
- B. During loading, transportation and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

PART 2 - PRODUCTS

2.01 PIPE:

- A. Ductile Iron:
 - 1. Design conforming to AWWA A21.50.
 - 2. Manufacture conforming to AWWA A21.15 or AWWA A21.51.
 - 3. Thickness class, unless otherwise indicated or specified:
 - a. Minimum Thickness Class 52.
 - 4. Pressure Class, unless otherwise indicated or specified:
 - a. Minimum Pressure Class, 4-inches through 12-inches: 350

2.02 FITTINGS:

- A. Provide fittings conforming to AWWA A21.10 or AWWA A21.53, at least Class 150 and match piping class.
- B. Provide all bell push-on or mechanical-joint fittings unless otherwise indicated or specified.
- C. If flanged fittings are not available under AWWA A21.10 provide fittings conforming to ASME B16.1 in 125 lb. pressure class.

2.03 NONSTANDARD FITTINGS:

- A. Acceptable design.
- B. Same diameter and thickness as standard fittings.
- C. Manufactured to meet requirements of same specifications as standard fittings except for laying length and types of ends.

2.04 ADAPTERS:

- A. Furnish and install for joining pipe of different types, unless solid sleeves indicated.
 - 1. Provide ends conforming to above specifications for the correct type of joint, to receive adjoining pipe.
 - 2. Joining two classes of pipe may be of lighter class provided annular space in bell-and-spigot type joints sufficient for jointing.

2.05 JOINTS:

- A. Provide push-on joint and mechanical joint pipe with necessary accessories, conforming to AWWA A21.11.
 - 1. Provide gasket composition designed for exposure to liquid within pipe.
- B. Provide restrained joint on pipe and fittings where indicated. Provide restrained joint which is:
 - 1. Boltless
 - 2. Capable of being deflected after assembly
 - 3. Designs using set screws or requiring field welding are not acceptable.
 - 4. Manufacturers:
 - a. American Cast Iron Pipe Co. Flex-Ring.
 - b. U.S. Pipe TR FLEX.
 - c. Clow Super-Lock.

2.06 MECHANICAL JOINT FITTINGS – RESTRAINT SYSTEM:

- A. Provide restraint devices for pipe consisting of multiple gripping wedges incorporated into a follower gland meeting requirements of AWWA A21.10.

1. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, retaining full mechanical joint deflection during assembly and allowing joint deflection after assembly.
2. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.
3. Provide restraint devices Listed by Underwriters Laboratories (3 inch (75 mm) through 24 inch (600 mm) size) and Designed by Factory Mutual (3 inch (75 mm) through 12 inch (300 mm) size).
4. Gland body, wedges and wedge actuating components must be domestic manufactured in the USA.

B. Working Pressure Rating:

1. 16-inch (400 mm) and Smaller: 350 psi.
2. Minimum safety factor: 2 to 1.

C. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.
3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.
6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.
7. Provide coating for restraint devices consisting of the following:
 - a. Process all wedge assemblies and related parts through a phosphate wash, rinse and drying operation prior to coating application.
 - b. Coating: A minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.

- c. Surface pretreat all casting bodies with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. Coating: Polyester based powder to provide corrosion, impact and UV resistance.
 - d. Coating system: MEGA-BOND by EBAA Iron, Inc.
 - D. Manufacturer:
 - 1. EBAA Iron MEGALUG Series 1100
- 2.07 BOLTED SPLIT SLEEVE COUPLINGS:
 - A. Provide in accordance with Section .
 - B. Pressure rating at least equal to that of related pipeline.
 - C. Provide with gaskets of composition designed for exposure to liquid within pipe.
- 2.08 FILLING RINGS:
 - A. Provide where necessary.
 - B. Materials, workmanship, facing, and drilling, conforming to 125-lb. ANSI (Class 125).
 - C. Suitable length with nonparallel faces and corresponding drilling, if necessary, for correct assembly of adjoining piping or equipment.
- 2.09 PIPE COATING:
 - A. Machined surfaces cleaned and coated with rust-preventative compound at shop.
 - B. Outside of buried pipe and fittings: Standard bituminous coating conforming to AN Standard.
- 2.10 CEMENT LINING:
 - A. Inside of pipe and fittings: Provide double thickness cement lining and bituminous seal coat conforming to AWWA A21.4.
- 2.11 GASKETS, BOLTS, AND NUTS:
 - A. Provide ring or full face synthetic rubber gaskets for flanged joints and neoprene faced phenolic for insulating gaskets in accordance with AWWA A21.11 and ASME B16.21.
 - 1. 1/8 inch thick.
 - B. Provide Type 316 stainless steel bolts, washers and nuts for all services:

PART 3 - EXECUTION

3.01 HANDLING AND CUTTING:

- A. Mark pipe and fittings "Rejected" and remove from site when cracked or has received a severe blow.
- B. If permitted, cut on sound barrel at a point at least 12 inch from visible limit of crack, at Contractor's expense.
- C. Machine cut with milling type cutters, knives, or saws. Snap cutters, torch, or hammer and chisel NOT ALLOWED. Examine for possible cracks.
- D. Chamfer cut ends if used for push-on joints.

3.02 INSTALLATION:

- A. Visually inspect before installation.
- B. Ensure pipelines parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distortion of pipe. Provide for expansion where necessary.
- C. Pitch piping toward low points. Provide for draining low points.
- D. Before assembly, remove dirt and chips from inside pipe and fittings.
- E. Pipe and Fittings:
 - 1. Remove and replace defective pieces.
 - 2. Clear of all debris and dirt before installing and keep clean until accepted.
 - 3. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically.
 - 4. Provide firm bearing along entire length of buried pipelines.
- F. Temporary Plugs: When pipe laying not in progress, close open ends of pipe with temporary watertight plugs. If water in trench, do not remove plug until danger of water entering pipe passed.
- G. Appurtenances: Set valves, fittings and appurtenances as indicated.

3.03 JOINTS AND COUPLINGS:

- A. Push-on Joints:

1. Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end.
2. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom.

B. Mechanical Joints:

1. Wire brush surfaces in contact with gasket and clean gasket.
2. Lubricate gasket, bell, and spigot with soapy water.
3. Slip gland and gasket over spigot, and insert spigot into bell until seated.
4. Seat gasket and press gland firmly against gasket.
5. After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

3.04 FIELD TESTING:

A. Provide in accordance with Section .

B. Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.

1. Conduct combined pressure and leakage test in pipelines.
2. Furnish and install temporary testing plugs or caps; pressure pumps, pipe connections, meters, gauges, equipment, and labor.
3. Test when desired and comply with specifications.
4. Test pipelines in excavation or embedded in concrete before backfill or placing of concrete and test exposed piping before field painting.
5. Fill section of pipe with water and expel air. If hydrants or blowoffs are not available at high points for releasing air, make necessary taps and plug after test completion.
6. Maintain section full of water for 24 hours before conducting combined pressure and leakage test.
7. Conduct pressure and leakage test consisting of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to pipe pressure rating, but not more than 50 psi

8. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section fails test.
9. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.
10. Modify test procedure only if permitted by Engineer.

3.05 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section .

END OF SECTION

SECTION 09940

SHOP PAINTING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide shop painting as specified and in compliance with Contract Documents.

1.02 REFERENCES:

- A. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.
2. D870: Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
3. D4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
4. D4585: Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation
5. G8: Standard Test Methods for Cathodic Disbonding of Pipeline Coatings

- B. The Society for Protective Coatings (SSPC):

1. SP6: Commercial Blast Cleaning
2. SP10: Near-White Blast Cleaning

1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with the General Specifications.
- B. Manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses, including list of items and surfaces to receive shop painting.

1.04 QUALITY ASSURANCE:

- A. Comply with the requirements specified in the General Specifications.

1.05 DELIVERY STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610.
- B. Deliver materials to application area in original, unbroken containers, plainly marked with name and analysis of product, manufacturer's name, and shelf life date. Do not store or use contaminated, outdated, prematurely opened, or diluted materials.
- C. Store coated items to prevent damage or dirtying of coatings. Avoid need for special cleaning, and store coated items out of contact with ground or pavement. Place suitable blocking under coated items during storage.
- D. Do not expose surfaces to weather for more than six months before being topcoated, or less time if recommended by coating manufacturer.
- E. Protect surfaces not to receive paint coatings during surface preparation, cleaning, and painting.
- F. Protect coatings from damage during shipment and handling by padding, blocking, use canvas or nylon slings, and use care when handling.
- G. At time of delivery of shop painted items to job site, ensure coatings are undamaged and in good condition.

1.06 PROJECT/SITE CONDITIONS:

- A. Environmental Requirements:
 - 1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied.
 - 2. Do not apply coatings when dust is being generated.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Coatings are divided into the following service types, as determined by conditions:
 - 1. Non-Potable Water:
 - a. All ferrous metals not subject to potable water provide one coat with a dry film thickness of 2.5 to 3.0 mils.
 - b. Manufacturers:
 - (1) Series 1 Prime made by Tnemec Co.

- (2) Carbozinc 859 by Carboline Co.
 - (3) Multiprime EFD Epoxy Fast Day Inhibitive Primer 94-109 made by PPG Protective & Marine Coatings (4.0 – 6.0 DFT).
- c. Performance Data:
- (1) ASTM- D4541- Adhesion – No less than 1250 psi pull
 - (2) ASTM- D4585- Humidity- no affect after 4800 hours with< 1% rust
 - (3) ASTM- B117 Salt Spray- No cracking , delamination or >1/64 creep after 9800 hours
- B. Shop prime with primers guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Division 09 “Field Painting” Section for use in the field and which are recommended for use together.

PART 3 - EXECUTION

3.01 APPLICATION:

- A. Surface Preparation and Priming:
- 1. Sandblast clean in accordance with SSPC-SP-6, Commercial Grade, immediately prior to priming non-submerged components scheduled for priming, as defined above.
 - 2. Sandblast clean in accordance with SSPC-SP-10, Near White, immediately prior to priming submerged components scheduled for priming, as defined above.
 - 3. Before priming, provide surfaces dry and free of dust, oil, grease and other foreign material.
 - 4. Shop prime in accordance with accepted manufacturer's printed recommendations.
- B. Non-primed Surfaces: Apply accepted coating in accordance with manufacturer's printed recommendation.

3.02 TOUCH-UP:

- A. Repair or replace damaged or defective coated areas. Resultant shop painting: Paint items as specified.
- B. Remove damaged or defective coatings by specified blast cleaning to meet surface cleaning requirements, just before recoating. When small areas of coating need touch up, surface preparation may be done with suitable power needle gun to match specified blast cleaning.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with the General Specifications.

END OF SECTION

SECTION 11377

ROTARY POSITIVE DISPLACEMENT

(SCREW TYPE) BLOWERS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test rotary screw positive displacement blowers, motors, V-belt drives, silencers, acoustical enclosures, variable frequency drives and appurtenances as indicated and specified.

1.02 REFERENCES:

- A. American Bearings Manufacturers Association (ABMA).
- B. American Gearing Manufacturers Association (AGMA).
- C. American National Standards Institute (ANSI):
 - 1. [S1.11](#): Standard Octave-Band and Fractional-Octave-Band and Digital Filters.
 - 2. [S2.19](#): Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications
- D. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- E. American Petroleum Institute (API):
 - 1. [619](#): Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries
- F. American Society of Mechanical Engineers (ASME):
 - 1. [B16.1](#): AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800
- G. American Society for Testing and Materials (ASTM):
 - 1. [A48](#): Standard Specification for Gray Iron Castings.
 - 2. [A336](#): Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts

3. [A1043](#): Standard Specification for Structural Steel with Low Yield to Tensile Ratio for Use in Buildings
- H. Hydraulic Institute: Current Standards.
- I. International Organization For Standardization (ISO):
1. [1217](#): Displacement compressors - Acceptance tests
 2. [2151](#): Acoustics Noise test code for compressors and vacuum pumps Engineering method (Grade 2)
- J. National Electrical Manufacturers Association (NEMA):
1. NEMA 4X
 2. [MG1](#): Motors and Generators.
- K. Institute of Electronics and Electrical Engineers (IEEE)
1. 519: IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
- L. OSHA

1.03 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Specifications:
1. Data regarding blower, motor, variable frequency drive, control panel and acoustical enclosure characteristics and performance:
 - a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate blowers, showing they meet indicated and specified requirements for capacity, pressure rise, horsepower, temperature rise and efficiency.
 - (1) For units of same size and type, provide curves for a single unit only.
 - b. Provide catalog performance curves at maximum blower speed indicated and specified for each service showing maximum and minimum speeds available.
 - c. Results of shop performance tests as specified.
 - d. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.

2. A data sheet indicating the following for design and minimum flow: differential pressure, intake temperature, discharge temperature, intake pressure, blower speed, maximum speed, brake horsepower, nominal horsepower, motor speed, motor efficiency at full load, tolerance for flow and power, sound pressure level with enclosure, weights, connection size and type.
3. An 11x17 to-scale drawing with title block, front view, top view, side view, details, and dimensions. Identify all major components, keyed to a bill of materials. Indicate weight, service clearances, and lifting points. Include the enclosure, blower, motor, drive, control panel, and a setting plan with tolerances for anchor bolts.
4. Schematic control and power wiring diagrams, including a drawing of the control panel interior and exterior.
5. Annotated product sheets for components inside the package such as the silencer, filters, check valve, unloading valve, relief valve, expansion joints, motor, instruments, etc.
6. Manufacturer's standard literature as needed to supplement certified data.
7. Operating and maintenance instructions and parts lists.
8. Listing of reference installations as specified with contact names and telephone numbers.
9. Evidence of dynamic balancing completed as part of ISO 9001 process.
10. Bearing temperature operating range for the service conditions specified.
11. List of recommended spare parts other than those specified.
12. Shop and field inspection reports.
13. Bearing Life: Certified by the pump manufacturer. Include design data.
14. Blower shop test results.
15. Motor shop test results.
16. Qualifications of field service technician.
17. Recommendations for short and long-term storage.
18. Resonant frequency analysis for variable speed systems.
19. Free field noise calculation for the entire blower package assembly.

20. Shop and field testing procedures, set up, equipment to be used and testing tolerances to be followed.
21. Special tools.
22. Number of service person-days provided and per diem field service rate.
23. Results of field vibration test data including a vibration signature for each blower and drive assembly. Provide vibration testing procedure for review.
24. Manufacturer's product data, specifications and color charts for shop painting.
25. The latest ISO 9001 series certification.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

- A. Comply with the requirements specified below.
- B. Provide spare parts that are identical to and interchangeable with similar parts installed.
 1. For each blower:
 - a. (2) sets of filters
 - b. (1) set of belts

- c. Enough oil for (3) oil changes
- 2. For each set of blowers of the same size and performance.
 - a. One set of all special tools required.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified in the General Specifications.
- B. Blower packages shall be provided as a single unit from the blower manufacturer. Third party packagers are not acceptable.
- C. Blowers shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.
- E. Shop tests as specified.
- F. The Contractor shall obtain the blowers, motors, filters, silencers, acoustical enclosures, controls and appurtenances from the blower manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
 - 1. Variable frequency motor drives shall be supplied by the blower manufacturer. The blower system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.
 - a. Coordinate the variable frequency motor drives with the blower and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, blower manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the blower and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.
- G. Services of Manufacturer's Representative as specified herein.
- H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
 - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
 - a. 1 person-days.
 3. Functional Testing: Calibrate, check alignment and perform a functional test with air. Tests to include all items specified.
 - a. 1 person-days.
 4. Field Performance Testing: Field performance test equipment specified.
 - a. 2 person-days.
 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
 - a. 1 person-day.
 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
 7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- I. Manufacturer of blowers shall have a minimum of (8) operating installations with blowers in the same service as specified operating for not less than (5) years.
 - J. If equipment proposed is heavier or taller, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.
 - K. For variable speed blowers systems the blower manufacturer must perform an analysis of the combined motor and blower assembly for resonant frequency or their harmonics independent of a structure.
 1. Submit a copy of these calculations for the record.
 2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point.
 3. Provide and install such additional devices at no additional cost to the Owner.

- L. Warranty: (24) months from date of startup or (30) months from date of shipment, whichever comes first.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

- A. Blower capacities and operating data are indicated in the Blower and Compressor Schedule on the Mechanical Process drawings.
- B. The blowers will be mounted outdoors on a concrete pad.
- C. System Operating Conditions:
 - 1. Site altitude above mean sea level: 100 feet
 - 2. Temperature Range: 0 to 100 degrees F
 - 3. Relative Humidity Range: 60 to 95
 - 4. Provide blower motors sized for operating at the minimum and maximum temperatures without overloading at the relief valve setting.
- D. Noise Criteria:
 - 1. Overall free field noise level from assembled blower, silencers, and enclosure not to exceed 78 dB(A) measured in free field at 3.0 feet from equipment.

2.02 MANUFACTURERS:

- A. Aerzen (Delta Hybrid)
- B. Or an acceptable equivalent manufacturer

2.03 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01900.
- B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 BLOWER CONSTRUCTION:

- A. Blowers: Rotary positive displacement screw type. Driven as indicated in the Blower and Compressor Schedule.
- B. Provide blower configuration as indicated in the Blower and Compressor Schedule.
- C. Design and proportion all parts of blowers to be especially adapted for the service specified and indicated. Provide room for inspection, repair and adjustment.
- D. Blower Housing:
 - 1. Cast iron ASTM A48 Class 30 externally ribbed to prevent distortion.
 - 2. Provide lifting devices for handling.
 - 3. Face and drill flanges of inlet and discharge connections in accordance with 150-lb. ASME B16.1 Standard. Threaded Inlet and outlet connections are not acceptable.
 - 4. Provide components with machined registered concentric shoulder fits to ensure precision alignment.
 - 5. Provide tapped connections on inlet and discharge for pressure and temperature instrumentation connections.
 - 6. Provide integral controlled pre-inlet for active pulsation control.
 - 7. Airflow: Vertical top to bottom with inlet and outlet connections offset so that the flow travels horizontally across the blower stage. Casings that do not utilize a horizontal internal flow are not acceptable.
 - 8. Vibration level, measured at the casing, in the X/Y planes of the bearings, not to exceed 0.3 in/sec RMS when operating at the specified operating pressure and speed. Checked at start-up and documented in the field start up report.
- E. Rotors:
 - 1. Provide each rotor (male and female) designed with first lateral critical speed at least 120% of the maximum allowable operating speed.
 - 2. Provide design for rotors to operate without rubbing nor shall they require lubrication.

3. Rotors: Drop forged in one single piece of AISI 1043 or equivalent.
4. Open rotors are not acceptable.
5. For maximum strength and reliability, provide the female rotor driven by the drive motor and the male rotor driven by the timing gear set. Stages that utilize a male driven rotor are not acceptable.
6. Provide a male and female rotor configuration with internal compression ratio and axial flow entry used to increase the adiabatic efficiency of the blower stage. Twisted rotor profiles applied for pulsation cancelation only are not acceptable. Radial flow entry type rotors are not acceptable.
7. Provide only precision-machined rotors with sealing strips to optimize clearance and performance, other types are not acceptable. Manufacturers using coated rotors are not acceptable.
8. Statically and dynamically balance rotors in accordance with ISO1940/ANSI S2.19 G2.5.

F. Bearings:

1. Provide each rotor/shaft supported by anti-friction bearings, and fixed to control the axial location of the rotor/shaft in the unit.
2. Anti-friction type.
3. Oil lubricated. Grease lubrication is not acceptable.
4. Provide the drive shaft bearing sized for an overhung V-belt drive under maximum continuous operating load.
5. Provide bearings with minimum B-10 life rating of 100,000 hours at specified operating conditions, based on latest ABMA and ANSI Standards. In addition, the bearing selection shall be such to achieve Mean Time Between Overhauls of five (5) years or more with normal maintenance.

G. Timing Gears:

1. Single helical type. Spur cut gears are not acceptable.
 - a. Minimum AGMA quality rating: 12.
 - b. Service factor: 1.70 minimum in accordance with AGMA.
2. Provide gears secured on tapered shaft ends using hydraulic expansion and interference fit allowing for stepless clearance setting and greater efficiency through accurate timing. Pinned gears are not acceptable.

H. Bearing and Timing Gear Lubrication:

1. Splash, pumped oil systems are not acceptable
 - a. Provide an oil level sight glass mounted on the exterior of enclosure.
2. Provide each blower with a factory fill of synthetic oil rated for 16,000 hours between changes.

I. Seals:

1. Provide seals designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine.
2. Provide cartridge type seals consisting of two rotary slip rings mounted in a retainer on the air end, an atmospheric air gap in the center with top and bottom ventilation and a noncontact labyrinth seal with no wearing parts on the oil end. Internal lip seals are not acceptable.
3. Provide the rotor input shaft with a noncontact labyrinth seal with no wearing parts.

2.05 DRIVES:

A. V-Belt Drive:

1. Provide each package with a V-belt drive of the high capacity type, oil and heat resistant.
2. Provide the drive designed for a minimum service factor of 1.4 times operating power (bhp), or 1.1 times the motor nameplate Hp, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bhp.
3. Belt tensioning: Automatic without the use of any spring devices or interaction on the part of the operator. Slide rails or spring tensioners are not acceptable for use as a tensioning device.
4. Sheaves: Dynamically balanced regardless of the operating speed and hydraulically mounted on the compressor drive shaft.
5. Automatic tensioning system V-belt life: 16,000 hours of operation.

2.06 INLET FILTERS/SILENCERS:

A. Cast aluminum housing or welded steel construction.

B. The inlet filter element shall be the last component in contact with the air prior to entering the blower. Any absorption material used in the intake silencer shall be upstream of the inlet filter element.

- C. Provide washable filter elements of spun PVC construction:
 - 1. Provide filter maintenance indicator.
 - 2. The filter media shall have an efficiency of 50 to 70 percent of 3 to 10 microns in accordance with EN779 G4 synthetic dust.
 - D. Provide arrangement that allows for the inspection of the blower rotor chamber without filter/silencer housing removal.
 - 1. Suitable for 15 psi.
- 2.07 BASE FRAME/DISCHARGE SILENCER:
- A. Provide a combination unit, cast iron or welded steel construction.
 - B. Provide capable of internal inspection without blower removal.
 - C. Distortion resistant, cylindrical vessel.
 - D. Provide low pressure drop design without diffuser elements.
 - E. Non-absorption material type. Fibrous materials or any absorption materials, which could deteriorate over time and are not acceptable.
- 2.08 DISCHARGE MANIFOLD:
- A. Welded or cast construction, flange mounted to discharge silencer discharge.
 - B. Designed to accommodate check valve, pressure relief valve
- 2.09 DISCHARGE CHECK VALVES:
- A. Provide full-bore type without the use of any internal springs.
 - B. Provide the discharge check valve removable without disconnecting the discharge piping.
 - C. Provide an EPDM coated steel flap.
 - D. Elastomer materials: Suitable for continuous operation at 300 degrees F.
- 2.10 PRESSURE RELIEF VALVES:
- A. Spring loaded, field adjustable with integral dampening air piston.
 - B. Body: Cast iron, flanged.
 - C. Trim: Bronze.

- D. Provide valves mounted vertically, downstream of discharge silencer and upstream of the discharge check valve and any potential obstruction to the air stream. Valve shall discharge within segmented section of sound enclosure, to isolate relief valve discharge from blower and motor airspace.
- E. Provide a single valve sized to pass full blower capacity.
- F. The valve shall start opening at the blower maximum rated pressure.
- G. The pressure rise across the fully opened valve not to exceed 10 percent of the pressure setting.
- H. Valve setting: At least 0.7 psi higher than the maximum operating pressure to prevent chattering.
- I. Provide the valve with a proportional characteristic and close within 0.1 psi of the pressure set point. Valves with a closing point lower than the set point are not acceptable.
- J. Provide the valve field adjustable, spring loaded, and have a certificate of conformity to PED if operating above 15 psig.

2.11 DISCHARGE FLEXIBLE CONNECTORS:

- A. EPDM rubber type, with Type 316 stainless steel clamps.
- B. Working pressure: 15 psig
- C. Suitable for 300 degrees F.

2.12 VARIABLE SPEED CONTROL REQUIREMENTS:

- A. Provide the variable speed drive as part of the blower package.
 - 1. Danfoss; no or equal.
 - 2. Each blower package shall include a factory mounted, 6-pulse, constant torque, variable frequency drive with 5% input line reactor. Provide trap filters with drive system either in blower control panel or located on the wall behind the blower control panel in NEMA 12 enclosures. All conduit and wiring required for operation of the trap filters shall be provided under this section. To maintain system integrity, the VFD shall maintain IEEE519 compliance, at the input terminals of the VFD, without exception, with up to and including a 3% voltage imbalance, phase to phase.
 - 3. Passive Harmonic Filter:

- a. Provide each blower package with a passive harmonic filter housed in a self-standing enclosure, to be installed by the contractor on the line side of the blower VFD.
- b. Filter to include the following features and accessories:
 - (1) Enclosure for indoor installation
 - (2) Contactor to disconnect capacitors to prevent leading power factor
 - (3) Internal vibration pads
 - (4) 5% of lower THD to the requirements of IEEE-519
 - (5) 100kA SCCR safety rating
- 4. Drive shall operate on 460 VAC, 3 phase, 60 hertz power and shall be integrated with the local blower permissive switches.
- 5. The drive shall include the following features and accessories:
- 6. NEMA 12 enclosure for indoor installation
- 7. Method to minimize power line harmonics while providing a near unity power factor.
- 8. Input surge protection to withstand surges of 2.3 times line voltage for 1.5 msec.
- 9. Allen Bradley Ethernet IP communication over CAT6 cable
- 10. 100ka SCCR safety rating
- 11. Branch wiring for AERtronic LCP supply power so that each blower/VFD will require a single 460VAC feed.
- 12. Single lockable disconnecting circuit breaker at face of panel interlocked with the door, rated 65 KAIC at 480VAC

2.13 BLOWER PACKAGE ASSEMBLY:

- A. Provide all specified blower components pre-piped and mounted on a structural steel frame.
 - 1. Blower package and sound enclosure to be factory assembled. Assembly to be provided, tested and guaranteed by the blower manufacturer.
 - 2. Mount blower for vertical flow top to bottom, side/side flow arrangements are not acceptable.

- B. Provide a vibration isolator for each leg of the assembly frame.
 - 1. Provide rubber type to absorb a minimum of 80 percent of the vibration over the entire operating range.
 - 2. Designed to bear weight of entire assembly without degradation.

C. Sound Enclosure:

- 1. Provide to cover the entire blower package and all accessories specified.
- 2. Provide mounted on steel skid, with oil drip pan and fork slots for lifting from the proper side.
- 3. Galvanized steel sheet, painted as specified.
- 4. No welding on external surfaces.
- 5. Provide quick release side panels and hinged roof.
- 6. Provide heavy duty steel latches and handles.
- 7. Provide forced ventilation by means of a fan driven by blower shaft or electric motor. If electric motor is used, provide an interlock preventing the main blower motor from starting until the cooling fan is running.
- 8. Provide pressure relief valve outlet connected to a separate louvered port.
- 9. Provide louvers of extruded and anodized aluminum.
- 10. Design for snow load indicated on the structural drawings.
- 11. Provide enclosure designed and suitable for outdoor installation.
- 12. Mount oil sight glass on exterior of enclosure and located oil drain so it is accessible from the front.
- 13. Provide the enclosure designed so as to be able to install them side-by-side with all maintenance done from the front or back of the package.

2.14 MOTORS AND GEARS:

- A. Provide as specified and indicated.
- B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of blowers under any condition of operation specified and indicated without operating in the motor service factor.

- C. Horizontal, variable speed Inverter duty totally enclosed fan cooled (TEFC) squirrel cage induction motor.
 - D. Provide premium efficiency design with efficiencies determined in accordance with NEMA Standard. Provide nominal and guaranteed efficiencies included on motor nameplates in compliance with NEMA Standard. IEC motors are not acceptable.
 - E. Provide a factory installed fail-safe winding protection in each phase. Connect winding temperature sensors or thermostats, one per winding wired in series, to the blower control panel for monitoring and alarm.
 - F. Bearings: SKF or equivalent and selected for worst case conditions, maximum peak torque transmission, maximum temperature, including vibration levels (up to 7.1 mm/s). The L10 lifetime at max. dynamic load (including vibrations) and at maximum temperature minimum 100,000 hours.
 - G. Provide high precision gears (DIN3961/ class 6) and material quality certified according to ISO6336-S-ML to optimize the performance of the transmission and the transmission losses reduced as much as possible.
 - H. In addition to the requirements for bearings specified under Electric Motors in Section 16220, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.
 - I. Operate without overheating at the speeds specified and indicated.
 - J. Service Factor: 1.15, with 1.0 inverter duty rating for blowers equipped with variable frequency motor controllers.
 - K. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.
 - L. Rating: 460V, 3 PH, 60 Hz.
 - M. Insulation: Class F with Class B temperature rise, 50 degrees C ambient.
 - N. Site Altitude: Less than 3,300 feet above sea level.
 - O. Provide insulated bearings and Aegis grounding ring.
 - P. The use of the TEFC motor to cool the blower system or circulate the enclosure air is not acceptable.
- 2.15 BLOWER CONTROL PANEL:
- A. Each package shall be supplied with the following control functions and features:
 1. Intuitive TFT color touch screen display with NEMA 4X protective cover.

2. Display, monitoring, alarm, and shutdown of inlet pressure, discharge pressure, discharge temperature, enclosure cooling fan thermal overload, main drive motor thermal overload and oil temperature.
3. Display run hours
4. Log errors and first out indication
5. Track and log maintenance
6. E-Stop button mounted on front of blower enclosure
7. Operation of enclosure cooling fan motor starter and oil demister
8. Ability to transfer measured values, fault and status messages, as well as remaining times of the service intervals to the customer control system via Allen Bradley Ethernet IP.
9. Permissive control function of customer start and stop signals to a motor controller
10. Digital potentiometer (EM4 Module)
 - a. LOCAL Operation: speed control of the VFD via the HMI screen.
 - b. REMOTE Operation: transfer of VFD speed command from external controller to the VFD
 - c. These signals can be communicated using either hard wire connection or the communication protocol
11. The local control panel shall be provided with the following digital outputs:
 - a. Common alarm
 - b. Common fault
 - c. Ready to run
 - d. Transfer of external start/stop command
 - e. Status remote
 - f. Maintenance required
 - g. Alternatively, these outputs can be obtained using the communication protocol
12. The local control panel shall be provided with the following digital inputs:

- a. Remote start/stop
 - b. Motor controller fault
 - c. Customer E-stop
 - d. Alternatively, these inputs can be supplied using the communication protocol
- B. Control Enclosure
1. IP54 suitable for indoor/outdoor installation
 2. Factory installed, integral to sound enclosure
- C. Control Supply Power
1. 460 VAC, 10 Amp feed with 24 VDC transformer
- D. Monitoring Sensors
1. Inlet Pressure Transducer
 2. Discharge Pressure Transducer
 3. PT 1,000 Discharge Temperature RTD
 4. PT 1,000 Oil Temperature RTD
 5. Current transducers for motor ampere readouts at existing Aeration Control Panel
- E. Local control panel shall be the Aerzen AERtronic Digital Controller
1. Connect each Aerzen Blower to Control Panel ACP-1 in the Blower Building using CAT-6 ethernet cable and display the following signals:
 - a. Run Status
 - b. General Fault
 - c. Not In Auto
 - d. Remote Start/Stop
 - e. Pacing Signal (speed or DO)
 - f. Blower Speed
 - g. Blower Motor Amps

- h. Suction Temperature
 - i. Discharge Temperature
 - j. Suction Pressure
 - k. Discharge Pressure
2. Provide communication module for each blower that uses Allen Bradley Ethernet protocol with a RJ45 port connection.
- F. Each blower shall receive its initial oil filling at the factory. Oil to be fully synthetic and rated for 16,000 hours of operation between change intervals.
- G. Acoustical Sound Enclosure:
- 1. Each package shall be supplied with a sound enclosure covering the entire blower package.
 - 2. The enclosure shall be designed so as to be able to install them side-by-side with all maintenance done from the front or back of the package.
 - 3. Details shall be as follows:
 - a. Enclosure Panels shall be made of galvanized steel sheet, powder coated in a light reflecting, blue color per RAL 5001. The skid shall be of the same color.
 - b. Sound enclosure acoustic material shall comply with UL 94 - HF1 for fire-retardant, self-extinguishing, non-dripping materials.
 - c. The enclosure and the blower package shall both be mounted on a skid / oil-drip pan designed for meeting environment protection standards and for easy transportation and installation.
 - d. A grounding strap shall be installed between the blower base and the package skid to bypass any vibration isolating mounts for grounding continuity.
 - e. Quick release panels, each less than 50 lb (as mandated by MSHA) must provide easy and quick access for routine maintenance of the blower and the package components.
 - f. Enclosure Cooling / Ventilation Fan:
 - (1) Ventilation fan shall be provided for cooling the sound enclosure.

- (2) The fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD.
 - (3) The cooling fan shall be driven separately by a 460V, 3Ph, 60Hz electric motor powered by the same 460 VAC electric feed as the local control panel. A 120V single phase motor for this application will not be acceptable as the current draw and motor operating temperature are too high.
 - (4) The enclosure cooling fan shall be a dedicated device. The use of the TEFC drive motor to cool the blower or circulate the sound enclosure shall not be allowed.
- g. To prevent possible operator damage, electrical components, instrumentation and instrument connections shall not be mounted or interface with moving panels of the sound enclosure.
 - h. Both blower oil sumps shall be piped to a common fill and drain, located at the front of the package for easy maintenance. An oil level indicator shall be mounted on the outside of the enclosure, which gives an accurate oil level indication while the blower is in operation. All oil lines shall be industrial-quality hydraulic hose and fittings.
 - i. Enclosure Space Heater:
 - (1) Machines with pressurized lubrication systems will require enclosure space heaters or oil heaters when operating outdoors at temperatures below -10C (14F)
 - (2) Enclosure space heater shall be powered internally from the blower package control power transformer.

2.16 SHOP PAINTING:

- A. Primer and Finish Paint: Provide manufacturer's standard painting system.
- B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.17 SHOP TESTING:

- A. Provide motor shop testing
- B. Blower Tests:

1. Test blowers casings under a hydrostatic head of at least 20 psi.
2. Provide certified performance tests as specified herein.
3. Certified performance testing.
 - a. Provide performance testing of the entire package assembly in the blower manufacturers facility
 - b. Run the blower assembly including acoustical enclosure at full speed rating point for 60 minutes prior to start of any testing.
 - c. Full speed and variable speed tests:
 - (1) Test blowers at the conditions specified and indicated and take readings to determine flow, differential pressure, rpm, horsepower, and efficiency.
 - (2) Provide performance testing in accordance with ISO 1217.
 - d. If blowers do not meet the tolerances specified, modify the equipment and retest until the specified results are obtained.
4. In the event specified tests indicate blower, motor, or variable frequency drive will not meet specifications, Engineer has the right to require additional complete witnessed tests for all blowers, motors, and variable frequency drives at no additional cost to the Owner.
5. Repeat tests until specified results are obtained.
6. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with shop drawings with no exceptions noted, manufacturer's printed instructions, and as indicated.
- B. Install and align blowers on a concrete pad as indicated.

3.02 FIELD TESTING:

- A. Test piping connections to prove the blower nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with blower nozzles. This must be performed and the piping acceptable prior to any field performance testing.

- B. Field testing will not be conducted without a written procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list.
- C. After installation of blowers, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each blower in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.
 - 1. During tests, observe and record capacity, differential pressure, blower bearing housings and motor bearing temperature, noise and vibration and motor inputs.
 - a. Provide vibration signature test data (bearing X and Y planes not to exceed 0.3-in per sec RMS when operating at full speed).
 - b. Bearing Temperature (not to exceed 180 Degrees F when operating at full speed)
 - c. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.
 - d. Acceptance Harmonic Testing: The Contractor shall record and provide in a report the harmonic line distortion for ac voltage and current to include individual harmonic values up to the 30th harmonic as well as the total harmonic distortion (THD) and total demand distortion (TDD) for all VFDs furnished. Testing shall be in accordance with IEEE.
 - 2. Run each blower for minimum one hour prior to taking temperature readings of the blowers and motors.
 - 3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
 - 4. Repeat tests until specified results are obtained.
 - 5. Include a copy of the test results in the O&M manual to assist Owner in future maintenance.
 - 6. Contractor to provide all labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.
 - a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all blower systems even in those cases where permanent flow meters are installed.
 - b. All calibrations must be within 30 days of the field testing.

- c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
 - D. Make all adjustments necessary to place equipment in specified working order at time of above tests.
 - E. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.
- 3.03 FIELD TOUCH-UP PAINTING:
- A. After installation and testing with no exceptions by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.
- 3.04 CONTRACT CLOSEOUT:
- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15056

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.
- B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.
- C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.
- D. Pipe support locations and types for piping 1/2-inch and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2-inch and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.
 - 1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.
- E. Design and provide all temporary pipe supports required during installation and testing.

1.02 REFERENCES:

- A. The American Society of Mechanical Engineers (AMSE):
 - 1. B31.1: Power Piping.

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel
2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
3. A312: Seamless and Welded Austenic Stainless Steel Pipe
4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.
5. A572: Specification for Steel Plate.
6. E165: Practice for Liquid Penetrant Inspection Method.
7. E709: Practice for Magnetic Particle Examination.

C. American Welding Society (AWS):

1. D1.1: Structural Welding

D. Fluid Sealing Association: Technical Handbook.

E. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.
2. SP-69: Pipe Hangers and Supports - Selection and Application.
3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.03 SUBMITTALS:

A. Submit the following in accordance with Specifications:

1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
 - a. Detailed drawing of the device with dimensions.
 - b. A table of applied forces and moments.
 - c. A complete bill of materials.

- d. A unique identification and revision level.
 - e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.
 - f. Detailed connections to existing structure.
 - g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.
2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.
 3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
 4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
 5. Pipe support manufacturers' qualifications as specified herein.
 - a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.
 - b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.
 6. Coordination drawings for pipe supports shall include as a minimum the following information.
 - a. Coordination drawings shall include all pipe supports covered by specifications.
 - b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.
 - c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.

- d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches or less in diameter that will be field routed need not be shown on coordination drawings.
 - e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
 - f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.
 - g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
 - h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.
7. Written notification of any deviations from the requirements of this specification.
 8. Support documentation and justification as specified.
 9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.
 10. Manufacturer's product data and specifications for shop painting.

B. Material Certification:

1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification

that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
- C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.
1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
 2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
 - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance as specified.
- B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.
- C. Welder Qualifications:
 1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.
- D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society

(MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

- E. Structural Concrete: Conform to the requirements of Section 03300. Concrete strength: 4,000 PSI (28 MPa) unless noted otherwise.
- F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.
- G. Pipe Support Manufacturer Qualifications:
 - 1. Must possess a written quality assurance program.
 - 2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.
 - 3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.
 - 4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.
 - 5. Manufacturers' Standardization Society (MSS) Member.
 - 6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.
- H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.
- B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

- C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.
- D. Provide only new material. Previously used and/or scrap material is not acceptable.
- E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.
- F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches (10 mm) glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.
 - 1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:
 - 2. Tensile strength -2,000 psi.
 - 3. Elongation -225 percent
 - 4. Specific Gravity -2.17 to 2.22
 - 5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.
 - 6. The compressive creep shall be a minimum of 2 percent at 2,000 psi and 70 degrees F.
 - 7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer's plant.
- G. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.02 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

- A. Design and provide pipe supports for piping 1/2-inch and larger to include the following loads:
 - 1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
 3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.
 4. Wind Loadings: Wind loadings.
- B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.
- C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.
- D. Where possible, provide pipe supports, which are the manufacturers' standard products.
1. Provide pipe supports with individual means of adjustment for alignment.
 2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.
 3. Hanger rods shall be subjected to tension only.
 4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.
 5. Provide concrete inserts capable of supporting the design loads.
 6. Metal framing systems will be acceptable to support piping 2 inch (50 mm) and smaller.
 7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge (1.5 mm) shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch (300 mm) in length.
 8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.
 9. Provide supplementary steel as needed.
 10. Do not support pipes from other pipe, conduits or metal stairs.
 11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.

12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
 13. All pipe supports located in fluid flow shall be supplied with double nutting.
- E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.
 - F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.
 - G. For piping 2-inch (50 mm) and smaller provide manufacturer's standard supports and standard spacing guidelines
 - H. All outside above ground supports shall be Type 316L stainless steel as specified herein.
 - I. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.
 - J. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.
- 2.03 FABRICATION:
- A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.
 - B. Providing welding in accordance with Structural Welding Code.
 - C. Provide dimensional tolerances as specified in MSS-SP-89.
 - D. Provide threading and tapping in accordance with MSS-SP-89.
- 2.04 SHOP PAINTING:
- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09940.
 - B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
 - C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.
- B. Perform welding in accordance with Structural Welding Code
 - 1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of groove welds for throat opening and for snug positioning for back-up bars.
 - 2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
 - 3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.
 - 4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.
 - 5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
 - 6. Test Locations: As selected by the Owner.
 - 7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.
- C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03300.
- D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.
- E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.
- F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

- G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet, for each 100 degrees F change in temperature exceed 1/2-inch, provide sliding supports.
 - I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.
 - J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.
 - K. Apply an anti-seize compound to nuts and bolts on all pipe supports.
 - L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.
- 3.02 INSTALLATION OF BUILDING ATTACHMENTS:
- A. Support piping from structural framing, unless otherwise indicated.
 - B. Concrete Inserts:
 - 1. Use existing embedded concrete items whenever possible.
 - 2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.
- 3.03 THRUST ANCHORS AND GUIDES:
- A. Thrust Anchors:
 - 1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
 - 2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.
 - B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS:

- A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.
- B. Provide minimum of two pipe supports for each pipe piece.
- C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.
- D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.
- E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch out from face of wall and at least 3 inches below ceiling.
- F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.
- G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.
- H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.
- I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.
- J. Do not support piping from other piping.
- K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.
- L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.
- M. All rigid rod hangers shall provide a means of vertical adjustment after erection.
- N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.
- O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.
- P. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
 2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.
- Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.
- R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.
- S. All threads shall be UNC unless otherwise specified.
- T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch fillet weld, 1/2-inch long every 3 inches on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.
- 3.05 INSULATED PIPING:
- A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.
 - B. Where vapor barriers are indicated on water piping, install coated protective shields.
- 3.06 CONTRACT CLOSEOUT:
- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15066

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test stainless steel pipe, fittings and appurtenances as indicated and in compliance with Contract Documents.
- B. Pipe and fittings 2-1/2 inch and larger are included in this specification, for pipe and fittings 2 inch and smaller provide in accordance with Section 15370.

1.02 REFERENCES:

- A. American Society of Mechanical Engineers (AMSE):
 - 1. B31.1: Power Piping.
- B. ASTM International (ASTM):
 - 1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
 - 2. A380: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems.
 - 3. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
 - 4. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 - 5. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

- C. Fluid Sealing Association: Technical Handbook.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Specifications
 - 1. Pipe manufacturer's technical specification and product data.
 - 2. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.

- a. Pipe layouts in full detail.
 - b. Location of hangers and supports.
 - c. Location and type of anchors.
 - d. Location of couplings and expansion joints.
 - e. 1/2-inch = 1 foot-0 inches scale details of all wall penetrations and fabricated fittings or special fittings.
 - f. Schedules of pipe, fittings, expansion joints and other appurtenances.
3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed with appropriate standard.
 4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports and other accessories.
 5. Submit reports required for welding certifications per ASME B31.1 paragraph 127.6.
 6. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.
- B. Material Certification:
1. Provide certification from the piping and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
 2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.
- C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
 - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance as specified.
- B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.
- C. Welder Qualifications:
 1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.
- D. Job Conditions:
 1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps and equipment to be installed in the piping systems.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610.
- B. During loading, transportation and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

PART 2 - PRODUCTS

2.01 STAINLESS STEEL PIPE:

A. Manufacturers:

1. Douglas Brothers
2. Felker
3. J.F. AhernMaterial:

1. Type 316L sheet and plate per ASTM A240.
2. Maximum carbon content of 316L material limited to 0.03 percent.
3. Finish: 2D.

C. Fabrication:

1. Fabricate in accordance with ASTM A778 in NPS sizes shown with dimensional tolerances per ASTM A530.
2. Perform welding by qualified welders conforming to standard procedures. Weld piping with wall thickness up to 11 gauge, 0.125-inch with the TIG (GTAW) process. Properly bevel heavier walls and use a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process.
3. Add filler wire of ELC grades to all welds to provide a cross section at the weld equal to or greater than the parent metal. Distribute smooth and evenly weld deposit and provide a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping.
4. Concavity, undercut, cracks or crevices are not acceptable.
5. Butt Welds: Full penetration to the interior surface, with inert gas shielding provided to the interior and exterior of the joint.
6. Remove excessive weld deposits, slag, spatter, and projections by grinding.
7. Continuously weld angle face rings on both sides to the pipe or fitting.
8. Grind all welds on gasket surfaces smooth.
9. Contour pipe branches, taps and bosses to the radius of the main pipe run and bevel and weld with full penetration. No projections to the inside of the branch or main run are acceptable. Provide a smooth transition from ID of run to ID of branch.

10. Wire-brush inside and outside weld areas with brushes of stainless steel that are specifically designed to be used only on stainless steel.
11. After manufacture, passivate stainless steel pipe, fittings, and appurtenances by immersion in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid. Temperature and detention time to be sufficient for removal of oxidation and ferrous contamination without more than superficial etch of surface. Perform a complete neutralizing operation by immersion in a trisodium phosphate rinse followed by clean water wash. Perform in accordance with ASTM A380.
12. After fabrication, either passivate by immersion (see above paragraph) or scrub interior and exterior of welds with same solution or pickling paste and stainless steel wire brushes to remove weld discoloration and then neutralize and wash clean. Perform in accordance with ASTM A380.
13. Perform all welding in the shop. Field welding is not acceptable.
 - a. If field welding is allowed for certain circumstances, the Contractor shall submit the welders qualifications and an acceptable method of cleaning the pipe and fittings for review prior to start of any field welding.
14. Fittings: Butt weld type manufactured in accordance with ASTM A774 of the same raw material and in the same thicknesses as the pipe. Socket weld fittings are not acceptable.
 - a. Elbows up to 24-inch diameter: Provide smooth flow-die formed, long radius; with centerline to end of elbow equal to 1.5 times the nominal pipe size.
 - b. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch diameter: Fabricate with pieces in accordance with the following table with dimensions in accordance with AWWA C208:

Bend, degrees	Number of Pieces
0 to 22.5	2
23 to 45	3
46 to 67.5	4
68 to 90	5

15. Fabricate tees and branch connections true and square with wall thickness same as pipe.
16. Reducers evenly tapered with tangent ends for butt weld connection.
 - a. Reducers may be straight tapered cone construction.
17. Secure flanges to pipe ends and plug openings prior to shipment.

D. Design:

1. Stainless steel pipe: Nominal pipe size diameter pipe fabricated of stainless steel sheets having the following Schedule, U.S.S. gauges and plate thickness:

Nominal Pipe Size inches (mm)	Actual O.D. inches	Schedule/Gauge/Plate	Nominal Wall Thickness inches
2.5	2.875	SCH 5S or 10S	0.083
3	3.500	SCH 5S or 10S	0.083
4	4.500	SCH 5S or 10S	0.083
6	6.625	SCH 5S or 10S	0.109
8	8.625	SCH 5S or 10S	0.109
10	10.750	12 Ga. Sheet	0.109
12	12.750	12 Ga. Sheet	0.109
14	14.000	11 Ga. Sheet	0.125
16	16.000	11 Ga. Sheet	0.125
18	18.000	11 Ga. Sheet	0.125
20	20.000	10 Ga. Sheet	0.140
24	24.000	3/16 inch Plate	0.188

2. Joints: Flanged or, bolted split sleeve type couplings as indicated and specified. Split couplings requiring cut or roll grooving of the pipe not allowed unless specifically called for.
3. Flanged Joints: Van Stone back-up flange type, ANSI Class 150 lb.
4. Provide stainless steel back-up flanges of the grade of pipe specified with the following thickness. Galvanized steel and ductile iron flanges are not acceptable.

Pipe Size, inches	Flange Thickness, inches
2.5, 3 and 4	0.375
6 and 8	0.500
10 to 18	0.750
20 and 24	0.750

5. Hardware: Type 316 stainless steel.
6. Fabricate flanged joint face rings fabricated of rolled stainless steel angles.
7. Use angle face rings with thickness equal to or greater than the wall of the pipe or fitting to which it is welded. Continuously weld on both sides to the pipe or fitting. Fabricate angle legs so as not to interfere with the flange bolt holes.
8. Isolate stainless steel flanges from all other ferrous metal connections at valves, flanges and equipment with flange insulating kit.

- a. Pipe Flange Insulating Kit:
 - (1) Flange gasket: Type E, 1/8-inch thick NEMA Grade G-10 reinforced epoxy retainer with two seals of the following material:
 - (a) Aeration Systems: EPDM.
 - (2) Insulating sleeves: 1/32-inch thick NEMA Grade G-10, full length, one for each flange bolt.
 - (3) Insulating washers: 1/8-inch thick NEMA Grade G-10, two for each flange bolt.
 - (4) Mechanical washers: 1/8-inch thick Type 316 stainless steel, two for each flange bolt.
 - (5) Manufacturers:
 - (a) Trojan Insulating Gasket Advance Products and Systems.
 - (b) Or equal.

2.02 BOLTED SPLIT SLEEVE TYPE COUPLINGS:

- A. Provide stainless steel couplings in accordance with Section 15370.

2.03 EXPANSION JOINTS:

- A. Provide in accordance with Section 15370.

2.04 PIPE SUPPORTS:

- A. Provide in accordance with Section 15056.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Ensure pipelines parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distortion of pipe. Provide for expansion where necessary.
- B. Pitch piping toward low points. Provide for draining low points.
- C. Before assembly, remove dirt and chips from inside pipe and fittings.
- D. Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped.

1. Except as otherwise specified, provide number and size of bolts conforming to same ANSI standards.
2. Provide Type 316 stainless steel hardware.
3. Provide ring gaskets of materials designed for the service specified and indicated, 1/16-inch thick gaskets.
4. Make up flanged joints tight with care being taken to prevent undue strain upon valves or other pieces of equipment.
5. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.
6. Provide insulating kits as specified herein.

3.02 FIELD TESTING:

- A. Clean of dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.
- B. Pressure and Leakage Tests:
 1. Conduct combined pressure and leakage test in pipelines.
 2. Furnish and install temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.
 3. Test when desired and comply with Engineer's orders and specifications.
 4. Fill section of pipe with water and expel air.
 5. Pressure and leakage test consists of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.
 6. No visible leakage in joints.
 7. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section failed to pass test.
 8. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.
 9. Immediately upon completion of testing, drain and dry piping to remove all traces of water and condensation.

10. Modifications to test procedure only if permitted by Engineer.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15101

PROCESS VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and process valves and appurtenances as indicated and in compliance with Contract Documents.
 - 1. Provide sizes and capacities as indicated or specified.

1.02 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
 - 1. B1.20.7: Hose Coupling Screw Threads.
 - 2. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.
 - 3. B16.4: Cast-Iron Threaded Fittings, Class 125 and 250.
 - 4. B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves.
- B. ASTM International (ASTM):
 - 1. A48: Standard Specification for Gray Iron Castings.
 - 2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - 3. A536: Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS:

- A. Submit the following in Specifications:
 - 1. Data, regarding valve characteristics and performance including Cv.
 - 2. Shop drawing data for accessory items.
 - 3. Manufacturer's literature as needed to supplement certified data.
 - 4. Operating and maintenance instructions and parts lists.
 - 5. Listing of reference installations as specified with contact names and telephone numbers.

6. Valve shop test results.
 7. Qualifications of field service technician.
 8. Shop and Field inspections reports.
 9. List of recommended spare parts other than those specified.
 10. Recommendations for short and long term storage.
 11. Special tools.
 12. Shop and field testing procedures and equipment to be used.
 13. Number of service technician days provided and per diem field service rate.
 14. Manufacturer's product data and specifications for shop painting.
 15. Provide a layout drawing, plan and section showing orientation of butterfly valves and actuators and nearest obstructions for each valve.
 16. Manufacturer's product data and specifications for shop painting.
 17. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
 18. The latest ISO 9001 series certification or quality system plan.
 19. Material Certification:
 - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
- B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

- A. Comply with requirements specified.

1.05 QUALITY ASSURANCE:

- A. Comply with the requirements specified.
- B. Provide enclosures for the area classifications specified and indicated.
- C. Contractor responsible for verifying outside diameter of pipe to be tapped.
- D. Services of Manufacturer's Representative as specified herein.
- E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610 and as specified.

PART 2 - MATERIALS

2.01 AIR FLOW CONTROL VALVES

- A. Provide in accordance with Section 15111.

2.02 BUTTERFLY VALVES – AERATION SERVICE-ISOLATION VALVES:

- A. Manufacturers:
 1. DeZurik
 2. Flowseal
 3. ABZ

B. Provide valves rated for 250 degree F (121 degrees C) continuous operation and 300 degree F (149 degrees C) intermittent operation.

C. Body:

1. Wafer-lug type with full-lug body, drilled and tapped for mounting bolts design.

2. Material:

a. Type 316 stainless steel

3. Provide to mate with 125-lb ANSI B16.1 flanges.

4. Wafer-lug type with full-lug body, drilled and tapped for mounting bolts.

D. Seat: Dovetail, EPDM, installed in the body with elastomer formed continuously over the ends to provide seal with mating pipe flanges.

E. Disk: Air profile design, aluminum bronze ASTM B148 Alloy 952 or Type 316 stainless steel. Provide bubble-tight shut off at 25 psi working air pressure.

F. Stem: One-piece of Type 316 stainless steel with bronze or Teflon bushings and EPDM or Buna-N O rings or self-adjusting packing.

1. Disc stem connection:

a. 12-inch and smaller: Type 316 stainless steel torque plug.

b. 14-inch and larger: Type 316 stainless steel disc screws.

G. Valve Operators:

1. Manually operated valves 10-inch and smaller provide lever-type with 10-position lock plate and valve position indicator.

2. Manually operated valves 12-inch and larger provide geared-type permanently lubricated, totally enclosed operator with stops to prevent over-travel, and with valve position indicator and hand wheel or chain wheel as specified.

3. Provide chainwheel operator where required as specified herein.

4. Electric motor actuators: Provide in accordance with Section 15109.

2.03 ECCENTRIC PLUG VALVES:

A. Manufacturers:

1. DeZurik

2. Val-Matic.
- B. Type: Non-lubricated, eccentric.
- C. Body Working Pressure:
1. Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536, Grade 64-45-12.
 - a. Valves 4-inch through 12-inch: 175 psi
- D. Ends: Exposed Valves: flanged, Buried Valves: Mechanical joint.
- E. Valve Ports:
1. Provide rectangular ported valves, circular ports are not acceptable.
 2. All valves 100% port.
- F. Valve Seats:
1. Coat plug with seat material specified. Bolted systems are not acceptable.
 - a. Seat Material: Neoprene or Buna-N synthetic rubber.
 2. Provide valves with one piece coated plugs with mating seats of 90 percent, minimum, pure nickel 1/8-inch welded into the body of valves.
 3. Provide valves with seats clamped to valve with mating seat of 90 percent, minimum, pure nickel welded to the valve body.
- G. Upper and Lower Plug Journal Bearings:
1. Removable, permanently lubricated stainless steel bushings.
 2. Provide grit seals for upper and lower plug shafts for all valves.
- H. Stem Seals:
1. Adjustable multiple V-packing.
 2. Replaceable and adjustable without valve disassembly.
 3. Provide valves with two sets of packing rated for vacuum service for all pump suction isolation service and for services where a vacuum is specified and indicated.
- I. Operators for Valves 4-inch and larger:
1. Manually Operators:

- a. Buried or submerged valves: Provide watertight gear operator with operator as indicated. Gear operator to be totally enclosed and gasketed with Type 316 stainless steel hardware.

J. Shop Testing:

1. Provide all plug valves tested and certified bubble tight in both directions at the full rated working pressure as specified herein.

K. Shop Painting:

1. Coat internal and external ferrous surfaces of valve with Epoxy.

2.04 BALL VALVES – GENERAL SERVICE:

A. Manufacturers:

1. Jamesbury
2. KF
3. Inline
4. Kitz

B. Valves 1/2-inch through 2-inch

1. Materials:

- a. Body and End Cap: Three piece, ASTM A351 Grade CF8M.
- b. Body Seal: PTFE.
- c. Seat: RTFE.
- d. Ball: Type 316 stainless steel.
- e. Stem: Type 316 stainless steel.

2. Pressure Rating: 1/2-inch through 2-inch: 1000 psi at 100 degrees F

3. Ends: 2-inch and Smaller: Screwed or flanged.

C. Actuators:

1. Manual: Lever.

2.05 KNIFE GATE VALVES

- A. All valves shall be model KGC-BD Bi-Directional Cast Knife Gate Valves as manufactured by DeZURIK or approved equal.
- B. Gate edges shall be machined, finished, and rounded. The gate faces shall be finish ground.
- C. Premium Packing System shall fit a rounded machined packing chamber. The Premium Packing System shall consist of multiple layers of packing with anti-extrusion guides. The packing gland shall match the valve body. The fasteners shall be stainless steel.
- D. Body shall be a one-piece casting of type 316 stainless steel. Valve inside port diameter shall be equal to ANSI B36.10 STD pipe inside diameter. Raised faces shall be full width per ASME B16.20 standards for spiral-wound gaskets.
- E. Resilient Seat shall be capable of bubble-tight bi-directional shutoff to the full pressure rating of the valve and provide shutoff on dead end service. Valves shall be of a perimeter seat design and the seat shall provide guiding for the gate. Resilient seat shall be a one-piece rubber molded seat with seat pucks at the top and an encapsulated full metal reinforcement insert in 316 stainless steel for rigidity. Seat pucks shall be locked into a machined pocket in the bottom of the packing chamber and not interfere with the integrity of the packing chamber. The perimeter seat shall be locked into the valve body in a dovetail groove. Resilient seat material shall be EPDM.
- F. Cold Working Pressure valve rating shall meet or exceed MSS SP-81. Valves shall be 150 psi.
- G. Manually actuated valves shall have handwheel actuators. The manual operated handwheel actuator yoke shall be one piece 304 stainless steel. The bevel gear yoke shall be a two-piece 304 stainless steel. The yoke sleeve shall be aluminum bronze. The stem shall be type 304 stainless steel. A standard locking device shall be available upon request. The lockout shall be rated to withstand the maximum output of the actuator.
- H. Warranty Valves and actuators shall be warranted by the manufacturer for defects in materials and workmanship for a period of two years (24 months) from date of shipment.

2.06 CHAINWHEEL OPERATORS – STAINLESS STEEL:

- A. Provide chainwheels with chain and chain guides. For all valves with handwheels or gear operators higher than 6.5 feet above operating floor level.
- B. Provide chain that reaches to within 3 feet of the operating floor level.
- C. For valves with gear operator mount with chainwheel in the vertical position.
- D. Provide secondary safety restraint system.

E. Manufacturer:

1. Trumbull.

F. Materials:

1. Chainwheels: Pocket type wheel, Type 316 stainless steel.
2. Chain: Type 316 stainless steel straight link machine chain.
3. Hardware and Attachments: Type 316 stainless steel.
4. Safety Restraint Cables and Hardware: Type 316 stainless steel.

2.07 EXTENSION STEMS:

A. Provide where indicated and required for operation of all valves

B. Material:

1. Stems: Type 316L solid stainless steel bar or Schedule 40 Type 316L pipe
 - a. Minimum Size: 1.25 inch diameter, Slenderness ratio <200
2. Connectors, thrust relief assemblies, torque tube assemblies, universal joints and operating nuts: Type 316 or Type 316L stainless steel
3. Miter gears: Cast iron with 2 part epoxy coating

2.08 ELECTRIC MOTOR ACTUATORS:

A. Provide in accordance with Section 15109.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.
- C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.

- D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.
- E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.
- F. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

3.02 FIELD TESTING:

- A. Pressure test valves with pipeline pressure testing.
- B. Test functions of each valve.
- C. Make all adjustments necessary to place valves in specified working order at time of above tests.
- D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15109

ELECTRIC MOTOR ACTUATORS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide electric motor actuators and appurtenances as indicated and in compliance with Contract Documents.
 - 1. Actuators for all valves to be the product of one manufacturer.

1.02 REFERENCES:

- A. ASTM International (ASTM):
 - 1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - 2. B179: Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes.
- B. Institute of Electrical And Electronics Engineers (IEEE):
 - 1. 802.15.4: Standard for Information Technology.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Specification 01300:
 - 1. Certified shop and erection drawings.
 - a. Drawings shall be in conformance with all other requirements as specified in this specification.
 - 2. Data, regarding actuator and motor characteristics and performance.
 - 3. Actuator and Valve set-up for each application: Position or torque seating
 - 4. Shop drawing data for accessory items.
 - 5. Manufacturer's literature as needed to supplement certified data.
 - 6. Operating and maintenance instructions and parts lists.
 - 7. Listing of reference installations as specified with contact names and telephone numbers.

8. Actuator shop test results.
9. Motor shop test results.
10. Qualifications of field service engineer.
11. Schematic control and power wiring diagrams.
12. Shop and Field inspections reports.
13. Recommended spare parts other than those specified.
14. Recommendations for short and long term storage.
15. Special tools.
16. Shop and field testing procedures and equipment to be used.
17. Torque capability and settings for each actuator.
 - a. Provide a listing of operating torque, safety factor applied and actuator torque capability and actuator safety factor as specified for each valve.
18. Number of service person days provided and per diem field service rate.
19. Manufacturer's product data and specifications for shop painting including statement of compliance for compatibility with field painting.
20. Provide a listing of the materials recommended for each service specified and indicated.
21. ISO 9001 certification.
22. Material Certification:
 - a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".
 - 1. Failure to include all drawings or a statement application to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
 - 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

- A. Comply with the requirements specified.
- B. Provide for each Actuator:
 - 1. Two fuses of each size
- C. Provide spare parts that are identical to and interchangeable with similar parts installed.
 - 1. One set of all special tools
 - 2. Supply each actuator with a start-up kit consisting of installation instructions, electrical wiring diagrams and two sets of cover screws and seals.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance as specified herein.
- B. Actuators for all valves to be the product of one manufacturer.
 - 1. Contractor to coordinate with all valve suppliers.
- C. Actuators to be manufacturer's standard cataloged product and modified to provide compliance with the specifications and the service conditions specified and indicated.

- D. Shop tests as specified.
- E. Provide Services of Manufacturer's Representative as specified herein.
- F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
 - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
 - 2. Installation: Inspect setting, alignment, field erection; coordination of electrical and miscellaneous utility connections:
 - a. 1/2 person-day per actuator.
 - 3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.
 - a. 1/2 person-day per actuator.
 - 4. Field Performance Testing: Field performance test equipment specified.
 - a. 1/2 person-day per actuator.
 - 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.
 - a. 1 person-day.
 - 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
 - 7. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- G. Manufacturer of actuators must have at least five (5) operating installations with actuators of the type and size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01600 and as specified

PART 2 - PRODUCTS

2.01 ELECTRIC ACTUATORS – 3 PHASE:

- A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, controls transformer, limit controls, non-intrusive local controls as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
 - 1. Provide actuators capable of setting of torque, turns, and configuration of indication contacts, through the use of a non intrusive infra red setting tool without the necessity to remove any electrical compartment covers. The setting tool must be the means for adjustment. The use of control knobs for programming the actuator is not acceptable.
 - 2. Provide actuators with torque capability 150 percent above the maximum operating torque required by each valve, gate or equipment.
 - 3. Enclosure:
 - a. Watertight to IP68, classification Enclosure must be certified NEMA 6 for all units.
 - 4. Provide an internal watertight compartment to protect switches, contacts, motor and internal electronics from ingress of moisture and dust when the external terminal cover is removed.
 - 5. Breathers, drains and or heaters are not permitted, enclosure must be totally sealed.
 - 6. Provide each actuator with a handwheel for manual operation. Provide a hammerblow device which permits motor to come up to speed before picking up load and unseating valve.
- B. Motors:
 - 1. Open/Close applications: Motors, Class F with 15 minute duty rating.
 - 2. Modulating applications: motors, Class H with a 30 minute duty rating.
 - 3. Motor: Low inertia, high torque type, specifically designed for use with motor actuators, to prevent over travel.
- C. Provide internal clutch that cannot engage handwheel operating mechanism and motor-operating mechanism at the same time. Friction type declutching is not acceptable.
 - 1. Provide handwheel with arrow and the word CLOSE or SHUT cast on handwheel to indicate turning direction to close.
 - 2. Handwheel must not rotate during power operation.

3. Provide handwheel and low gear ratio combined to give maximum rate of movement possible with 80 lb rim pull.
- D. Drive Unit:
1. Metal worm wheel and worm shaft type.
 2. Provide an oil filled drive housing. Grease lubrication is not acceptable.
 3. Worm shaft to operate in ball or roller bearings and be machine cut, ground, and highly polished, hot rolled steel, hardness 50-60 Rockwell Scale C bronze worm wheel with large contact area. Provide mating surfaces of dissimilar metals to prevent galling. Cast metals or gears manufactured from non-metallic materials are not acceptable.
 4. Worm and shafts: Heat treated steel and accurately machined. Output or driving shaft to operate in bronze bearing or in ball or roller bearings.
 5. Make provisions to take thrust in both directions.
 6. Worm and wheel to be oil lubricated at all times.
 7. Drive housing: Cast iron or aluminum depending on size of actuator offered, all thrust or torque bearing components shall be ductile iron.
 8. Provide drive bushing as part of a detachable thrust base making for easy retrofit.
- E. Fully wire electric motor operators at factory and furnish complete with terminal strips for external power and control connections. Wiring: copper with tropical grade PVC cover. Internal wiring to remain in a water tight compartment with external cover removed.
- F. Provide manual or automatic control as indicated and specified.
- G. Manual Control: Provide the following Control, Status, Alarm and Diagnostic capabilities locally, at the actuator:
1. Control:
 - a. Open/Stop/Close.
 - b. Desired Valve Position Control 0-100 percent.
 2. Status:
 - a. Motor Running Open Direction.
 - b. Motor Running Close Direction.

- c. Fully Open.
 - d. Fully Closed.
 - e. Percentage Open 0-100 percent in 1 percent increments.
 - f. Percentage Output Torque 0-100 percent in 1 percent increments.
3. Alarms:
- a. Remote Control Communications Failure.
 - b. Actuator Alarm.
 - c. Valve Alarm.
 - d. Battery Low Alarm.
4. Diagnostics:
- a. Provide an integral diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator, gate or valve performance. Access to data shall be via a non-intrusive an IrDA™ port to an appropriate device capable of standard IRDA communications i.e. Notebook PC, Windows CE based “Personal Digital Assistant (PDA)” or an IrDA™ compatible cellular telephone.
 - b. Provide diagnostic software from actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured. Provide diagnostic status screens capable of showing multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently.
- H. Automatic Control: Provide REMOTE automatic control specified in Section 13300 and as indicated.
- I. Provide each actuator fitted with four (4) hard-wired configurable contacts. Each Contact shall be rated at 5A, 250VAC, 30VDC and able to provide any one of the following:
- 1. Status:
 - a. Valve Fully Open.
 - b. Valve Fully Closed.
 - c. Valve Opening or Closing.
 - d. Valve Moving (Continuous or Pulsing).

- e. Local Stop Selected.
 - f. Local Selected.
 - g. Remote Selected.
 - h. Open or Close Interlock Active.
 - i. ESD Active.
2. Alarms:
- a. Motor Tripped on Torque in Mid-Travel.
 - b. Motor Tripped on Torque Going Open.
 - c. Motor Tripped on Torque Going Closed.
 - d. Pre-Set Torque Exceeded.
 - e. Valve Jammed.
 - f. Actuator Being Operated by Handwheel.
 - g. Lost Main Power Phase.
 - h. Customer 120V AC Supply Lost.
 - i. Battery Low.
 - j. Internal Failure Detected.
 - k. Thermostat Tripped.
- J. Provide a back-up power source integral to the actuator to ensure that in the event of a main power supply loss or failure that the LCD display indication contacts must remain operational for a minimum of 24 hours and still function on change of status.
- K. Provide contacts and operating parts made of non-corrodible metal and suitable for a sea atmosphere and for contact with H₂S.
- L. Control
- 1. Provide non-intrusive selectors on actuator electrical controls cover. One for Local/Stop/Remote selection, pad-lockable in each position and the other for local Open/Close control. Switches penetrating the housing are not acceptable.
- M. Starters/transformers: Consists of two relay contactors, 3-pole, mechanically interlocked, reversing with suitable arc suppressors.

1. Electrical Service:
 - a. 460V, 3-phase, 60 Hertz.
 2. Provide inverse time element overload relays.
 3. Provide a control transformer capable of generating 110VAC.
 4. Provide electromechanical starter capable of OPEN/CLOSE sixty starts per hour or solid state starter for modulating service capable of 1200 starts per hour.
 5. Provide replaceable fuses to protect wiring, fuses must be locally available.
 6. Provide automatic phase correction.
- N. Limit Controls:
1. Type: Positive in action ensuring tight seating and full openings.
 2. Position Setting Range: 2.5 to 100,000 turns, with resolution of 7.5 degrees of one actuator output revolution.
 3. Provide mechanism designed to minimize drift or over-travel and to open or close valve, gate or equipment to fixed, predetermined limits of opening and closing travel.
 4. Provide controls that disconnect driving mechanism from stem utilizing Hall effect magnetic pulse system or similar technology. Measurement of torque shall be by direct measurement of force at the output of the actuator. Methods of measuring torque derived from the motor such as motor speed, current, flux, are not acceptable. Position and torque sensor shall accurately measure and control the position of the actuator without the use of mechanical gears. Potentiometers for position transmission are not acceptable.
 5. Provide torque switches for both directions of travel.
 - a. Sensing to be independent of voltage fluctuation.
 - b. Provide torque protection to prevent repeated starting in the same direction.
 - c. The initial unseating hammer blow shall not cause overtorque.
 - d. Provide torque switch settings independent of OPEN/CLOSE position switches.
- O. Provide output drive coupling to accept rising stem for rising spindle valves and include roller and ball type thrust bearings.

- P. Provide actuator sized to close valve against differential pressure as specified and indicated. Size actuator motor to seat and unseat valve gate or equipment and ensure torque switch trip at maximum valve torque when supply voltage is 10 percent below normal. Size motor to open or close valve, gate or equipment to satisfy the process dynamics.
- Q. All fasteners and hardware: Type 316 stainless steel.
- R. Secondary Gear Boxes:
1. Provide secondary gearing for multi turn or quarter-turn applications where operating times, thrust or torque considerations require.
 - a. Secondary Gearing: Bevel or spur, totally enclosed in a cast iron housing, fully sealed and lubricated for the service indicated and specified.
 2. Provide gear assemblies that are a manufacturer's standard selection or combination of as detailed in published product literature.
 - a. Provide each gearbox with a removable output drive coupling sized for the service specified and indicated.
 - b. Provide quarter-turn gearboxes equipped with adjustable mechanical stops (at 0 and 90 degrees +/- 5 percent) to permit limiting open and closed travel during manual operation.
 - c. Factory prime and finish paint all gear boxes with 2 part high solids epoxy or as specified herein for the actuator.

2.02 SHOP PAINTING:

- A. Paint Finish: Baked on polyester powder coating 70 microns thick and must have passed ASTM B117 35 degrees C Salt Spray Test for 1,000 hours.
1. Provide materials for touch-up of all damaged or abraded surfaces due to installation.
 2. Ferrous surfaces obviously not to be painted shall be given a shop applied coat of grease or rust resistant coating.

2.03 DISCONNECT AND LOCAL CONTROL STATION:

- A. Enclosure:
1. NEMA 4X (Ingress Protection Rating IP68) Type 316 stainless steel for all non classified areas.
 2. Mount on a pedestal, or on adjacent structure.

- a. Hardware and Mounting Supports: Type 316 stainless steel.
- B. Provide each actuator with a primary voltage rated non-fused disconnect.
- C. Provide each actuator mounted in excess of 6.5 feet above the operating level or in a position that cannot be accessed with a single integrated disconnect and local control station. Mount the disconnect and local control station on a wall, column or pedestal 5.0 feet above the operating level.
- D. Provide red, green, and yellow indicating lights as on actuator. GREEN light on when valve, gate or equipment is completely opened, RED light on when valve, gate or equipment is completely closed, and YELLOW light when valve, gate or equipment is in mid travel.
- E. Control circuits: 120VAC as required.
- F. LOCAL/STOP/REMOTE switch: Padlockable in all positions. With actuator selector set to "Remote" actuator shall be capable of accepting operation input through separate pushbutton station, that pushbutton station has been selected for remote "COMPUTER" control.
- G. OPEN/CLOSE switch: With actuator selector set to "Remote", actuator shall be capable of accepting operation input from separate pushbutton station, when pushbutton station has been selected for local "Open/Close" control.

2.04 MANUFACTURER

- A. Rotork or equal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.

3.02 FIELD TESTING:

- A. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service engineer, conduct running test for each actuator in presence of Engineer to determine its ability to operate without vibration or jamming and to operate at the speeds specified.
 - 1. During tests, observe and record, motor inputs.
 - 2. Promptly correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.

3. Contractor to provide all labor, equipment, and materials necessary for conducting tests.

B. Make all adjustments necessary to place equipment in specified working order at time of above tests.

C. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to satisfaction of the Engineer that units will perform the service specified and indicated.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide submittals in accordance with Specifications.

END OF SECTION

SECTION 15111

AIR FLOW CONTROL VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test air flow control valves, actuators, flow meters controls and appurtenances as indicated and in compliance with Contract Documents.
 - 1. Provide sizes and capacities as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
 - 1. B16.1:
 - 2. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
- B. ASTM International (ASTM):
 - 1. A48/A48M: Standard Specification for Gray Iron Castings.
 - 2. A276: Standard Specification for Stainless Steel Bars and Shapes.
 - 3. A351/A351M: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
 - 4. A536: Standard Specification for Ductile Iron Castings.
 - 5. A743/A743M: Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

1.03 SUBMITTALS:

- A. Submit the following in accordance with the General Specifications:
 - 1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the performance size and arrangements as indicated and specified.
 - a. Data, regarding valve characteristics and performance including Cv.
 - b. Provide repeatability lab testing as described herein.

- c. Provide Cv values and repeatability testing based on actual third party test results from a North American testing lab regularly conducting valve performance testing.
2. Calculations for actuator sizing and design stresses in the major valve components. All calculations stamped by a Professional Engineer.
3. Shop drawing data for accessory items.
4. Certified results of actuator shop testing.
5. Motor shop test results.
6. Number of service person-days provided and per diem field service rate.
7. Control schematics and operating description.
8. Manufacturer's literature as needed to supplement certified data.
9. Operating and maintenance instructions and parts lists.
10. Valve shop test results.
11. Qualifications of field service technician.
12. Shop and Field testing and inspections reports.
13. List of recommended spare parts other than those specified.
14. Recommendations for short and long term storage.
15. Special tools.
16. Shop and field testing procedures and equipment to be used.
17. Number of service technician days provided and per diem field service rate.
18. Manufacturer's product data and specifications for shop painting.
19. Provide a layout drawing, plan and section showing orientation of valve and actuators and nearest obstructions for each valve.
20. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
21. The most recent ISO 9001 series certification or quality system plan.
22. Material Certification:

- a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
 - B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
 - 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.
- 1.04 SPARE PARTS:
- A. Comply with requirements specified.
- 1.05 QUALITY ASSURANCE:
- A. Comply with the requirements specified.
 - B. Provide enclosures for the area classifications specified and indicated.
 - C. Services of Manufacturer's Representative as specified herein.
 - D. Manufacturer of valves shall have a minimum of five (5) operating installations with valves of the size specified and in the same service as specified operating for not less than five (5) years.
 - E. Valves shall be the product of one manufacturer.

- F. Valves shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- G. Shop tests as specified.
- H. The Contractor shall obtain the valves, actuators, flow meters, pipe spools including reducers and appurtenances from the valve manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.
- I. Services of Manufacturer's Representative as stated in the General Specifications and as specified herein.
- J. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
 - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
 - 2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
 - a. 1 person-day.
 - 3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.
 - a. 1 person-day.
 - 4. Field Performance Testing: Field performance test equipment specified.
 - a. 1 person-day.
 - 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
 - a. 1 person-day.
 - 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
- K. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01610 and as specified.

PART 2 - MATERIALS

2.01 SYSTEM DESCRIPTION:

- A. Valves sizes and operating data are specified in the Valve Schedule herein.

2.02 APERTURE VALVES – AERATION SERVICE:

A. Manufacturer:

- 1. Egger
- 2. No other manufacturers are acceptable

B. Valve Type:

- 1. Multi-segment valve designed to maintain the valve port geometry with central axial flow from open to close. Valves that have a changing geometry and a varying flow position in relationship to the flow meter as the valve moves from open to close and are not monotonic are not acceptable.
 - a. Minimum of six (6) segments
 - b. Hysteresis free
 - c. Monotonic responsive
- 2. Provide valve with gear for operation with rotary motion
- 3. Provide position indicator
- 4. Permanently lubricated
- 5. Provide valves optimized in accordance with DIN EN 60534

C. Valve Working Pressure: 87 psi.

D. Valve Temperature Rating: 284 degrees F

E. Body Type: Flanged

F. Materials:

- 1. Valve Body: Type 316 stainless steel ASTM A351/A351M CF8M.

2. Valve Disc Segments: Stainless steel: AISI Type 316L or DIN 17440/41
 - a. Provide segments with rounded edges and self cleaning characteristic.
 3. Elastomers: EPDM
 4. Hardware: Type 316 stainless steel
- G. Ends: Flanged, ANSI B16.1 Class 125
- H. Performance:
1. Minimum Control Range Turndown: 10:1
 2. Maximum Required Pressure Drop for Control: 0.15 psi
 3. Hysteresis-free performance
 4. Aeration Control Valve Schedule: As indicated
 5. Gain ($\frac{\Delta Q}{\Delta H}$) with Q = flow and H = relative stroke: The gain must be $0.50 < \frac{\Delta Q}{\Delta H} < 2.0$ for the complete regulation range.
 6. Repeatability: 1percent maximum flow variation
- I. Actuator:
1. Electric Motor Operators: Provide in accordance with Section 15109
- J. Flow Meter:
1. Manufacturer:
 - a. Kurz
 - b. ABB Sensyflow
 - c. E&H
 - d. Or Equal
 2. Type: Thermal dispersion principle with automatic real-time temperature compensation
 3. Material: Type 316L stainless steel
 4. Sensor: Ceramic with protective cage

5. Provide Type 316L stainless steel weld-on adaptor with centering pin
6. Operating Pressure: 0 to 250 psi (0 to 1.7 MPa)
7. Operating Temperature:
 - a. Operating: -13 degrees F to 302 degrees F (-25 degrees C to 150 degrees C)
 - b. Ambient: -13 degrees F to 122 degrees F (-25 degrees C to 50 degrees C)
8. Mounting: Provide a nominal 1-inch flanged weld-on pipe section with Type 316 stainless steel full port ball valve with lever actuator.
 - a. Pipe Material: Provide material to match process piping system as specified and indicated.
9. Transmitter:
 - a. Mounting: remote
 - b. Power: 120 V
 - c. Output: 4 to 20 mA DC and digital linear to flow
 - d. Accuracy: +/- 1 percent of flow and +0.5 percent of full scale
 - e. Repeatability: +/- 0.5 percent of reading
 - f. Turndown: 10:1 to 100:1 within calibrated flow range
 - g. Response Time: 0.5 seconds
 - h. Enclosure: NEMA 4X

K. Provide the following Valve data and information:

1. Valve Cv
2. Valve pressure drop and position for each valve for maximum and minimum flow rates indicated
3. Valve dimensional drawing with actuator and flow meter
4. Recommended upstream straight pipe length and reducer geometry for each valve
5. Actuator data
6. Test results of C v and repeatability

L. Equipment Schedule:

TAG NUMBER	SERVICE	AIR FLOW RANGE, SCFM	VALVE SIZE, IN	PIPE SIZE UP AND DOWNSTREAM, IN	ACTUATOR TYPE	OPERATION
FCV 4-5-2	ALP	550-2000	6	8/8	ELECTRIC	THROTTLING
FCV 5-5-2	ALP	550-2000	6	8/8	ELECTRIC	THROTTLING
FCV 4-5-1	ALP	450-2000	6	8/8	ELECTRIC	THROTTLING
FCV 5-5-1	ALP	450-2000	6	8/8	ELECTRIC	THROTTLING

1. Maximum valve pressure drop: 1 psi

2.03 AIR FLOW CONTROL VALVE ASSEMBLY:

- A. Valve manufacturer must provide the one piece flange x flange assembly as indicated including the following components:
 1. Flow control valve and actuator
 2. Flow meter and isolation valve
 3. Piping and reducers, provide in accordance with Section 15066

2.04 ELECTRIC MOTOR ACTUATORS:

- A. Provide in accordance with Section 15109.
- B. Provide actuator sized to guarantee valve closure at the specified differential pressure and provide safety margin of motor power available for seating and unseating the valve sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 percent below nominal.

2.05 SHOP TESTING:

- A. Provide certified performance testing
 1. Provide third party test data for each specific valve size either from a previous test of that valve size on a certified valve control test bench in accordance with DIN EN 60534-2-3. or provide third party testing of one (1) valve of each size and piping configuration including the flow meter on a certified valve control test bench in accordance with DIN EN 60534-2-3.
 - a. Test valve repeatability in accordance with the following at 90, 75 and 50% open:

- (1) Open valve to each position specified above for 2 minutes and measure flow rate in scfm
 - (2) Close valve to 30% for 1 minute, open valve to original position and measure air flow rate in scfm
 - (3) Maximum % repeatability: 1%
- b. Conduct all testing with air or water
- B. Hydrostatically test valve body and head for a minimum of 10 minutes and at a pressure of 1.50 times the working pressure as specified herein.
 - C. Once the valves have passed the above testing, test valves through three (3) cycles with the job actuators and all controls so that each valve is tested as a complete unit
 - D. Functional test of five (5) complete cycles of operation with the valve actuator settings in place (limit switches, torque switches, pilot pressure settings, etc).
 - E. In the event that specified tests indicate that the valves or the controls will not meet specifications, **[Engineer][CM]** has the right to require additional complete witnessed tests for all valves and control at no additional cost to the Owner.
 - F. Repeat tests until specified results are obtained.
 - G. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.06 ELECTRIC MOTOR ACTUATORS:

- A. Provide in accordance with Section 15109.
- B. Provide actuator sized to guarantee valve closure at the specified differential pressure and provide safety margin of motor power available for seating and unseating the valve sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 percent below nominal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.
- B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.
- C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in

workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which does not operate easily or are otherwise defective at no additional cost to the Owner.

- D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in piping system for access.

3.02 FIELD TESTING:

- A. Performance test valves with pipeline under normal operating pressure.
- B. Test piping connections to prove the valves are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with valve.
 - 1. After installation of valves, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service technician, conduct tests for each valve in presence of the Engineer to determine its ability to operate within the specified conditions.
 - 2. During tests, observe and record flow rate, pressure drop, valve position and noise.
 - 3. Test valve repeatability in accordance with the following at 90, 75 and 50% open:
 - a. Open valve to each position specified above for 2 minutes and measure flow rate in scfm
 - b. Close valve to 30% for 1 minute, open valve to original position and measure air flow rate in scfm
 - c. Maximum % repeatability: 1%
 - 4. Noise Limit: 80 dba at a distance of 3 feet from the valve.
 - 5. Immediately correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.
 - 6. Contractor to provide all labor, piping, equipment, flowmeters, test gauges and materials for conducting tests.
 - 7. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.
- C. Test functions of each valve.
- C. Make all adjustments necessary to place valves in specified working order at time of above tests.

- D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

- A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15370

PROCESS PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and test process piping and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

- A. American Society of Mechanical Engineers (ASME):
 1. B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
 2. B16.9: Factory-Made Wrought Butt welding Fittings
 3. B31.1: Power Piping
- B. ASTM International (ASTM):
 1. A36: Standard Specification for Carbon Structural Steel
 2. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 3. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 4. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 5. A269: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 6. A312: Seamless and Welded Austenitic Stainless Steel Pipe
 7. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
 8. A449: Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
 9. D1330: Standard Specification for Rubber-Sheet Gaskets

10. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

11. F1476: Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

C. American Welding Society (AWS):

1. B3.0: Welding Procedure and Performance Qualification

D. American Water Works Association (AWWA):

1. C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe

2. C606: Grooved and Shouldered Joints

E. Expansion Joint Manufacturers Association Standards.

F. Fluid Sealing Association - Technical Handbook.

G. Manufacturer's Standardization Society (MSS):

1. SP-69: Pipe Hangers and Supports - Selection and Application

1.03 SUBMITTALS:

A. Submit the following in accordance with Specifications:

1. Submit manufacturer's certificates of conformance.

2. Submit certified copies of test reports.

3. Piping layouts in full detail.

4. Location of pipe hangers and supports.

5. Large scale details of wall penetrations and fabricated fittings.

6. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.

7. Reports as required for welding certifications per ASME B31.1 Paragraph 127.6.

8. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

B. Grooved joint couplings and fittings: Provide product submittals with products specifically identified by the manufacturer's style or series designation.

1. Brochures and technical data on coatings and linings and proposed method for application and repair.
 2. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.
 3. Shop drawing data for accessory items.
 4. Manufacturer's literature as needed to supplement certified data.
 5. Operating and maintenance instructions and parts lists.
 6. Schematic control and power wiring diagrams.
 7. Shop and Field inspections reports.
 8. List of recommended spare parts other than those specified.
 9. Recommendations for short and long term storage.
 10. Special tools.
 11. Shop and field testing procedures and equipment to be used.
 12. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.
 13. The latest ISO 9001 series certification or quality system plan.
 14. Material Certification:
 - a. Provide certification from the piping and equipment manufacturers that the materials of construction specified are recommended and suitable for the service conditions specified and as indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified. And indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Authority.
 - b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.
- C. A copy of the contract mechanical process, civil, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this

specification section. If no changes are required, mark all drawings with “No changes required”.

1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ANSI B31.1, for shop and project site welding of piping work.

2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Provide all grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools used must be of the same manufacturer as the grooved components.

1. Provide all castings used for coupling housings, fittings, and valve bodies date stamped for quality assurance and traceability.

C. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01610.
- B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS:

- A. Provide in accordance with Section 02615

2.02 STAINLESS STEEL PIPE AND FITTINGS 2-1/2-INCH (65 MM) AND LARGER:

- A. Provide in accordance with Section 15066.

2.03 STAINLESS STEEL PIPE AND FITTINGS 1/2-INCH:

- A. Provide either Pressfit, grooved or a socket welded system.
 - 1. Provide a sufficient number of unions for Vic-Press and socket welded systems to allow removal of all valves and inline devices.
 - 2. Provide threaded connections only where required.
- B. Vic-Press Schedule 10S System:
 - 1. Vic-Press system, 1/2-inch through 2-inch Schedule 10S comprised of stainless steel Vic-Press fittings, couplings and pipe.
 - 2. Type 316 stainless steel Pressfit couplings and fittings and Type 316 stainless steel Pressfit pipe UL classified to ANSI/NSF 61 for cold +86 degrees F and hot +180 degrees F potable water service.
 - a. Maximum working pressure of 500 psi for water, oil, gas, chemical, air and vacuum services.
 - 3. Couplings, Fittings: Pressfit products formed of Type 316/316L stainless steel tubing including a self-contained o-ring seals molded of synthetic HNBR rubber suitable for water operating temperatures to +210 degrees F.
 - 4. Valves 1/2-inch through 2-inch ball valves with Type 316 stainless steel plain ends for Pressfit assembly. Victaulic Series 569.

- a. Pressure Rating: 300 PSI.
 - b. CF8M stainless steel body and ball
 - c. Type 316 stainless steel stem
 - d. PTFE seats.
5. Pipe: Type 316/316L ASTM A312 stainless steel
- a. Schedule 10S.

C. Socket Welded System:

- 1. Schedule 40 Type 316L stainless steel pipe and fittings with socket welded connections.

D. Grooved System:

- 1. Schedule 10S type 316L stainless steel pipe and fittings with Type 316 stainless steel grooved end connections and couplings.
- 2. Fittings: ASTM A403 or be factory fabricated from ASTM A312 stainless steel pipe.
- 3. Provide couplings consisting of ductile iron or stainless steel housings, with pressure responsive elastomer gasket.
 - a. Rigid Type: Victaulic Style 489 (SS) or equal.
 - b. Flexible Type: Victaulic Style 77S (SS) or equal.

2.04 COUPLINGS-BOLTED SPLIT SLEEVE TYPE:

A. Manufacturers:

- 1. Victaulic

B. Type: Bolted, split-sleeve type coupling consisting of four basic components; one piece housing, gaskets assembly, bolts and nuts, and restraint rings as required for restraint.

- 1. Provide split-sleeve with a double arch cross section closing around pipe ends that are smooth for expansion or contraction requirements or pipe ends with end rings affixed for pipe end restraint requirements. As the coupling housing closes, it confines the elastomeric gasket beneath the arches of the sleeve to create the radial seal. The axial seal is affected by the sealing plate at the closure plates as the bolts pull the coupling housing snug around the pipe.

2. Provide sealing members comprised of two “O” ring gaskets and an elastomer sealing pad bonded to the integral sealing plate.
- C. Provide couplings designed for the type, size, and working pressure of the piping system as indicated in the Process Piping Schedule and specified.
- D. Materials:
1. Split-sleeve:
 - a. Carbon Steel and Ductile Iron pipelines: ASTM A36 Carbon Steel.
 - b. Stainless steel pipelines, ASTM A240 Type 316L stainless steel.
 - c. Provide stainless steel couplings where there is a transition for ductile iron to stainless steel piping.
 2. Gaskets:
 - a. Material: Elastomers in accordance with ASTM D2000.
 - (1) Air Service: Silicone conforming to ASTM D2000 for air service up to 240 degrees F (115 degrees C) with intermittent exposure to 280 degrees F (138 degrees C).
 3. Bolts and Nuts:
 - a. Bolts: Stainless steel conforming to ASTM F593 Type 316, minimum tensile strength 85,000 psi, (or threaded studs to ASTM A193, Class 2 Grade B8M Type 316)
 - b. Nuts: ASTM F593 Type 316.
 4. End Restraint Rings:
 - a. Provide restraint rings of the same material as the coupling housing.
 - b. Non-restrained (ExE) type couplings allows for up to 4 degree deflection. Provides for coupling joint where restraint is not required. If restraint is required, it must be provided independent of the coupling.
 - c. Fixed x Expansion (FxE) type couplings: Allows for thermal expansion and contraction at the pipe joint. Provide one or two restraint rings fixed to one end of the pipe to keep coupling in the proper location. Where split sleeve coupling FxE for expansion is used provide the expansion side of the coupling with a combination of fixed and sliding supports for thermal movement.

- d. Fixed x Fixed (FxF) type couplings: Provides a fully restrained pipe joint. Provide one restraint ring welded to each of the pipe ends fitting beneath the coupling to prevent the pipe joint from pulling apart.
 - e. Provide type as indicated and specified.
 - f. Follow manufacturer's written recommendations and instructions for location dimensions and welding detail required to attach the restraint rings.
- E. Provide a Type 316 stainless steel nameplate welded to each coupling with the following data:
- 1. Manufacturer and date fabricated.
 - 2. Type of Coupling (ExE, FxE, FxF).
 - 3. Working Pressure in psi (kPa).
 - 4. Test Pressure in psi (kPa).
 - 5. Materials for coupling, hardware and gaskets.
- F. Protective Coating: Prior to installation, couplings shall be coated on the I.D. and O.D. in accordance with section 09940.
- G. Installation of couplings shall be in accordance with manufacturer's recommendation.
- 1. The coupling housing shall be assembled pulling the closure plates together with the bolts tightened to assure snug coupling housing contact with the pipe OD. Follow the manufacturer's recommendation regarding the installation and tightening of the bolts.

2.05 EXPANSION JOINTS-ELASTOMERIC FLEXIBLE CONNECTION:

- A. General: Provide flexible connectors as indicated, specified and as required for ductile iron, steel and stainless steel piping
- 1. At equipment connection: To eliminate vibration and stress on equipment.
 - 2. Elsewhere: Designed for expansion/contraction.
 - a. Piping Systems: 0.5 inch per 100 feet.
- B. Manufacturers:
- 1. Mercer Rubber Co.
 - 2. General Rubber Co.

3. Garlock, Inc.
- C. Products:
1. Straight-through or tapered design as required.
 2. Filled arch type for wastewater, sludge and scum applications
 3. Furnish control rods for test pressures as indicated or required.
 4. Materials: Suitable for service specified and indicated.
 5. At expansion joints, provide guide supports located per manufacturer's recommendations.
 6. Flanges: 125 lb (Class 125) drilling.
 7. Provide Type 316 stainless steel retaining rings.
 8. Aeration Systems: EPDM, suitable for 300 deg F service temperature
- D. Install joints in their neutral position.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

- A. Install pipelines parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 15056 to prevent shifting or distortion of pipe. Provide for expansion.
- B. Slope piping toward low points and provide for draining at low points.
- C. Before assembly, remove debris from inside pipes and fittings.
- D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.
 1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.
- E. Install grooved joints in accordance with the manufacturer's written recommendations.
 1. Grooved ends: Clean and free from indentations, projections, or roll marks.

2. Gaskets: Molded and produced by the coupling manufacturer of an elastomer suitable for the service specified and indicated.
 3. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed.
- F. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.
 - G. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.
 - H. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.
 - I. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.
 - J. Welding in accordance with AN Standard B31 and AWS B3.0.

3.02 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

- A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.
- B. Water for testing provided by the Contractor.
- C. Pressure and Leakage Tests:
 1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.
 2. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gauge location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.
 3. No visible leakage in joint is acceptable.
 4. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.
 5. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

- D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.
 - E. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.
 - F. Test pressures as indicated in Process Pipe Schedule.
 - G. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.
- 3.03 CONTRACT CLOSEOUT:
- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 15817

FINE BUBBLE DISC DIFFUSERS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Remove all aeration equipment as indicated and provide and test entire aeration and piping systems including air mains, drop legs, manifolds, distribution headers, fine bubble air diffuser assemblies, expansion joints, supports, and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

- A. American Society for Testing and Materials International (ASTM):

1. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
3. A554: Specification for Welded Stainless Steel Mechanical Tubing.
4. D395: Standard Test Methods for Rubber Property—Compression Set
5. D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
6. D573: Standard Test Method for Rubber—Deterioration in an Air Oven
7. D1171: Standard Test Method for Surface Ozone Cracking Outdoors (Triangular Specimens)
8. D2240: Standard Test Method for Rubber Property—Durometer Hardness
9. D573: Standard Test Method for Rubber Deterioration in an Air Oven
10. D2564: Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems
11. D2855: Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
12. D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

13. D3915: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications
14. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
15. A554: Specification for Welded Stainless Steel Mechanical Tubing.
16. D573: Standard Test Method for Rubber Deterioration in an Air Oven
17. D2564: Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems
18. D2855: Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
19. D3034: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
20. D3915: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications

B. American Iron and Steel Institute (AISI):

1. Specification for Type 316L.

C. ASCE Oxygen Transfer Standards.

1.03 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01300:

1. Certified shop and erection drawings.
2. Data, regarding diffuser characteristics and performance, to include complete headloss calculation for the aeration equipment from the manufacturer's point of responsibility and certified oxygen transfer performance curves.
3. Shop drawing data for accessory items.
4. Templates or certified setting plans, with tolerances, for anchor bolts.
5. Manufacturer's literature as needed to supplement certified data.
6. Operating and maintenances instructions and spare parts lists.
7. Listing of reference installations as specified with contact names and telephone numbers.

8. Qualifications of field service engineer.
 9. Shop and Field inspections reports.
 10. Recommended spare parts other than those specified.
 11. Recommendations for short and long term storage.
 12. Special tools.
 13. Shop and field testing procedures and equipment to be used.
 14. Number of service man days provided and per diem field service rate.
 15. Provide a listing of the materials recommended for each service specified and indicated.
 16. The latest ISO 9001 series certification or quality system plan.
- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no charges are required.
1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.
- 1.04 SPARE PARTS:
- A. Provide spare parts that are identical to and interchangeable with parts installed.
 - B. Furnish and deliver the following spare parts:

1. Quantity of complete diffuser assemblies amounting to 5 percent of the total installed.
2. One (1) pressure gauge (0-7 kPa) mounted on a female end quick disconnect for use with the pressure monitoring system.
3. One (1) hand type air pump with female quick disconnect suitable for clearing pressure monitoring lines.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance with Section 01400 and as specified herein.
- B. Diffusers, aeration system piping and appurtenances to be the product of one manufacturer.
- C. Diffusers to be manufacturer's standard cataloged product and modified to provide compliance with the specification and the service conditions specified and indicated.
- D. Welding: In accordance with American Welding Society Code or equivalent.
- E. Provide services of manufacturer's representative as stated in Section 01730 and as specified herein.
- F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
 2. Installation: Supervise location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, and miscellaneous utility connections:
 - a. 1 person-days.
 3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
 - a. 1 person-days.
 4. Field Performance Testing: Field performance test equipment specified.
 - a. 1 person-days.
 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.

- a. 1 person-day.
 - 6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
 - 7. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or testing, or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- G. Manufacturer of diffusers must have at least five (5) operating installations with systems of the size specified and in the same service as specified operating for not less than five (5) years.
- 1.06 DELIVERY, STORAGE AND HANDLING:
- A. Provide in accordance with Section 01610 and as specified.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

- A. Tapered fine bubble membrane type diffuser system.
- B. Process operating mode:
 - 1. Conventional activated sludge.
- C. Minimum aeration system configuration requirements are indicated on the drawings and specified herein for 9-inch diffusers.

2.02 MANUFACTURERS:

- A. Xylem/Sanitaire
- B. SSI
- C. Or Acceptable Equivalent Product

2.03 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified herein.
- B. It shall be the responsibility of manufacturer and supplier along with the Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 SERVICE CONDITIONS:

- A. Number of Reactors: 4, dimensions as indicated
- B. Number of Diffuser Grids Per Basin: As Indicated
- C. Manifold Size: As indicated
- D. Number and size of Distribution Headers per Zone: As indicated
- E. Total No. of Diffusers/Reactor: As indicated
- F. Total No. of Diffusers: As indicated
- G. Type 316L Stainless steel drop pipes to limit indicated.
- H. PVC manifold and distribution headers pipes.
- I. Diffuser assembly consisting of membrane diffuser element, PVC or Polypropylene diffuser element holder, integral sealing gasket or O-ring, air flow control orifice and retaining device.
- J. PVC drain line, sump and airlift purge system.
- K. Expansion joints and fixed joints.
- L. Bolts, nuts and gaskets for flanged joints.
- M. Type 316 Stainless steel supports and anchor bolts.
- N. (Digital) Diffuser pressure monitoring system.
- O. Removable endcaps on lateral branches.

2.05 STAINLESS STEEL MATERIALS AND FABRICATION:

- A. Provide all welded parts and assemblies fabricated from sheets and plates of Type 316L stainless steel with a 2D finish conforming to AISI 316L and ASTM A240-78a.
- B. Provide nonwelded parts and pieces fabricated from sheets and plates of Type 316 stainless steel conforming to AISI 316 and ASTM A240.

- C. Provide stainless steel piping fabricated in accordance with ASTM A778 and stainless steel fittings in accordance with ASTM A774.
 - D. Provide upper drop legs of the diameter shown on the Drawings with dimensional tolerances conforming to ASTM A554 and ASTM A530 with a minimum nominal wall thickness of 0.109-inch.
 - E. Welding
 - 1. Provide all welding done in the factory using shielded arc, inert gas, MIG or TIG method.
 - 2. Add filler wire to all welds to provide for a cross section and weld metal thickness equal to or greater than the parent metal.
 - 3. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of joint.
 - 4. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1/16-inch (1.6 mm) beyond the ID of the air header or fittings.
 - 5. Continuously weld both sides of face rings and flanges.
 - 6. Field welding will NOT be permitted.
 - F. Passivate all welded stainless steel fabrications by using the following procedure:
 - 1. Wire brush all outside weld areas to remove weld splatter. Brushes shall be of stainless steel and used only on stainless steel.
 - 2. Remove all carbon deposits, greases, and oils by pickling and neutralization to aid the regeneration of a uniform corrosion resistant, chromium oxide film.
 - 3. Completely immerse all stainless steel assemblies and parts after welding and brushing in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid at 60 degrees C for a minimum of 15 minutes. Parts shall be free of iron particles or other foreign material after this procedure.
 - 4. Neutralize all stainless steel assemblies and parts previously pickled by immersion in a trisodium phosphate rinse.
 - G. Provide all nuts, bolts, and washers including anchor bolts in Type 316 stainless steel.
- 2.06 PVC MATERIALS AND FABRICATION:
- A. Provide all PVC moldings and extrusions from PVC compound conforming to ASTM D3915, compound cell classification 124544 ASTM D1784 with a minimum tensile strength of 7,200 psi (50.3 MPa).

- B. Blend UPVC resins and limit amount of fillers to achieve a minimum "K" value of 58 for fittings and a minimum "K" value of 64 for pipe.
- C. Provide Schedule 80 lower drop legs and manifolds of the diameter shown on the Drawings. Transition from Type 316L stainless steel drop leg to Schedule 80 PVC shall be 2 feet-0 inches (600 mm) above centerline of manifold.
- D. Provide 4-inch (100 mm) diameter SCH 40 distribution header piping as indicated.
- E. Provide PVC fittings as shown on the Drawings conforming to ASTM 2466.
- F. Add two parts by weight of titanium dioxide per 100 parts of resin to PVC compounds for air lateral piping, diffuser element holders, and retainer rings to minimize ultraviolet light degradation.
 - 1. Solvent weld all PVC joints in the factory in accordance with ASTM D2855 except edges need not be chamfered.
 - 2. Do all solvent welding with solvent cements specifically formulated for use with PVC in accordance with ASTM D2564.

2.07 AIR MANIFOLD PIPING:

- A. Provide a stainless steel upper drop leg section from the air main connection as indicated:
 - 1. Provide Type 316L Van Stone flange assembly with ANSI-150-lb (Class 150) drilled flanged connection at the top of the drop leg as indicated.
 - 2. Provide a plain end for the lower end of the drop leg. Connect upper section of drop leg to lower PVC section with a Type 316 stainless steel band coupling.
 - 3. Support drop leg with Type 316L stainless steel type supports.
- B. Provide PVC manifold piping as indicated, perpendicular to the distribution header air piping:
 - 1. Provide manifolds of the same nominal pipe sizes as associated drop legs and as indicated.
 - 2. Fabricate manifolds in sections up to 20 feet (6 metres) in length. Join manifold sections with ANSI 150-lb (Class 150) drilled flanges and gaskets, or Type 316 stainless steel band couplings.
 - 3. Support manifolds with Type 316L stainless steel supports. Maximum spacing between supports shall not exceed 8 feet (2.5 metres). Design manifold connections and supports to resist thrust generated by expansion or contraction of the lateral piping. Provide supports as described in this specification.

4. Fabricate manifold piping with 4-inch (100 mm) diameter fixed joint connections to each distribution header pipe:
 - a. Provide manifolds with minimum Schedule 80 dimensions when stub to submain connection is reinforced with a solvent welded saddle tee.
 - b. Provide manifolds with Schedule 80 dimensions when stub to manifolds connection is unreinforced.
 5. Provide manifolds for long-term exposure to 130 degrees F (55 degrees C) mean-wall temperatures.
- C. Provide 4-inch (100 mm) SCH 40 PVC air distribution header piping as indicate, perpendicular to the air submain:
1. Fabricate distribution header piping in sections up to 23 feet (7 metres) in length. Join sections of lateral piping with fixed joints or expansion joints.
 2. Fabricate distribution header piping with diffuser element holders factory solvent welded to the crown of the pipe. Attach diffuser element holders to lateral pipe to resist the following applied torque values:
 - a. About polar axis of holder: 150 lb-ft (200 Nm).
 - b. About longitudinal axis of holder: 100 lb-f (135 Nm)
 3. Support each section of distribution header piping with a minimum of two supports having a maximum spacing of 7 feet-6 inch (2.3 metres).
 - a. Locate distribution header piping supports at approximately 1/4 span to coincide with the zero bending moment point.
 - b. Distribution header piping supports, or guides, shall allow longitudinal movement of the lateral section to prevent stress buildup in the lateral due to thermal expansion/contraction forces. Guides that clamp or grip the lateral will be unacceptable.
 - c. Provide supports as specified in paragraph 2.08.
 4. SDR piping is not acceptable.

2.08 DIFFUSER ASSEMBLIES:

- A. Provide diffuser assemblies consisting of a nominal 9-inch dia. EPDM membrane diffuser, a PVC or Polypropylene retainer ring and a diffuser support piece. Provide diffusers composed of EPDM elastomer resistant to attack by common municipal wastewater. EPDM material to meet the requirements of ASTM D-573.

- B. Provide diffusers free of voids, tears, bubbles, creases or other structural defects.
- C. Provide diffusers with a uniform distribution of air release across the entire surface area of the diffuser except for the center 1-inch diameter which is not perforated. Provide the non-perforated center of the diffuser to provide the necessary sealing capabilities and backflow prevention when air supply to the diffuser is interrupted. Provide the center thickened to prevent ballooning and air abrasion where the air is released under the diffuser.
- D. Provide disc-shaped diffusers with a 9-inch nominal diameter and integral O-ring seal molded into the diffuser assembly. Provide a thickened diffuser cross-section at the center as noted above and at the periphery near the O-ring to resist stretching.
- E. Diffusers:
 - 1. 60 +/- 5 durometer Shore A, with a minimum tensile strength of 1375 psi, and a minimum elongation of 600 percent at break. Compression set: <=11 percent at 23 deg C.
 - 2. After 48 hours of oven age testing, the diffuser to be 50 Shore A +5 or less,, tensile strength 1,200 psi or greater, and elongation > 400 percent. Compression set 18 percent.
 - 3. Provide the diffuser perforated with uniform slits of a shape and size to prevent tearing or lengthening of the slits during operation.
 - 4. Provide uniform distribution of air across the entire surface area when submerged and operating at 1.0 cfm per diffuser.
- F. Dynamic wet pressure of the membrane diffuser element: <11 inches of water column when operated at 1.0 SCFM. Dynamic wet pressure is the pressure required to operate the diffuser in tap water at the specified flow rates minus any losses for submergence and flow control devices.
- G. Provide PVC or Polypropylene diffuser element holders with an air plenum. Provide a mechanism to attach the diffuser element to the element holder:
 - 1. Provide element holders for complete peripheral edge support for the diffuser element.
 - 2. Solvent weld element holders to the lateral pipes in the factory to resist the torque values specified.
 - 3. Provide a retaining device to securely hold and seal the membrane diffuser element to the element holder. Design diffuser assembly and retaining device to prevent air escape at the diffuser element-sealing gasket interface. Gasket integral with diffuser membrane.

- 4. Provide screw on retainer rings with a positive O-ring seat and have a minimum of 2-1/2 complete threads for engagement. Provide threads with a minimum cross-section of 1/8-inch.
- 5. Manufacture each diffuser element holder with an air flow control orifice.
- H. Furnish sealing gaskets or O-rings to provide long-term service and minimum compression set:
- I. Provide sealing gaskets or O-rings manufactured of polyisoprene or other synthetic material resistant to attack by wastewater
- J. Number of diffuser assemblies: Provide supports as specified, indicated, and required.

2.09 SUPPORTS:

- A. Provide all supports as specified, indicated and required.
 - 1. Provide supports designed to withstand all uplift forces encountered up to the 100 year flood elevation as indicated on the hydraulic profile.
- B. Manifold Supports:
 - 1. Provide manifold supports as indicated or required by the manufacturer and as specified.
 - 2. Provide submain supports including manifold hold-down and guide straps mounted on anchor bolts attached to the tank floor in accordance with equipment manufacturer's recommendations.
 - 3. Provide guide straps designed to resist the following uplift without exceeding specified design stress. Submain guide straps to be minimum 2-inches (50 mm) wide:

Manifold Diameter, inch (mm)	Uplift force per support lbs. (Newtons)
4, 6 and 8 (100, 150 and 200 mm)	325 (1450 N)
 - 4. Submit certification prepared by a registered professional engineer to show compliance of support design.
 - 5. Provide supports with a mechanism to provide for plus or minus 2 inches vertical and 1/2-inch lateral adjustment for alignment of the manifold in the field.
 - 6. Provide manifold supports with a pipe centerline of 22 inches (559 mm) or higher with a diagonal stainless steel support strut for additional support rigidity.
- C. Distribution Header Piping Supports:

1. Provide stainless steel distribution header piping supports as specified.
2. Fixed supports: Consist of a hold-down mechanism and self-limiting clamp device:
 - a. Hold-down mechanism and clamp: Provide a 1-1/2 inch wide contoured bearing surface for the air distribution header piping.
 - b. Provide clamping device to positively grip the air distribution header piping when tight and be self-limiting to prevent overstressing the pipe if the clamp is overtightened.
3. Intermediate guide supports
 - a. Consisting of a self-limiting hold-down and sliding mechanism:
 - b. Hold-down and sliding mechanism: Provide a 1-1/2 inch wide contoured bearing surface with chamfered leading edges to maintain contour of the air distribution header piping.
 - c. Sliding mechanism: Provide minimum resistance to movement of the air distribution header under full buoyant uplift load. Mechanism to provide 1/8-inch clearance around piping and be self-limiting if the mechanism is overtightened.
 - d. Design for a maximum horizontal thrust of 20 pounds or less to initiate movement of the piping relative to the mechanism under full buoyant uplift load.
4. Provide supports with a mechanism to provide for plus or minus 1-1/2-inch vertical adjustment for alignment of the air distribution header piping in the field.
5. Adjusting and aligning mechanism: Infinitely adjustable within its limits to allow precise leveling of the air distribution header piping and diffuser assemblies to within +/- 3 mm of a common horizontal plane without removing the piping from the support.
6. Fixed and guide distribution header piping supports: Provide sufficient strength to resist both axial and lateral loads of 140 pounds) applied 6 inches above the base without deflecting more than 1/2-inch.
7. Anchor supports to tank floor with one stainless steel wedge anchor bolt designed for embedment in 3,000 psi concrete:
 - a. Design wedge anchors with a pullout strength, factor of safety of 4 or more.
 - b. Static load test 1 percent of all anchorage assemblies as hereinafter specified

2.10 EXPANSION JOINTS AND FIXED JOINTS:

- A. Provide a PVC expansion system to prevent thermally induced stresses due to expansion and contraction over a temperature range of 125 degrees F (52 degrees C). Provide all expansion joints airtight and to allow free and easy movement of the plain end of the pipe within the coupling barrel.
- B. Expansion Joints: Provide a barrel section solvent welded to one end of the lateral pipe, an O-ring gasket and a threaded, screw-on retainer ring.
- C. Provide Expansion couplings meeting the following criteria:
 - 1. Maximum Stroke: 4 inches
 - 2. Average Force to Operate: 50 lbs
- D. Provide fixed joints consisting of a spigot section solvent welded to one end of a distribution lateral, a threaded socket section solvent welded to the mating distribution lateral, an O-ring gasket, and a threaded screw-on retainer ring.

2.11 DRAIN LINE, SUMP AND AIRLIFT PURGE SYSTEM:

- A. Provide a PVC drain line, sump, and airlift purge system to drain the entire submerged aeration piping system for each aeration diffuser grid.
- B. Construct each aeration grid with an integral 4-inch (100 mm) diameter drain line terminating at a sump. The sump bottom elevation shall be lower than the invert of the air distribution header piping and drain line:
 - 1. Connect drain sump to 3/4-inch diameter airlift eductor line extending to the drain line invert elevation. Extend airlift eductor to a point 18 inches above the basin water level and terminate with a PVC ball valve.
 - 2. Support airlift eductor with Type 316L stainless steel brackets at walkway or platform beam location.
 - 3. Provide systems using drain lines at the ends of the aeration grids with a combination support/thrust anchor at each header-drain line connection to prevent joint blow-apart.

2.12 DIFFUSER PRESSURE MONITORING SYSTEM:

- A. Provide monitoring equipment to measure dynamic wet pressure (DWP) and diffuser air flow of a typical diffuser in each type of diffuser aeration grid.
- B. Provide one portable routine maintenance pressure monitoring panel, housed in a fiberglass NEMA 4X enclosure, suitable for hand carrying and containing the following equipment components:

- C. Furnish one pressure monitoring connecting box assembly per aeration diffuser grid. The connecting box assembly shall be used to connect the pressure monitoring panels to the in-tank aeration grids. This assembly shall contain the following equipment components:
1. Orifice and diffuser differential pressure gauges. (Digital or analog)
 2. Bubble pipe blow-down valve.
 3. Bubble pipe air flow rotameter.
 4. Quick coupling connectors.
 5. Polypropyrolene fittings.
 6. Polyethylene fittings.
 7. One set of pressure monitoring instructions complete with calibration curves.
 8. Provide a stainless steel hanger device mounted on the enclosure of a design suitable to hang the enclosure on the handrail.
 9. The portable panel dimensions shall be a minimum 14 inches high x 10 inches wide.
- D. Provide one pressure monitoring connecting box assembly per aeration diffuser grid. The connecting box assembly shall be used to connect the pressure monitoring panels to the in-tank aeration grids. This assembly shall contain the following equipment components (Remains more or less the same for Digital):
1. One fiberglass connecting box housing, three sets of isolation valves and male quick disconnects.
 2. One each 1/2 inch diameter, 3/8 inch diameter and 1/4-inch diameter polyethylene tubes and fittings running from one connecting box isolation valves to the in-tank aeration grid.
 3. One each 1/2-inch diameter, 3/8-inch diameter and 1/4-inch diameter tapped holder, header and bubble pipe connections on one air distributor on the in-tank aeration grid.
 4. All pressure monitoring tubes shall be housed in a Schedule 80 PVC carrier column extending from the top of the tank near the connecting box to the bottom of the tank.
 5. The carrier column shall be anchored to the tank floor and wall using Type 316L stainless steel supports and Type 316 stainless steel fastening hardware.

6. The connecting box shall be mounted to the handrail using stainless steel supports and fastening hardware.
7. Provide one set of 10 feet long pressure monitoring leads to connect the connecting boxes to the pressure monitoring panels. Each set to contain one 1/2-inch, 3/8-inch and 1/4-inch diameter polyethylene tube with female end quick disconnects. The tube bundle shall be encased in a 1-1/2 inch polyethylene tube.
8. The pressure monitoring connecting box dimensions: Minimum 14 inch high x 12 inch wide.

E. Monitoring system to be suitable for either gas or liquid cleaning systems

2.13 FACTORY TESTING:

- A. Prior to initiation of production, submit a testing plan designed to insure consistently good quality and uniformity of the diffuser assemblies, including a sampling plan. After testing, all diffusers tested shall be marked with their test results.
- B. Test diffusers in a plan designed to give 95 percent confidence that the diffusers meet the quality control requirements listed below. Submit a test plan designed to meet the above requirements. The testing plan to be in accordance with Mil. Standard 105D, AQL Level 1.5, Double Normal Sampling or in accordance with ISO-9001:2015 certification documenting quality at the source.
- C. Test all diffusers in accordance with the sampling plan to insure uniformity. Uniformity is defined as substantially even distribution of air bubbles when the diffuser is submerged and operating at 1.0 SCFM.
- D. Test all diffusers in accordance with the sampling plan for dynamic wet pressure. Dynamic wet pressure is defined as the pressure loss across the diffuser when operated at a specific airflow minus any pressure for orifice headloss or diffuser submergence. The dynamic wet pressure of the membrane must be between <11 inches of water column when operated at 1.0 SCFM.
- E. Inspect all diffusers in accordance with the sampling plan for compliance with dimensional tolerances.
- F. Oxygen Transfer Test:
 1. Perform a shop oxygen transfer test per latest ASCE Standard "Measurement of Oxygen Transfer in Clean Water."
 2. Perform tests at the actual water depth, submergence, diffuser density and air rate per diffuser as that proposed for the full scale tank using membranes from the materials to be supplied to site..
 3. Perform tests at each diffuser density.

4. Clean tank in which diffusers are tested and then fill with fresh tap water. Care must be taken to avoid any contamination of test water with chemicals used for tank cleaning.
5. Temperature of the fresh water, if possible, should be about 20 degrees C.
6. Station sampling points at different points throughout geometry of tank so as to give true effective cross sample within tank. Minimum of six samples are required per test. If submerged tank is used individual sample pumps must be used for each sample. Run sample pumps continuously to insure representative samples. Take samples concurrently and of equal volumes. To facilitate above, all pumps and lengths of tubing to be identical. In tank dissolved oxygen probes can be used if desired.
7. A rotameter, orifice plate or similar device is installed to measure air flows. This apparatus sized such that flows to be measured are all within range of accuracy.
8. Dissolve and mix catalyst, cobalt chloride or cobalt sulfate, into tank contents. Cobalt concentration of 0.05 - 0.25 mg/l and measured prior to initial run and immediately after final run.
9. While mixing, release a deoxygenating solution of sodium sulphite into tank contents of at least two different locations. Sodium sulphite Reagent grade by Fisher or Mallinckrodt or Santosite as manufactured by Monsanto or international standard brand to insure no build-up of cobalt ion concentration. Sodium sulphite added at 1.5 times stoichiometric requirements or approximately 12 mg/l sodium sulphite per mg/l of tank D.O. to provide excess for oxidation during mixing.
10. Calculations: Provide all calculations relating to field oxygen transfer efficiency. Calculations shall be based on the ASCE Non-Linear Regression Method.
11. A maximum of ten test runs made on any tank full of water.
12. Provide TDS corrections

2.14 SPARE PARTS

- A. Provide spare parts that are identical to and interchangeable with parts installed.
- B. Provide the following spare parts:
 1. Quantity of complete diffuser assemblies amounting to 5 percent of the total installed.
 2. One (1) pressure gauge (0-10 psi) mounted on a female end quick disconnect for use with the pressure monitoring system.

3. One (1) hand type air pump with female quick disconnect suitable for clearing pressure monitoring lines.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Follow equipment manufacturer's recommendations for sequencing of equipment installation:
 1. Layout and install supports in accordance with manufacturer's instructions and anchor setting plan.
 2. Level aeration system such that all diffusers are within plus or minus 1/8-inch (3 mm) of a common horizontal plane.
- C. Clean air header pipe, mains, submains, distribution headers, blowers, filters, and drop legs prior to installing diffuser elements:
 - a. Install diffuser elements and retaining devices.
 - b. Protect diffuser elements from unpressurized submergence in wastewater.

3.02 FIELD PERFORMANCE TESTING AND INSPECTION:

- A. Mounting tests:
 1. Test support and tie-down provisions of PVC diffuser piping to insure a margin of safety of 10 against calculated buoyant forces. Test support and tie-down system of PVC header piping to insure a margin of safety of 2 against calculated buoyant forces.
 2. Upon installation of supports and prior to installation of piping, test all supports of each type with no less than 10 percent of supports of each type, chosen at random to be witness tested by **[Engineer][CM]**. Tests shall be conducted on a complete support assembly including anchor bolt, hold-down mechanism, and clamp by inserting a 6-inch (150 mm) diameter metal pipe specimen in the assembly attached to a lever which is placed on a fulcrum. Apply a static load to the opposite end of the lever to produce a vertical extracting force on the complete support assembly equal to 180 pounds (800 Newtons) or four times the calculated maximum buoyant force that the support assemblies will be subjected to during normal operation.

- B. Inspection of Piping: Inspect piping for proper joints, supports and tie-downs, end plugs and drain relief valves.
- C. Level Test: Flood tanks with clean water to top of dome diffusers. Check level of diffusers to verify same elevation within +1/8-inch (3 mm).
- D. Leakage Tests:
 - 1. Introduce clear water into the basin after cleaning and completion of installation.
 - 2. Admit compressed air to the system when diffusers covered by about 2 inches (50 mm) of water.
 - 3. Inspect all piping for leakage and make necessary repairs.
 - 4. Demonstrate a watertight system to the satisfaction of [**Engineer**][**CM**].

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

SECTION 16050

ELECTRICAL WORK - GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete and operational systems for the electric power system modifications indicated. Provide all associated work including grounding systems and other specified systems, including the demolition and installation and wiring of raceways, wiring and miscellaneous equipment and devices. Perform all work and testing as indicated and specified.
1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.
 2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system. Perform work at the convenience of the Owner.
 3. Electrically powered equipment and devices provided under other divisions and sections of the specifications are connected to the project specified electrical systems as part of the Electrical Work. Refer to Paragraph 1.02 - Related Work.
- B. Perform the following work
1. Demolish raceways and wiring as indicated for existing reaeration blowers M-5-1-1 and M-5-1-2 rated 60 Hp each along with motor capacitors
 2. Provide raceways and wiring as indicated for the two new 125 Hp blowers and self-contained VFDs
 3. Demolish raceways and wiring associated with TSH-5-1-1, TSH-5-1-2, FCV-5-1-1, FCV-5-1-2, FV-1-11 along with ZS-5-1-1, and FV-1-21 along with ZS-5-1-2.
 4. Provide raceways and wiring to support remote Reaeration Blower start/stop control at existing control switches at the existing Control Panel ACP-1 in the electrical room.
 5. Provide all work at support remote valve(s) operation from the existing control switches at Control Panel ACP-1.

6. Disable existing reaeration blower motor starter control within MCC-7A and MCC-7B starter cubicles.
 7. Replace existing blower motor starters with new 250 Amp molded case circuit breakers as indicated on contract drawings.
 8. Demolish the existing 480V power raceways and wiring from each of the two demolished reaeration blower to its respective MCC; provide new 480V power raceways and wiring from each new reaeration blower to its respective MCC.
 9. Provide core drills through structures where required. Fire stop and seal all openings in structures that result from the work indicated.
- C. Provide complete and operational systems for the electric power system modifications indicated. Provide all associated work including grounding systems and other specified systems, including the demolition and installation and wiring of raceways, wiring and miscellaneous equipment and devices. Perform all work and testing as indicated and specified.
1. Provide conduit, wiring and connections for power, control, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.
 2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system. Perform work at the convenience of the Owner.
 3. Electrically powered equipment and devices provided under other divisions and sections of the specifications are connected to the project specified electrical systems as part of the Electrical Work. Refer to Paragraph 1.02 - Related Work.

1.02 RELATED WORK:

- A. Division 11: Equipment
- B. Variable frequency drive (VFD) units shall be furnished, installed, and tested by the driven equipment supplier (pump, fan, etc.). All associated conduit, wire, and terminations of the VFD units shall be provided under the electrical sections.
- C. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions.
- D. Conduit, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection

equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions.

- E. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract and is specified under this Section. Make equipment schedule for removal free of shock hazard. Coordinate the sequence of demolition with the sequence of construction to maintain facility operation. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of power.
- F. Provide electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment. Make equipment scheduled for relocation free of electrical shock hazard.
- G. Sequencing and Scheduling:
 - 1. Coordinate electrical equipment installation with other building components.
 - 2. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.
 - 3. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 - 4. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work. Coordinate the installation of large equipment requiring position prior to closing in the building.

1.03 SUBMITTALS:

- A. Submit the following in accordance with Specifications:
 - 1. Shop Drawings and Data: Include manufacturer's drawings, bills of material, panel and equipment layouts, catalog data, schematics diagrams, interconnection diagrams, wiring diagrams and other documentary or descriptive information as required for each assembly submitted in one package insofar as possible.
 - a. Bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
 - b. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.

- c. For informational purposes only, submit equipment installation instructions in separate submittals from other shop drawings.
- d. Shop drawings and data are required for the following list:
 - (1) Conduit and Fittings
 - (2) Wire and Cable
 - (3) Grounding Equipment and Devices
 - (4) Control Stations
 - (5) Enclosures
 - (6) Safety Switches
 - (7) 600 Volt Motor Control Center Modifications
 - (8) Field Acceptance Test Reports
 - (9) Record Drawings
- e. Mark shop drawings and data submitted showing only items applicable to specific contract.
- f. Include one-line diagrams, schematic diagrams, wiring diagrams, control sequence diagrams, relay diagrams, and metering. Submit only completed drawings showing all local and remote devices associated with each item. Submit one complete package of shop drawings. Partial submittals will be returned without action.
- g. Submit time-current characteristic curves for all circuit breakers and fuses.
- h. Install permanent nameplates on all devices or pieces of equipment for which use or identification not readily apparent, such as starters, relays, contactors, pushbuttons, indicating lights, and switches. Ensure position of nameplates readable after equipment installation.

1.04 QUALITY ASSURANCE:

- A. Provide in accordance with Specifications.

- B. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and in accordance with requirements of State and Local Codes.

1.05 INTERFERENCE AND ERRONEOUS LOCATIONS:

- A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
- B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.
- C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.
- D. All raceways and equipment installed under Division 16 shall utilize earthquake resistant supporting systems as specifically required in each applicable section.

1.07 APPROVAL AND MARKING EQUIPMENT:

- A. Insure that devices and materials are listed and/or labeled by Underwriters' Laboratories, Inc., wherever standards have been established by that agency. Where Underwriters' Laboratories listing is not available for equipment, submit certified test reports of Nationally Recognized Testing Laboratory, approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.
- B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.08 EQUIPMENT SPECIFIED ELSEWHERE:

- A. Certain items of control equipment and other equipment are indicated on electrical drawings for connection, but are specified in other sections pertaining to plumbing, heating, ventilating and air conditioning, mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

1.09 ARC FLASH HAZARD ANALYSIS:

- A. Provide each blower control panel and MCC cabinet door with an arc flash label in accordance with NFPA 70E – Standard for Electrical Safety in the Workplace and the National Electrical Code.
- B. For the arc flash calculation, utilize the available fault current indicated at the upstream motor control centers as the fault current available at each blower control panel and

breaker.

- C. Submit arc flash labels and the method of calculation utilized to determine values for review prior to installing in the field. Document the available fault current and circuit breaker TCC curves and include within the submittal for review.

PART 2 - PRODUCTS

2.01 ELECTRICAL EQUIPMENT:

- 1. Submit shop drawings in accordance with each Division 16 Specification section.

PART 3 - EXECUTION

3.01 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT:

- A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, boxes, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.
- B. Remove from site and dispose of material and equipment not indicated for reuse.

3.02 WORK IN EXISTING STRUCTURES:

- A. Each bidder or authorized representative shall, before preparing their proposal, visit all areas of the existing structures in which work under this bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.
- B. In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the drawings or as required for the proper execution of the work.
- C. In each area of the work, disconnect and carefully remove the existing electrical equipment and devices so noted. With the exception of items indicated as having to be re-used, all such existing equipment and device shall be turned over to the Owner. If not required by the Owner, remove them from the premises and site. All existing electrical equipment and devices indicated as not removed or abandoned are to be maintained in operation and any circuits disturbed by the construction shall be restored.
- D. Maintain existing electrical services and systems to and in the buildings throughout the project and all "down-time" shall be scheduled at least two weeks in advance with the permission of the Engineer and such scheduling shall be rigidly adhered to.

3.03 DEMOLITION:

- A. Survey the existing electrical systems and equipment identified for removal and representative from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.
- B. Where a piece of equipment is to be removed all associated ancillary components (e.g. solenoid valves, pressure switches, etc) and associated wiring and conduit shall also be removed.
- C. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.
- D. Equipment scheduled to be turned over to the Owner shall be carefully disconnected, removed and delivered to the Owner where indicated. Provide labor, hoisting and transportation of the equipment. All other miscellaneous electrical materials, devices, etc., associated with the equipment being turned over shall be demolished and removed from the site.
- E. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.
- F. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to point of concealment including abandoned circuit above accessible ceiling finishes. Removed unused wiring back to source (or nearest point of usage).
- G. Disconnect abandoned outlets and removed devices. Removed abandoned outlets if conduit services them is abandoned or being removed. Provide blank covers for abandoned outlets which are not removed.
- H. Disconnect and remove abandoned panelboards, disconnect switches, control stations, distribution equipment, etc.
- I. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

- L. Coordinate electrical power outages to the electrical systems and equipment with the Owner. Where duration of proposed outage cannot be allowed by the Owner, phase the retrofit work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the Owner or provide temporary power connections as required to maintain service to the systems or equipment. The temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity.
- M. Continuous service is required on all circuits and outlets affected by these changes, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.
- N. The electrical and process equipment to be removed or relocated under this contract has been identified on the Drawings. The removal and or relocated of existing conduit, wire and equipment have not been detailed on the Drawings. Survey the affected equipment and building areas before submitting bid proposal.
- O. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removed work as required for a complete operating and safe system.
- P. Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide blank covers for abandoned outlets which are removed.
- Q. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc. furnished and installed to the temporarily keep circuits energized shall be removed when the permanent installation is fully operational.

3.04 PROTECTION OF ELECTRICAL EQUIPMENT:

- A. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction. Do not store equipment outdoors. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.05 DEFECTIVE OR DAMAGED EQUIPMENT:

- A. Thoroughly dry out equipment or material subjected to possible water damage, and put through special dielectric test as directed, without additional cost to Owner.

3.06 EQUIPMENT ENCLOSURE:

- A. The equipment enclosure classification requirements are indicated in the specification sections and drawings. Provide all equipment, devices and material meeting these requirements unless otherwise noted or specified.

3.07 DRAWINGS AND SPECIFICATIONS:

- A. Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.
 - 1. At the completion of the project, provide two sets of drawings that are marked to show the as-installed equipment, devices, and wiring. These sets are to be provided to the Owner. The markings on the drawings are to be neat, clean and legible.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 16110

ELECTRICAL RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide complete raceway systems, with matching accessories, fittings, boxes, and other hardware, as indicated and specified. When non-metallic raceway systems are specified, provide green insulated grounding conductor sized per NEC requirements.
- B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.
- C. Provide raceway systems in accordance with the following:
 - 1. In NEMA 12 or NEMA 1 areas, use galvanized rigid steel raceway systems.
 - 2. In NEMA 4 areas, and where subject to wetting or wash down, use galvanized rigid steel raceway systems.
 - 3. In exterior building applications, use PVC coated rigid steel raceway systems.
 - 4. In areas designated NEMA 4X, use PVC coated rigid steel raceway systems.
- D. All raceway systems shall be installed in accordance with the criteria described in this section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.
 - 1. Use Type 316 stainless steel support systems for exterior application and in NEMA 4 and NEMA 4X areas.
 - 2. All NEMA 1 and NEMA 12 areas shall use hot dipped galvanized steel support systems.
- E. Aluminum conduit and boxes are not acceptable products.

- F. All raceways shall be supported to National Electrical Code requirements and to meet all applicable seismic criteria. Raceways 2-in. [50 mm] outside diameter or greater shall be independently supported in a manner to meet the criteria to resist failure during earthquake events. All hardware supports shall be specifically designed for the magnitude of the earthquake event as defined in Section 16050.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. National Fire Protection Association (NFPA):

- 1. National Electrical Code (NEC)

- B. Underwriter's Laboratories, Inc. (UL):

- 1. U.L.-1: Electrical Flexible Metal Conduit
- 2. U.L.-6: Rigid Metal Electrical Conduit
- 3. U.L.-360: Electrical Liquid-Tight Flexible Steel
- 4. U.L.-651: Schedule 40 and 80 PVC Conduit
- 5. U.L.-886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C, and D and Class 11, Groups E, F, and G
- 6. U.L.-1242: Intermediate Metal Conduit

- C. National Electrical Manufacturers Association (NEMA):

- 1. RN-1: Polyvinylchloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
- 2. TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

1.04 SUBMITTALS:

- A. Submit the following in accordance with Specifications:

1. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 16050.

1.05 QUALITY ASSURANCE:

- A. Provide in accordance as specified.

1.06 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements as specified in Section 01900.
- B. It shall be the responsibility of manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.
- C. Install supports for raceway systems greater than 2 inches [50 mm] in diameter to meet the seismic requirements indicated and specified.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S:

- A. Rigid Metal Conduit, intermediate metal conduit and polyvinylchloride-coated rigid steel conduit.
 1. Triangle/PWC, Inc.
 2. Perma-Cote Industries.
 3. Republic Steel Corporation.
 4. Robroy Industries.
 5. Allied Tube and Conduit.
 6. Or acceptable equivalent product.
- B. Polyvinylchloride (PVC) Conduit:
 1. Triangle/PWC, Inc.
 2. Robroy Industries.
 3. Carlon Electrical Sciences, Inc.

4. Or acceptable equivalent product.

C. Flexible Conduit:

1. American Flexible Conduit Company.
2. Anamet, Inc.
3. Electri-Flex Company.
4. International Metal Hose Company.
5. Or acceptable equivalent product.

D. Boxes and Fittings:

1. O.Z./Gedney Company.
2. Crouse-Hinds Electrical Construction Materials.
3. Appleton Electric Company.
4. Or acceptable equivalent product.

E. Fiberglass-Reinforced Polyester Boxes:

1. Crouse-Hinds Electrical Construction Materials.
2. Fibox.
3. Hoffman Engineering Company.
4. Vynckier Enclosure Systems.
5. Or acceptable equivalent product.

F. Support Systems:

1. Michigan Hanger Co., (O-Strut).
2. Thomas & Betts (Superstrut).
3. Unistrut Corp.

4. Or acceptable equivalent product.

2.02 MATERIALS AND COMPONENTS:

A. Rigid Metal Conduit:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.
2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to U.L.-6.

B. Flexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to U.L.-1.
2. Provide liquid-tight flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. Provide stainless steel, braided flexible conduit in NEMA 4X, corrosive areas. On larger than 1-1/4-in. [30 mm], furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to U.L.-360.

C. Polyvinylchloride-Coated Rigid Steel Conduit:

1. Provide polyvinylchloride-coated (PVC-Coated), rigid steel conduit conforming to NEMA Standard RN-1 consisting of hot-dipped galvanized rigid steel conduit, as specified hereinbefore, with a polyvinylchloride jacket bonded to the outside of all conduit surfaces with a nominal thickness of 40 mils meeting the requirements of NEMA RN-1, 3.1. The adhesive strength of the bonding to equal or exceed tensile strength of the coating. Provide couplings and fittings for this conduit conforming to the requirements of NEMA RN-1, 3.5.
2. A two-part urethane coating shall be applied to the interior of all conduit and fittings at a two mil thickness. The interior coating shall be flexible to allow field bending without cracking or flaking.

D. Boxes:

1. In NEMA and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box as required by the NEC.
2. Provide boxes containing fixture studs for hanging fixtures. Use concrete-tight boxes for installation in concrete. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.
3. Provide outlet boxes and fittings for hazardous locations conforming to U.L.-886 for class, group, and division indicated.
4. Provide boxes and covers for polyvinylchloride-coated steel conduit made of (fiberglass reinforced resin) (galvanized cast iron, with a polyvinylchloride factory-applied coating over the galvanizing. Provide coating thickness of 40- mil minimum.) Boxes shall have hubs with extruded sleeves extending beyond the hub in the same manner as specified for conduit couplings. Provide cover screws of stainless steel.
5. Provide cast boxes with covers or device plates suitable for the area classification. Use cover screws of stainless steel or high brass for iron boxes.
6. Provide polyvinylchloride boxes for use as junction boxes and provide high impact strength fiberglass-reinforced polyester boxes for use as device boxes, pull boxes, and terminal boxes for use with polyvinylchloride conduit. Size each box as required by the National Electrical Code.
7. Provide pull boxes below motor control center installations (20 inches [50 cm] by 20 inches [50 cm] by 12 inches [30 cm] deep minimum.) Boxes of dimensions 10 inches [250 cm] by 10 inches [250 cm] by 6 inches [15 cm] deep and larger shall be hung from ceilings constructed of angle or channel frames, and shall be made of sheet metal with welded joints. All welds shall be ground smooth. Provide neoprene gaskets for complete sealing. Sectionalize covers longer than 36-in. [90 cm] to facilitate handling and gasket sectionalized covers where covers meet, using angle iron or channel cross members at the joint. Sheet metal shall be not less than No. 12-gauge galvanized sheet steel. Fabricate interior angles and supports of galvanized steel. Provide each box with a grounding lug for connection to the nearest ground bus. Current capacity of ground lug shall be at least that required by the National Electrical Code for the largest feeder entering the equipment.
8. Construct telephone cabinets of 14-gauge galvanized steel with a hinged, lockable, flush door and handle mechanism. Provide backboard of 3/4-in.

[20 mm] x 4 ft. [1.2 m] x 8 ft. [2.4 m] exterior grade plywood behind the cabinet. Cabinet sizes and locations shall be as indicated on the drawings and required by the telephone company. Furnish and install specific telephone cabinet termination materials as directed by the telephone company.

E. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.
2. Provide suitable expansion fittings where conduits cross expansion joints. Equip these fittings with grounding straps, clamps, and copper bonding jumpers.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Perform all work in accordance with the National Electric Code.
- B. Use no conduit less than 3/4-in. [20 mm] in diameter, unless otherwise indicated.
- C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's printed instructions.

3.02 SEISMIC RESTRAINTS:

- A. For conduits and other raceways installed in open areas, not adjacent to and secured to structural elements, and 2-in. [50 mm] outside diameter or greater, support such raceways using seismic restraints rated for the applicable project earthquake criteria.
- B. Methods of Restraining Raceways:
 1. Utilize threaded rod with rod stiffeners and transverse channel braces at approximately 45 degrees angle, at 15-ft. [4.5 m] on center, maximum, and on one side of rod support.
 2. Utilize longitudinal bracing with channel braces at 30 feet [9.1 m] on center, maximum.
 3. Strap raceways directly to transverse channel braces, using pipe strap with both ends of strap bolted into the channel brace.

4. Do not rigidly brace raceways to different parts of a building that may respond differently during an earthquake. Seismic restraints shall not limit expansion and contraction of the raceway support system.
5. Provide flexible connections for conduits 2-in. [50 mm] outside diameter or greater than when terminating to fixed equipment to prevent loss of raceway integrity in the event of an earthquake.

3.03 INSTALLATION OF FITTINGS:

- A. Install expansion fittings wherever conduits cross structural expansion joints. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.
- B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.
- C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.
- D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 awg. Install ground wire larger than 12 gauge when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires No. 6 Awg. copper or larger.
- E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.
- F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.
- G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.
3. Tighten set screws of threadless fittings with suitable tool.

3.04 INSTALLATION OF RACEWAYS:

- A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with listed bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by hangers and fasteners. Ground raceways by connection to properly grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.
 1. Run parallel or banked raceways together, on common supports where practical.
 2. Install raceways level and square and at proper elevations. Provide minimum 7 ft. [2 m] headroom.
- B. Support raceways concealed above suspended ceilings from slab above ceiling in same manner as exposed raceways. Do not support raceways from ceiling supports.
- C. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, and conduit supports. Provide Type 316 stainless steel nut, bolts, and washers, for use with concrete anchors.
- D. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet [3 m] on centers.
- E. Provide hot-dipped galvanized supports for galvanized conduit.
- F. When specified on the Contract Drawings, install conduits in slabs as close to middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with outside diameter exceeding one-third of slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where slab thickness is increased as permitted by Engineer.

- G. Where conduits are concealed in bottom floor slab, place in concrete slab and not in fill below slab. Install in middle third of the slab thickness where practical, and leave at least 4 inches [100 mm] of concrete cover.
1. Secure raceways to reinforcing rods and to prevent sagging or shifting during concrete placement.
 2. Space raceways laterally to prevent voids in the concrete.
 3. Run conduit larger than 1-inch [25 mm] trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.
- H. 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 steel conduit. Flexible metal conduit may be used 6 inches [150 mm] above the floor. Where equipment connections are not made under this Contract, terminate ends of floor conduits installed for future use with couplings and readily removable plugs 8-in. [250 mm] above finished floor surface. Cap spare wall conduits at wall entrance to building.
- I. Provide sleeves passing through exterior walls and slabs which are wall entrance seals of watertight construction. For new construction, furnish watertight seal between slab and sleeve, and between sleeve and conduit or cable similar to O.Z./Gedney Type "FSK". For existing construction, furnish watertight seal for use in core bit drilled holes that provides seal between concrete and conduit or cable similar to O.Z./Gedney Type "CSM1". Use wall-entrance seals of malleable iron with watertight sealing gland which may be tightened any time after installation.
- J. Do not use dissimilar metals in conjunction with each other. Use an insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.
- K. Install fittings to match raceway being used.
- L. Install expansion fittings wherever conduits cross structural expansion joints at connections between buildings. Keep fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

- M. Where conduits pass through firewalls, grout hole around the conduit to the full depth of the material penetrated.
- N. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.
- O. 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; use two locknuts, one inside and one outside the box.
- P. 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 nipple so no threads are exposed.
- Q. Install pull wires in all empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb. tensile strength. Leave not less than 12 inches [300 mm] of slack at each end of the pull wire.
- R. Keep raceways at least 6 inches [150 mm] away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.
- S. Complete raceway installation before beginning conductor installation.
- T. Use temporary closures to prevent foreign matter from entering raceway.
- U. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- V. Where metal conduits rise through floor slabs in wet areas, coat conduits for a distance of 6 inches [150 mm] above and below slab grade with brush coat of waterproof bituminous cement.

3.05 BENDS:

- A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit shall have an inside radius of not less than nine diameters.
- B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.

- C. Allow no conduit greater than 50 feet [15.2 meters] to have more than two 90 degree bends or equivalent thereof between pulling points. For conduits less than 50 feet [15.2 meters] in length, allow only three 90 degree bends between pulling points.

3.06 CUTTING, THREADING AND CONNECTING:

- A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with N.E.C.. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

3.07 CONDUIT CLEANING:

- A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.
- B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.
- C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.
- D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

3.08 CONDUIT DRAINAGE:

- A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with drain hole at low point.

3.09 INSTALLATION OF BOXES:

- A. Unless otherwise indicated, install sheet metal boxes only in dry, accessible locations. Install cast-metal boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Cast metal boxes shall be used (unless otherwise indicated) where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use. Install pull boxes for motor control centers and large ceiling hung boxes where indicated.

- B. Install boxes in conformance with all the requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.
- C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.
- D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels of suitable size. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls, appropriate for type of construction being used.
- E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.
- F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

3.10 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT:

- A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.
- B. Install the conduits in locations permitting direct connection to motors.
- C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection.
- D. Install flexible metal conduit, fittings, and accessories in dry areas in accordance with requirements of NEC.
- E. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets.

- F. Use maximum of 6 feet [2 m] of flexible conduit for recessed and semirecessed lighting fixtures and; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install liquid-tight flexible metal conduit in areas subject to wetting due to fire protection sprinklers or broken or ruptured water line. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

3.11 PROTECTION:

- A. Provide protection and install in accordance with manufacturer printed instructions. The conduit and raceway equipment manufacturers, to ensure that coatings, finishes, and enclosures are without damage or deterioration at completion of project.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.12 FINAL SYSTEM ACCEPTANCE:

- A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and at no additional cost to the Owner.
- B. Label all raceways and boxes in accordance with the requirements of Section 16050.

3.13 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 16120

ELECTRIC WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide wires and cables for complete electrical systems as indicated and specified.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. American Society for Testing and Materials (ASTM):
 - 1. B3: Soft or Annealed Copper Wire.
 - 2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 3. B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA-70: National Electrical Code (NEC).
- C. Underwriters Laboratories, Inc. (UL):
 - 1. U.L. 44: Thermoset-Insulated Wires and Cables
 - 2. U.L. 83: Thermoplastic-Insulated Wires and Cables
 - 3. U.L. 854: Service Entrance Cables Wires and Cables
- D. Insulated Cables Engineers Association, Inc. (ICEA)/National Electrical Mfg's Association (NEMA):
 - 1. ICEA S-61-4021/WC 5: Thermoplastic Insulated Wire & Cable.
 - 2. ICEA S-66-524/NEMA WC7; Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable

3. ICEA S-68-516/WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

E. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA):

1. ANSI/TIA/EIA-568-B; Commercial Building Telecommunications Cabling Standards.

1.04 SUBMITTALS:

A. Submit the following in accordance with Specifications:

1. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 16050.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 600V Cable:

1. Okonite.
2. Southwire.
3. American Insulated Wire.
4. Or acceptable equivalent product.

B. Control and Metering Wire:

1. Belden Wire and Cable.
2. Alpha Wire.
3. Coleman Cable.
4. Or acceptable equivalent product.

C. Cable Fireproofing Tape:

1. MAC Products, Inc.
2. 3M Electrical Products.
3. Or acceptable equivalent product.

2.02 MATERIALS AND COMPONENTS:

- A. Furnish copper conductors. Material and stranding of conductors to conform to ASTM B3, ASTM B33, and to ASTM B8, for the appropriate class.
- B. Uncoated, soft or annealed copper wire conforming to ASTM B3.
- C. Wires and Cables for Maximum 600-Volt Power Circuits: For No. 8 AWG gauge and smaller provide type THWN/THHN. Where used in lighting or receptacle branch circuits provide No. 12 AWG gauge and No. 10 AWG gauge as solid conductor. Provide other wire with Class C stranding. Provide No. 6 AWG gauge and larger as XHHW-2 with Class B stranding. Provide wires and cable conforming to UL 83.
- D. Wires and Cables for Control, Indicating, Metering, or Alarm Circuits: Single and multi-conductor control cable, copper conductors, Class B or C stranding. Insulation; 600-volt polyethylene, polyvinylchloride, or EPR. Continuous rating of 90C dry and 75C wet. Color coding conforming to Table K-2, NEMA Standard WC-5.
- E. Shielded Cable for Instrumentation Wiring: 7-strand copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinylchloride. Twist pairs with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket: polyvinylchloride. Cables: rated 600 volts and 90 degrees C.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Perform work in accordance with the National Electrical Code.
- B. Provide power cable identification as follows:

<u>System Voltage</u>	<u>Neutral</u>	<u>Phase A</u>	<u>Phase B</u>	<u>Phase C</u>
208/120V	White	Black	Red	Blue
240/120V	White- Gray Stripe	Black- Blue Stripe	Red- Blue Stripe	None
480/277V	Gray	Brown	Orange	Yellow

- C. Use green to identify insulated ground conductors.

NOTE: Colored insulation, tapes or sleeves may be used to provide color coding. Insulated ground conductors must have green covering.

- D. Permanently identify each grounded and ungrounded conductor for each nominal voltage system at each panelboard, switchboard and motor control center.

3.02 INSTALLATION OF WIRING:

- A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.
- B. Number and sizes of wires and conduits indicated are a guide only and are not necessarily correct for the actual equipment installed. Install as many wires and conduits as necessary for complete electrical system, and provide adequately for the equipment actually installed.
- C. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.
- D. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.
- E. Draw all conductors contained within a single conduit at the same time.
- F. Apply wire pulling compound to conductors being drawn through conduits. Use pulling compound, Minerallac No. 100, Y-er-Eas, Yellow 77, High Performance Polywater Cable Lubricant or acceptable equivalent.
- G. Use no cable bend with radius of less than eight times its diameter.
- H. Wires and cables installed without prior submittal review are subject to removal at no additional expense.

3.04 CONDUCTOR IDENTIFICATION:

- A. Label each wire at both termination points. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.
- B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, self-adhesive, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.
- C. In cases similar to above where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.

- D. In manholes and handholes, identify each power wire by laminated plastic tag located so it is easily seen. Control wires to be bundled and marked as listed in conduit and wire schedule.

3.05 CONNECTORS, TERMINAL LUGS AND BOARDS:

- A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, use self-insulated pressure type connectors for all splices or joints.
- B. Terminate all wires connected to terminal boards, terminal blocks, or to other similar terminals by means of ring and tongue, nylon self-insulated, tin-plated copper pressure terminals.
- C. Terminal boards shall be 600 volts and rated for 125% of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type, as necessary.
- D. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:
 - 1. 10AWG and smaller: Use self insulated pressure-type connectors.
 - 2. 8AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.
- E. Clearly and permanently mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams wherever possible.

3.06 TESTING:

- A. Perform tests of all cables prior to energizing in accordance with Section 16999.
- B. Submit results of all cable tests on forms indicating cable size, voltage, from, the and date with name of tester and witness.

3.07 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Upon completion of all work, verify installation of a single, complete, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the National Electrical Code Article 250 and the National Electrical Safety Code.
- B. Check grounding of motor control centers, electric equipment enclosures etc.; ground grid systems with ground rod and water pipe connections; structural steel, and lightning protection system.
- C. Include grounding conductors completely inter-connecting water supply pipe, ground rods, ground grid, substation, switchgear and motor control center ground buses, other distribution equipment, and other groundable equipment.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):
 - 1. ANSI/IEEE C2: National Electrical Safety Code.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA-70: National Electric Code.
 - 2. NFPA-780: Lightning Protection Code.
- C. ASTM International (ASTM)
 - 1. ASTM B3: Standard Specification for Soft or Annealed Copper Wire.
 - 2. ASTM B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. ASTM B33: Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

D. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE Standard 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System.

E. Underwriters Laboratories (UL):

1. UL 467: Standard for Grounding and Bonding Equipment.

1.04 SUBMITTALS:

A. Submit the following in accordance with Specifications:

1. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 16050.
2. Submit catalog and dimensional data for the following:
 - a. Ground rods
 - b. Exothermic welding
 - c. Connecting hardware
3. Submit grounding system test results.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

- A. Manufacturer's acceptance contingent upon products' compliance with the specifications.

2.02 MANUFACTURERS:

A. Ground Rods:

1. ERICO Products Inc.
2. Galvan Electrical Products
3. Nehring Electrical Works
4. Or an acceptable equivalent product.

B. Exothermic Welding:

1. ERICO Products, Inc.
2. American Brass Mfg. Co.
3. Orgo-Thermit, Inc.
4. Or an acceptable equivalent product.

C. Connecting Hardware:

1. American Brass Mfg. Co.
2. Thomas and Betts
3. Anderson Electric Corp.
4. Or an acceptable equivalent product.

2.03 MATERIALS AND COMPONENTS:

A. Conductors:

1. Provide copper grounding conductors bare or insulated, sized as indicated. When not indicated on the drawing provide in accordance with the NEC. Provide protection of conductors in locations where physical damage would result from direct exposure.
2. Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B 3, stranded, with 98 percent conductivity.
3. Equipment ground conductors run with circuit conductors and grounding electrode conductor shall be 600 volt with green insulation, unless noted otherwise on the Contract documents.
4. Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8.
 - a. Uninsulated conductors shall be bare copper in accordance with ASTM B3, tinned in accordance with ASTM B33.
 - b. Use tinned-coated in corrosive environments including when buried in earth or embedded in concrete.

PART 3 - EXECUTION

3.01 EXOTHERMIC WELDING:

- A. Welding shall be by the exothermic process.
- B. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.
- C. Welding processes shall be the exothermic fusion type that will make a connection without corroding or loosening.
- D. The welding process shall join all strands and not cause the parts to be damaged or weakened.
- E. Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.
- F. Paint buried ground connection with a bitumastic paint.

3.02 INSTALLATION OF GROUNDING CONDUCTORS:

- A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.
- B. Run grounding conductors associated with direct burial cables in common trenches above or if indicated beside cables.
- C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.
- D. Where raceways are used to contain and protect grounding conductors, install in accordance with Sections 16110.
- E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.
- F. Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.
- G. Connect structural steel to the external perimeter loop of grounding conductors installed around all sides of building foundation, buried at least 30 inches below grade. Connect to

each vertical column by loop or tap. Connect two opposite points on external loop to two different points on grounding system.

- H. Buried and concealed ground connections shall use exothermic welding.
- I. Make accessible connections to structural members by exothermic welding process or by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.03 EQUIPMENT GROUNDING:

- A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600-volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.
- B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.
- C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, motor control centers, switchboards and all outdoor substation and transformer equipment. Ensure that each connection for item of equipment is from different section of ground grid.
- D. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.
- E. Conduits entering metal enclosures shall utilize bonding type locknuts and grounding bushings. Locknuts that gauge into the metal enclosures are not acceptable.
- F. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run. Conduit connections shall be wrench tight.
- G. Install a separate grounding conductor from ground system to motors of 100 hp. and larger, in addition to raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.
- H. Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system. Mount ground bus on 600v pedestal insulators.
- I. Connect lightning arresters to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not

inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

- J. Connect generator neutral to grounding system by a grounding conductor. Connect grounding conductor to generator disconnect enclosure and generator neutral on generator side of disconnect. Ground generator frame with two separate independent connections, so removal of one connection will not impair continuity of other.
- K. Ground each street lighting standard by ground rod driven near base of standard, in accordance with requirements of National Electric Safety Code. Connect ground rods to grounding conductor brought with street lighting feeder cable.
- L. Ground transformers, lightning arresters, insulators and other appurtenances, installed on poles, poles and timber structures, or metal structure. Run grounding conductors between poles or structure and ground rods. Protect grounding conductor by molding applied for at least 8 ft. above ground, with both molding and conductor stapled. Install ground rod where indicated, and driven until top of rod is 1 ft. below ground.
- M. Ground wire fences when used to enclose electrical equipment or when overhead electrical lines cross fence. Unless otherwise indicated, provide grounding by buried outside peripheral ground loop; connections to each corner fence post and nearby ground rod; flexible connections to each gate; and at least two connections to grounding system from approximately opposite positions on fence.
- N. Connect individual ground rods to the grounding loop using the direct burial grounding cable.
- O. Bond individual cable tray sections with bonding jumpers.

3.04 SIGNAL GROUNDING:

- A. Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.
- B. Where convenient several signal bonding conductors may be combined, providing that all the following conditions are met:
 - 1. The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.

2. The combined signal bonding conductor shall be isolated from the equipment grounding conductor.
3. Where two signal bonding conductors are combined use a three port insulated splice.
4. Where three or more signal bonding conductors are combined, use a copper bus mounted on 600V insulators. Attach each conductors to the bus using an insulated ring tongue lug and screw terminal.

3.05 TESTS AND CHECKOUTS:

- A. Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 5 ohms.
- B. Ground resistance and counterpoise tests must be made during dry weather, and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.
- C. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.
- D. Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.
- E. Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE Standard 81.
- F. Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.
- G. Furnish copies of test reports on ground system.

3.08 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 16900

ELECTRICAL CONTROLS AND MISCELLANEOUS ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Provide and connect the electrical control equipment and miscellaneous electrical equipment, including such instruments and devices indicated and specified. Device enclosures for electrical equipment as indicated and specified.
- B. Control panel enclosures and devices specified herein are provided under those specification sections which invoke this section for control panel requirements or as indicated on electrical drawings.

1.02 RELATED WORK:

- A. Section 16050: Electrical Work - General

1.03 REFERENCES:

- A. Underwriter's Laboratories, Inc. (U.L.):
 - 1. UL-467: UL Standard for Safety, Grounding and Bonding Equipment.
 - 2. UL-489: UL Standard for Safety, Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
 - 3. UL-823: Electrical Heaters for Use in Hazardous (Classified) Locations.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. 250: Enclosures for Electrical Equipment (1000 volts maximum).
 - 2. ICS 1: General Standards for Industrial Control and Systems.
 - 3. ICS 2: Industrial Control Devices, Controllers and Assemblies.
 - 4. ICS 4: Terminal Blocks for Industrial Use.
- C. American Society for Testing and Materials (ASTM) Publications:
 - 1. D 178: Specification for Rubber Insulating Matting.

D. National Fire Protection Association (NFPA):

1. NFPA-70 National Electric Code (NEC).

1.04 SUBMITTALS:

A. Submit the following in accordance with Specifications:

1. Submit shop drawings and manufacturer's product data, brochures including wiring diagrams in accordance with Section 16050.
2. Wiring diagrams to show control interface points provided with other equipment.
3. Shop drawings to include:
 - a. Outline drawings with elevations.
 - b. Equipment arrangement drawings.
 - c. Anchor bolt location drawings.
 - d. Electrical schematics and wiring diagrams.
 - e. Electrical fuse/circuit breaker characteristic.
 - f. Equipment performance curves and data.
 - g. Bill of installation/assembly materials.
 - h. Equipment weights.
 - i. Completed manufacturer's data sheets.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Specifications.

PART 2 - PRODUCTS

2.01 ELECTRICAL DISTRIBUTION MANUFACTURERS:

- A. Siemens.
- B. General Electric Company.

- C. Cutler-Hammer.
- D. Square D Company.
- E. Appleton Electric Company.
- F. Crouse-Hinds Company.
- G. O-Z/Gedney.
- H. Or acceptable equivalent product.

2.02 STAINLESS STEEL/GALVANIZED STEEL CHANNEL MANUFACTURERS:

- A. Unistrut Corp.
- B. Power-Strut.
- C. B-Line Systems, Inc.
- D. Or acceptable equivalent product.

2.03 FIBERGLASS CHANNEL MANUFACTURER:

- A. Omnistrut, Champion Fiberglass.
- B. Durostrut, Enduro Composite Systems.
- C. Struttech, Entrum Industries.
- D. Or acceptable equivalent product.

2.04 SAFETY DISCONNECT SWITCHES:

- A. Provide heavy duty type, safety switches, with external operating handles, 3 PST, rated 600 volt, 60 Hertz with ampere rating as indicated, and having provisions for padlocking.
- B. Provide fuses for safety switches as indicated.
- C. Heavy duty safety switches to be UL listed, File E 2875 and 154828, and meet or exceed NEMA Standard KS1.
- D. Provide auxiliary electrical interlocks for motor heaters or other motor control circuits, including auto-transformer starter, starter control where indicated.

2.05 PUSHBUTTON AND SELECTOR SWITCH STATIONS:

- A. Provide HAND-OFF-AUTO switches, push buttons, tumbler switches and other accessory devices as necessary for the control of motors and other electrical equipment or devices.
- B. Provide pushbutton and selector switch stations designed for heavy-duty service and with momentary or maintaining contacts as indicated or as necessary for starting and stopping of equipment with 10 amp contact ratings.
- C. Provide heavy duty switches and pushbuttons, Square D Class 9001, or approved equal. Indicating lights to be led cluster type.
- D. At stations provide nameplates with white letters on black background.
- E. Provide safety lockout station with position indication located near motor to prevent application of current. Where pumps are located on lower levels than driving motors, furnish safety lockout station near each pump or other item of equipment.
- F. Rate explosion-proof stations for the Group, Division and Class as indicated.
- G. Provide galvanized cast-iron enclosures for NEMA Type 4 watertight stations.
- H. Provide fiberglass reinforced polyester NEMA Type 4X enclosures for stations located in highly corrosive areas. Provide gaskets and Type 316 stainless steel screws, to prevent entry of chemicals.

2.06 CIRCUIT BREAKERS:

- A. Provide manually operated circuit breakers, ambient-compensated, providing thermal magnetic inverse time-limit overload and instantaneous short circuit protection. Provide overload protection on all poles; trip settings as indicated.
- B. Provide breakers that are rated 480 volt alternating current; 3 PST or 2 PST, have 100-amp. or larger frames, with matching interrupting rating of the MCC at 480 volts.
- C. Provide time-current characteristic curves for each size of circuit breaker furnished.
- D. Install circuit breakers as indicated, having external operating handles with provisions for padlocking.

2.07 NAMEPLATES:

- A. Provide nameplates for equipment (including pushbutton and selector switch stations) listed in this section and other controls furnished under this contract, to designate the equipment controlled and their function.
- B. Nameplates shall be laminated black bakelite with one-quarter inch (1/4-in.) high, white, recessed letters. Securely attach to the equipment with Type 316 stainless steel screws, or rivets. Adhesives, glue or cements will not be permitted.
- C. Provide all junction boxes, pull boxes, disconnect switches and control panels with a nameplate to designate the system wiring contained within.
- D. Install nameplates in a location near or on the equipment or devices.

2.08 CHANNEL:

- A. Provide Type 316 stainless steel channel or fiberglass channel with corresponding accessories.
- B. Provide hot-dipped galvanized after fabrication for steel channel and accessories.
- C. Provide channel of the proper material to match equipment classifications.

PART 3 - EXECUTION

3.01 WIRING OF MISCELLANEOUS DEVICES:

- A. Make electrical connections required for recording and indicating instruments, and miscellaneous devices. Provide electrical supplies to metering, instrumentation, control, and alarm systems.
- B. Connect HAND-OFF-AUTO switches, safety switches, tumbler switches, and other accessory devices as indicated or necessary for control of motors and other electrical equipment or devices.
- C. Install conduit and wiring and make electrical connections between all instrument panels, consoles, cabinets, and external equipment and devices. Panels, cabinets, etc., are indicated.

3.02 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS:

- A. As specified in Section 16050, install conduit, wiring, and connections for equipment and devices furnished under other Sections of specifications, and as indicated.

3.03 CHANNELS:

- A. Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas and on below grade, outside building and structure walls.
- B. Install galvanized steel channels for interior building mounting of electrical equipment except for those locations listed above and unless otherwise indicated.
- C. Install fiberglass channel in chemical areas with NEMA 4X enclosures.

3.04 CONTRACT CLOSEOUT:

- A. Provide in accordance with Specifications.

END OF SECTION

SECTION 16999

FIELD INSPECTION AND ACCEPTANCE TESTS

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. Provide field inspections and acceptance testing as specified herein.
- B. After electrical installation is complete, (a) adjust and set all protective devices (in accordance) with results of electrical studies, (b) perform tests to demonstrate that the entire system is in working order and in accordance with applicable codes, manufacturer's instructions, drawings and specifications. Test shall be performed per InterNational Electrical Testing Association (NETA): Acceptance Testing Specification for Electrical Power Distribution System and Equipment (STD). Tests are in addition to, and not a substitution for, tests of individual items at the manufacturer's facilities. Perform insulation and ground resistance tests before operating tests. Determine proper rotation of motors before permanent connections are made.
- C. Tests are also intended to accomplish the following:
 - 1. Provide initial acceptance tests and recorded data.
 - 2. Ensure a successful start-up with a minimum of last minute interruptions and problems.
 - 3. Determine the suitability of the equipment and systems for energizing and placing into operating service.
 - 4. Ensure that each system component is installed satisfactorily, will perform and will continue to reliably perform its function.
- D. Provide all necessary supervision, labor, materials, tools, test instruments or other equipment or services and expenses required to test, adjust, set, calibrate, functionally and operationally check all work and components of the various electrical systems and circuitry throughout the installation.
- E. Engage the services of a nationally recognized Independent Electrical Tester to perform the required field inspections, test, and adjustments specified. The Independent Electrical Tester shall meet the following qualifications:
 - 1. The testing firm is not to be a subsidiary, division, or department of the Contractor performing the work of Division 16.

2. The testing firm is not to be subsidiary, division, or department of the manufacturer of the equipment, materials or systems being inspected or tested.
 3. The testing firm shall perform all testing in accordance with International Electrical Testing Association, Inc. (NETA), standards and procedures. All testing results shall be submitted on NETA forms and the testing data shall be certified by a Registered Professional Electrical Engineer. Test results shall indicate recommended action for sub-par test results. Results shall list recommended test values that should be obtained for a new installation.
 4. Testing and checkout work shall be performed with personnel skilled and trained in the particular tests being conducted.
 5. Evidence of the proposed testing firm's qualifications, accreditation, and experience shall be submitted for evaluation. Testing firm shall be member of NETA with minimum of five years of testing industrial electrical systems to NETA requirements and procedures.
- F. The Independent Electrical Testing Contractor shall provide supervision, labor, materials, tools, test instruments, or other equipment, and services, required to adjust, set, calibrate, and test operate the components of the various electrical systems and circuits throughout the installation, the construction package, and as specified herein.
- G. Perform these tests after the electrical installation is complete. These tests shall demonstrate that the entire electrical system is in proper working order and in accordance with: applicable codes; and the supplier's instructions, drawings, and specifications.
- H. Testing by the Independent Electrical Tester in no way changes the requirements to perform the specified tests, checkouts, and inspections required under the equipment specification sections.
- I. The listings and descriptions of the tests, and checks described herein is not to be considered as complete and all inclusive.
- J. Retests required by defects and failures of equipment to meet specifications shall be conducted at no additional cost.
1. Replace wiring and equipment found to be defective, or failing to meet specified requirements, at no additional cost.
 2. Supply electric current necessary for tests.
- K. Where specified in other Division 16 sections, perform work under the supervision of factory trained technicians, representing the equipment being tested or inspected.

1.02 RELATED WORK:

- A. Division 1: General Requirements
- B. Division 16: Electrical

1.03 SUBMITTALS:

- A. Submit the following in accordance with Section 01300:
 - 1. Submit inspection and testing forms for all electrical distribution equipment to be inspected and tested under this section.
 - 2. Submit data sheets for the insulation resistance testing of conductors and motors prior to performing operating testing. List all cables and motors to be tested.
 - 3. Provide space on data sheet forms to enter the results of testing, instruments used with serial numbers, and name of personnel performing testing. This data to be filled out during testing.
 - 4. After completion of the testing, submit all test results with observed notes and recommendations.

1.04 REFERENCES:

- A. All inspections and tests shall be in accordance with the following applicable codes and standards latest revisions except as provided otherwise herein.
 - 1. National Electrical Manufacturer's Association – NEMA
 - 2. American Society for Testing and Materials – ASTM
 - 3. Institute of Electrical and Electronics Engineers – IEEE
 - 4. InterNational Electrical Testing Association – NETA – Acceptance Testing Specification for Electric Power Distribution Equipment and Systems (STD).
 - 5. American National Standards Institute – ANSI:
 - a. ANSI C2: National Electrical Safety Code
 - b. ANSI Z244-1: American National Standard for Personnel Protection
 - 6. State and Local Codes and Ordinances

7. Insulated Cable Engineers Association – ICEA
8. Association of Edison Illuminating Companies – AEIC
9. Occupational Safety and Health Administration:
 - a. OSHA Part 1910; Subpart S, 1910.308
 - b. OSHA Part 1926; Subpart V, 1926.950 through 1926.960
10. National Fire Protection Association – NFPA:
 - a. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - b. NFPA 70E: Electrical Safety Requirements for Employer Workplaces
 - c. ANSI/NFPA 70: National Electrical Code
 - d. ANSI/NFPA 780: Lightning Protection Code
 - e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:

1. Project Design Specifications
2. Project Design Drawings
3. Manufacturer’s instruction manuals applicable to each particular apparatus

1.05 SCHEDULING:

- A. The Contractor is responsible for the preparation of proposed procedures, testing and inspection forms, and schedules for all inspections, tests, settings and calibrations specified or otherwise required prior to or during the check out for start-up and acceptance of all the electrical components, equipment and systems. This work to be coordinated and to be compatible with the work of other crafts and the project schedule. The above must be organized and submitted with all proposed testing and NETA approved check out forms for the review. The procedures must provide specific instructions for the checking and testing of each component in addition to the system functional checks.
- B. Prior to check out and testing for start-up, verify that all equipment and wiring is permanently identified with nameplates and tags. Check and tighten all terminals and connection points, remove all shipping blocks and hardware, thoroughly clean all equipment, repair all damaged or scratched finishes, inspect for broken and missing parts

and review and collect manufacturer's drawings and instructions. Make routine checks and tests as the job progresses to verify that all wiring and equipment are properly installed.

- C. Safety practices shall include, but are not limited to, the following requirements:
 - 1. Occupational Safety and Health Act
 - 2. Accident Prevention Manual for Industrial Operations, National Safety Council
 - 3. Applicable state and local safety operating procedures
 - 4. Owner's safety practices
 - 5. National Fire Protection Association
 - 6. American National Standards for Personnel Protection
- D. All tests shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
- E. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.
- F. Ensure that all testing and checkout work is conducted in a safe manner. Special safety precautions such as the following to be utilized where appropriate:
 - 1. Locking and tagging procedures
 - 2. Barricades
 - 3. De-energization and/or isolation of equipment prior to testing
 - 4. Review of procedures with site personnel
 - 5. Erection of warning signs
 - 6. Stationing of guards and watchmen
 - 7. Maintenance of voice communications
 - 8. Personnel orientation

- G. Report all inspections, tests, and calibration in writing on NETA approved report forms. The recorded data from shall have the signatures of the persons conducting the tests and authorized witnesses. The forms shall serve as the test and inspection checklist for inspection requirements. Submit all test and check out data in accordance with Section 01300 prior to adjustments, repairs, drying out, or similar work prior to final testing and acceptance. "As-found" and "as-left" test data to be recorded and reported in writing.
- H. Sequence tests and checks such that the equipment can be energized immediately after the completion of the applicable tests.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT:

A. Calibration:

1. All calibration and setting checks by the Independent Electrical Test shall be performed with the laboratory's calibrated test instruments. This test equipment to have calibrations traceable to the National Bureau of Standards. The Independent Electrical Tester dated calibration labels shall be visible on all test equipment. Calibrations over 6 months old will not be acceptable on field test instruments. All testing instruments shall be checked to verify satisfactory operation prior to proceeding with the tests. Serial and model numbers of the instruments used shall be recorded on the test forms.
2. Make necessary openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, necessary for the tests. Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.

2.02 TESTING:

A. Coordination:

1. Coordinate activities, and cooperate with others on project, to ensure that systems are ensure that systems are energized when required, loads applied, and other requirements are carried out on timely, coordinated basis.
2. Conduct tests in presence of the Owner's representative. Provide ten calendar days or more advance notification of when any test is to be performed.
3. Conduct testing such that warranties or guarantees are not voided. Coordinate all testing with manufacturer's factory trained technicians, where applicable. Where specified tests are not compatible with the manufacturer's recommendations, obtain the manufacturer's review prior to testing. Permit witnessing by the

manufacturer's representative if so requested.

B. Preparation:

1. Make up no low voltage connections at service entrance, transformers, motors, switchboard and motor control centers, permanently until correct phase rotation of all equipment is determined. Install and insulate these connections temporarily, if necessary, while determining proper rotation. Make permanent connections after proper rotation has been established and subsequent to completion of insulation resistance and dielectric tests.

PART 3 – EXECUTION

3.01 INSULATION TESTS OF EQUIPMENT, CABLE, AND CIRCUITS:

A. Independent Electrical Testing:

1. The Independent Electrical Tester shall perform all inspections and testing as specified herein.

B. List each circuit and measured resistance as test data.

C. Maintain records of all insulation resistance values. Identify conductor, or equipment, date that value was taken, and resistance value. Submit the information in neat tabular forms.

3.02 SPECIFIC TESTS AND INSPECTIONS:

A. General:

1. The following specific items or work shall be performed by the Independent Electrical Tester. The equipment and cable shall be de-energized and isolated as necessary to perform the tests.
2. Perform tests and inspections as specified throughout Division 16. Tests and inspections required by these sections are not necessarily repeated under this section.
3. Provide assistance as requested by the Independent Electrical Tester in performing its work.

B. Equipment Test and Inspection During Construction and Prior to Acceptance Testing:

1. Motors:

- a. Visually inspect the motor for any physical damage.
- b. Before energizing any machine, visually inspect for serviceability. Verify that proper alignment has been performed. Check nameplate for electrical power requirements.
- c. Test run all motors before placing into regular service. A check on the motor for rotation, speed, current and temperature rise shall be made and results recorded. Maintain the proper color codes for phase identifications. A motor phase rotation meter should be used prior to connection at motor to prevent later swaps of phase wires.

2. Grounding Systems:

- a. All main plant building loops and major equipment grounds to be tested to remote earth or directly referenced to an extremely low resistance (3 ohm) reference ground bench mark. Visual inspection of all systems, raceway and equipment grounds to be made to determine the adequacy and integrity of the grounding. All ground testing results to be properly recorded, witnessed, and submitted.
- b. Ground tests shall be performed in accordance with NETA using a J. G. Biddle Company low resistance, Null balance type, ground testing ohmmeter, and test lead resistance compensated for. The test instrument to be the type, which compensates for potential and current rod resistances.

- c. Test entire grounding system for continuity of connections and for resistance. Ensure that ground resistance of conduits, equipment cases, and supporting frames does not vary appreciably from that of system as whole and does not exceed 3 Ohms.
3. Circuit Breakers – Low Voltage:
 - a. At the time of equipment receipt, visually check the exterior for any damage or defects.
 - b. Perform complete inspection and electrical test in accordance with NETA.
4. Motor Control Centers:
 - a. At the time of equipment receipt, visually check the exterior for any damage or defects.
 - b. Perform complete inspection and electrical test in accordance with Section 16920 and NETA.
5. 600 VAC Wire and Cable:
 - a. Before energizing, the continuity and insulation resistance of all wiring shall be measured with a megger from each wire to all others and to ground.
 - b. All cables and wires to be checked for proper identification numbering and/or color coding.
 - c. Perform inspection checks and electrical tests in accordance with NETA.
6. Overhead Conduit Systems:
 - a. The overhead conduit system to be checked for proper installation by using the following check list: (This list not to be considered all inclusive but as a guide for inspection).
 - (1) Conduits are supported on appropriate independent supports (i.e., not on process piping, pipe ways, or piping hangers).
 - (2) Exposed conduits are run in a neat workmanlike manner, parallel or perpendicular to structural members.
 - (3) Conduits are routed as far away from possible fire hazards and heat sources as practical.

- (4) Conduits are supported at the required intervals.
 - (5) Pull boxes and fittings are installed so that covers are easily removable. Verify that all covers are installed and tightly bolted with gaskets provided where needed.
 - (6) Number of bends in the conduit does not exceed NEC requirements without a pull box installed.
 - (7) Circular cross sectional area is uniform at conduit bends. Single bends do not exceed 90 degrees.
 - (8) Conduits are terminated in threaded hubs or bushings to prevent damage to wire.
 - (9) Conduits joints have joint compound of the type specified and are tight and conduit ends are properly reamed and threaded not to engage less than 5 threads.
 - (10) Pull fittings are of adequate size such that cable can be installed and replaced at a later date without bending the cable less than code or manufacturer's requirements.
 - (11) Seal fittings and/or sealing compound is installed at moisture barriers to prevent entry of moisture into equipment and/or where shown on plans.
 - (12) Drains and conduit seals are installed on vertical conduit runs entering devices, equipment, and enclosures to prevent entrance of moisture.
 - (13) Flexible conduit is installed at motors and other equipment as specified or required. Verify that all cabling and conduit runs are properly identified at each end.
7. Panelboard electrical checks to be as included in the Wire and Cable section of this specification. Panelboards to be checked for proper circuit identification on the door schedule.
 8. Sealing of Openings: Inspect the entire job to insure that all openings and holes provided or utilized are properly sealed as specified.
 9. Where referenced NETA Standards indicate optional testing, perform these tests as described.

3.03 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01700.

END OF SECTION

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