SECTION 009113 - ADDENDA

1.1 ADDENDUM NO. 1

A. Project Information:

1. To: Prospective Bidders.
2. Project Title: Wastewater Treatment Plants Rehabilitation.
3. Bid No.: WW-16-10-02.
4. Date: October 3, 2016.
5. Owner: Laguna Madre Water District.
6. Engineer: Charles Ortiz, P.E., District Engineer.
7. This Addendum forms a part of the Contract Documents and modifies the Bidding Documents dated September 13, 2016, with amendments and additions noted below.
8. Acknowledge receipt of this Addendum in the space provided in the Bid Form. Failure to do so may disqualify the Bidder.
9. This Addendum consists of 4 pages and following Drawings:

    a. No. 4, Isla Blanca WWTP Site Plan and Mechanical Modifications.
    b. No. 5, Isla Blanca WWTP Blower Modifications.
    c. No. 6, Isla Blanca WWTP Chlorination & Dechlorination Equipment.
    d. No. 7, Andy Bowie WWTP Site Plan and Mechanical Modifications to Air Supply Line.
    e. No. 8, Andy Bowie WWTP Chlorination and Dechlorination Equipment.
    f. No. 9, Port Isabel WWTP Chlorination and Dechlorination Equipment.
    g. No. 10, Laguna Vista WWTP Design Data and Process Schematic.
    h. No. 11, Laguna Vista WWTP Chlorine System Feed / Blower Building Mechanical Modifications.
    i. Issue Date: October 3, 2016.

B. Changes to the Contract Documents and Technical Specifications:

1. Table of Contents:

    a. Added "Section 016120 – Seismic Design Criteria" to listing.
    b. Added “Section 407055 – Master Control Panel” to listing.
    c. Added “Section 407305 – Flow Measurement: Thermal Mass” to listing.
    d. Corrected title “Section 461372 – Positive Displacement with Rotary Screw Blower System.”
    e. Revised number of pages as applicable for specification revisions.

2. Section 001116 - Invitation to Bid:

    a. (Article 1.2, Paragraph A): Extend Bid Date as follows: "... Owner will receive Bids … until 2:00 PM local prevailing time on the 18th day of October, 2016 …"

3. Section 004143 – Bid Form:

a. (Article 1.5, Paragraph A): Revise Unit Price Schedule to reflect all revisions to Drawings and Specifications.

4. Section 005213.12 – Agreement Form"
   a. (Article 4.5): Remove Article 4.5 Special Damages in its entirety.
   b. (Article 5.1, Paragraph A): Revise Unit Price Work to reflect all revisions to Drawings and Specifications.

5. Added "Section 016120 – Seismic Design Criteria" to provide guidance for anchorage of mechanical and electrical equipment.

6. Added "Section 407055 – Master Control Panel" to provide general requirements for a MCP designed to monitor and control all local control panels for each turbo blower and field instruments required for a complete package control system.

7. Added "Section 407305 – Flow Measurement: Thermal Mass" to improve control of air modulating valves.

8. Section 407506 – Analyzers: Dissolved Oxygen (DO) and Common Work Results for Process Control and Instrumentation Systems:
   a. (Article 2.1, Paragraph A.1): Revise to specify Hach SC100 controller.
   b. (Article 3.8): Revise Schedule to state that one aeration controller may be used for up to two DO probes. For Isla Blanca WWTP: Aeration Basins 1 & 2 will have one transmitter, and Aeration Basins 3 & 4 will have one transmitter.

9. Section 461371 – Direct Drive High-Speed Turbo Blower Systems: Revise specification to address comments from prospective Bidders and Manufacturers and to correct sizing requirement for blower at Laguna Vista WWTP. Addendum No. 1 replaces the previous specification in its entirety.

10. Section 461372 – Positive Displacement with Rotary Screw Blower System:
    a. (Article 1.1, Paragraph A.1) – Add requirements for alternate blower for Laguna Vista WWTP to the end of the paragraph.
    b. (Article 2.1, Paragraph N) – Add Performance and Design Criteria for alternate blower at Laguna Vista WWTP site.
    c. (Article 3.5, Paragraph A) – Revise minimum time for services of the representative to one 8-hour day for each blower.
    d. (Article 3.5, Paragraph B.1) – Revise start-up time for services of the representative to one 8-hour day.

11. Section 463111 – Chlorine Gas Feed Equipment
    a. Revise vacuum regulator and ejector assembly capacity to 250 ppd.
    b. Remove automatic switchover module from plans and specifications.
    c. Propose to replace trunions rather than refurbish at Isla Blanca WWTP.

12. Section 463113 – Sulfur Dioxide Feed Equipment
    a. Revised Sulfur Dioxide capacity to 250 ppd.
    b. Remove automatic switchover module from plans and specifications.
    c. Propose to replace trunions rather than refurbish at Isla Blanca WWTP.

C. Changes to the Drawings:

1. Drawing 4 – Isla Blanca WWTP Site Plan and Mechanical Modifications:
    a. Revise Air Supply Modifications to include thermal mass flowmeter.
    b. Specify Schedule for all stainless steel air supply lines.

2. Drawing 5 - Isla Blanca WWTP Blower Modifications:
    a. Revise Turbo Blower to show that blower must be elevated 12-inches above finished floor elevation to stay above the 100-yr floodplain.
    b. Layout is preliminary is subject to revision during Submittal phase.

3. Drawing 6 - Isla Blanca WWTP Chlorination & Dechlorination Equipment:
    a. Revise all proposed rotameters for 250 ppd.
    b. District does not use induction pumps for chlorination and dechlorination equipment. Existing venturi system to remain in place.
    c. Automatic switchover modules removed from plan.

4. Drawing 7 - Andy Bowie WWTP Site Plan and Mechanical Modifications to Air Supply Line:
    a. Add restoration of 14" DI Wall Pipe at Bar Screen to plan.
    b. Specify Schedule for all stainless steel air supply lines.

5. Drawing 8 – Andy Bowie WWTP Chlorination and Dechlorination Equipment:
    a. Provide dual sensor for chlorine and sulfur dioxide leak detectors.
    b. Add Bar Screen Mechanical Plan and Profile Details to plans.

6. Drawing 9 – Port Isabel WWTP Chlorination and Dechlorination Equipment:
    a. Revise all proposed rotameters for 250 ppd.
    b. District does not use induction pumps for chlorination and dechlorination equipment. Existing venturi system to remain in place.
    c. Automatic switchover modules removed from plan.

7. Drawing 10 – Laguna Vista WWTP Design Data and Process Schematic:
    a. Changed proposed to existing as needed to show existing conditions
    b. Revise proposed Turbo Blower to Neuros Model No. NX30-C050 or approved equal.

8. Drawing 11 – Laguna Vista WWTP Chlorine System Feed / Blower Building Mechanical Modifications:
    a. Revise proposed Turbo Blower to Neuros Model No. NX30-C050 or approved equal.
    b. Provide dual sensor for chlorine leak detector.

D. Clarifications:

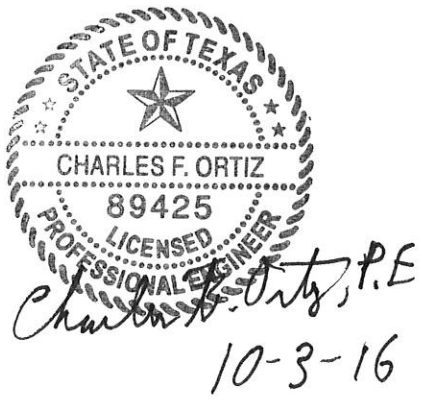
1. Grit removal means "remove from the WWTP and disposal by the Contractor."

2. To be qualified for the award of a contract, BIDDERS must satisfy the following minimum criteria:
    a. The Bidder must demonstrate successful completion during the last five (5) years of at least three (3) projects comparable in nature and scope to this project.
    b. At least two key personnel, and their potential alternate, employed by the Bidder must have a minimum of five (5) years' experience in similar construction

projects. A Superintendent meeting the experience criteria will be required to be on site at all times during the course of construction.

c. The Bidder must have an employee, to be dedicated to this project, who is experienced in scheduling, with demonstrated ability in employing scheduling techniques similar to those to be used for this project.

END OF DOCUMENT 009113



Laguna Madre Water District
Wastewater Treatment Plants Rehabilitation
Bid # WW-16-10-02
Table of Contents

END OF TABLE OF CONTENTS

SECTION 004143 - BID FORM - UNIT PRICE (SINGLE-PRIME CONTRACT)

1.1 BID INFORMATION

A. To: Laguna Madre Water District.

B. Project Name: Wastewater Treatment Plants Rehabilitation.

C. Bid No.: WW-16-10-02.

D. Date: .....

E. Submitted by:

1. Name: .....
2. Address: .....

1.2 OFFER

A. Having examined the Place of the Work and all matters referred to in the Instructions to Bidders and the Contract Documents prepared by the Owner for the above-referenced Project, we, the undersigned, hereby offer to enter into a Contract to perform the Work for the Unit Prices listed in this Bid Form in lawful money of the United States of America.

B. Include Bid security as required by the Instructions to Bidders.

C. All applicable federal taxes are excluded and State of Texas taxes are excluded from the Unit Prices.

1.3 ACCEPTANCE

A. This offer shall be open to acceptance for 60 days from the Bid closing date.

1. If this Bid is accepted by the Owner within the time period stated above, we will:

a. Execute the Agreement within 15 days of receipt of Notice of Award.
b. Furnish the required bonds within 15 days of receipt of Notice of Award.
c. Commence Work within seven days after written Notice to Proceed.

B. If this Bid is accepted within the indicated time, and we fail to commence the Work or we fail to provide the required bonds, the Bid security shall be forfeited as damages to the Owner by reason of our failure, limited in amount to the lesser of the face value of the Bid security or the difference between this Bid and the Bid upon which a Contract is signed.

C. In the event our Bid is not accepted within the time stated above, the required Bid security will be returned to the undersigned, according to the provisions of the Instructions to Bidders, unless a mutually satisfactory arrangement is made for its retention and validity for an extended period of time.

1.4 CONTRACT TIME

A. If this Bid is accepted, we will:

1. Complete the Work in 180 calendar days from Notice to Proceed.

1.5 UNIT PRICES

A. Following are Unit Prices for specific portions of the Work as listed:

UNIT PRICE SCHEDULE					
Item Number	Description	Unit	Estimated Quantity	Unit Price	Total Estimated Price $
BASE BID					
1	Mobilization	LS	1		
Isla Blanca Wastewater Treatment Plant					
2	Install 38x48 Waterman Slide Gate	EA	4		
3	Install 30x30 Waterman Slide Gate	EA	1		
4	3 in. SS316 (Sch. 40) Air Supply Line	LF	124		
5	6 in. SS316 (Sch. 40) Air Supply Line	LF	34		
6	6 in. Tap into Exist 14 in. pipe	EA	1		
7	Disconnect 6" Pipe from 14" Air Supply and Replace with 14" Spool Piece	EA	1		
8	8 in. SS316 (Sch. 40) Air Supply Line	LF	34		
9	4”x8” Tee SS316, Sch. 40	EA	1		
10	6”x6” Tee SS316, Sch. 40	EA	1		
11	8”x6” Tee SS316, Sch. 40	EA	2		
12	10”x8” Tee SS316, Sch. 40	EA	1		
13	12”x10” Reducer, SS316, Sch. 40	EA	1		
14	4” – 90 Deg. Bend Air Supply	EA	3		
15	6” – 90 Deg. Bend Air Supply	EA	1		
16	8” – 90 Deg. Bend Air Supply	EA	1		
17	Remove 6” Pipe and install blind flanges as shown on Plan	LS	1		
18	Install 1” G-O Diffuser Assembly	EA	80		

19	12” Butterfly Valve with Electric Actuator	EA	1		
20	14” Butterfly Valve with Electric Actuator	EA	1		
21	3” Butterfly Valve with Manual Actuator	EA	3		
22	4” Butterfly Valve with Manual Actuator	EA	2		
23	6” Butterfly Valve with Manual Actuator	EA	1		
24	10” Butterfly Valve with Manual Actuator	EA	2		
25	Pipe Supports - Air Supply	LS	1		
26	Bypass Operation	LS	1		
27	Grit Removal	CY	1,475		
28	Analyzer Dissolved Oxygen – One Controller with two DO probes	EA	2		
29	Master Control Panel	EA	1		
30	Thermal Mass Flowmeter	EA	2		
31	Turbo Blower Package	EA	2		
32	Positive Displacement IQ-HE Blower Package	EA	1		
33	Furnish and Install Chlorine Feed Equipment	LS	1		
34	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
35	Effluent Weir, Chlorine Contact Chamber “A”	LS	1		
36	Ultrasonic Level Transmitter	EA	3		
37	Refurbish Jib Crane and Replace Hoist and Trolley	EA	2		

38	Isla Blanca WWTP Electrical System	LS	1		
39	Replace Belt Filter Press Control Panel	EA	1		
Subtotal Isla Blanca Wastewater Treatment Plant:					
Andy Bowie Wastewater Treatment Plant					
40	14 in. DI Wall Pipe	LS	1		
41	6 in. Plug Valves	EA	3		
42	12 in. SS316 (Sch. 10) Air Supply Line	LF	44		
43	4 in. SS316 (Sch. 40) Air Supply Line	LF	74		
44	Install 1" G-O Diffuser Assembly	EA	41		
45	4" Butterfly Valve with Manual Actuator	EA	3		
46	Pipe Supports - Air Supply	LS	1		
47	Bypass Operation	LS	1		
48	Grit Removal	CY	194		
49	Furnish and Install Chlorine Feed Equipment	LS	1		
50	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
51	Refurbish Monorail, and Replace Hoist and Trolley (Chlorine)	EA	1		
52	Refurbish Monorail, Restore Festoon Hardware and Wire, and Replace Hoist and Trolley (Sulfur Dioxide)	EA	1		
Subtotal Andy Bowie Wastewater Treatment Plant:					

Port Isabel Wastewater Treatment Plant					
53	Furnish and Install Chlorine Feed Equipment	LS	1		
54	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
55	Refurbish Monorail, Furnish and Install New Festoon Hardware and Wire, and Replace Hoist and Trolley	EA	2		
Subtotal Port Isabel Wastewater Treatment Plant:					
Laguna Vista Wastewater Treatment Plant					
56	Turbo Blower Package	EA	1		
57	Furnish and Install Chlorine Feed Equipment	LS	1		
58	Replace Hoist and Trolley	EA	1		
Subtotal Laguna Vista Wastewater Treatment Plant:					
Total Base Bid Wastewater Treatment Plants Rehabilitation:					
				(price in figures)	
				_____ (price in words)	

1.6 ALTERNATE BID ITEMS

A. At Owner's option, alternate blowers will be selected in lieu of the Turbo Blowers shown in Base Bid. The following table is to be completed to allow the District to evaluate alternative equipment. In the spaces below, the Contractor may enter the price of supply and installation of equipment. If the District chooses other than that which the tenderer has included in the tender, extra or credit adjustments will be made based on the prices entered. No extension to time of completion will be provided for any alternatives.

UNIT PRICE SCHEDULE					
Item Number	Description	Unit	Estimated Quantity	Unit Price	Total Estimated Price $
Isla Blanca Wastewater Treatment Plant					
31A	Positive Displacement IQ-HE Blower Package for Aeration Basins	EA	2		
Laguna Vista Wastewater Treatment Plant					
56A	Positive Displacement With Rotary Screw Blower Package	EA	1		

1.7 ADDENDA

A. Following Addenda have been received, and the modifications to the Bid Documents noted below have been considered and all costs are included in the Bid Price.

1. Addendum No. ....., dated .....
2. Addendum No. ....., dated .....
3. Addendum No. ....., dated .....

1.8 APPENDICES

A. Following documents are attached to and made a condition of the Bid:

1. Bid security in form of a certified check, bank money order, or Bid Bond issued by a surety meeting the requirements of Paragraphs 6.01 and 6.02 of the General Conditions.
2. Bidder's qualifications statement and supporting data.

1.9 BID FORM SIGNATURES

A. Full Name of Bidder: .....

B. Hereunto affixed in the presence of .....

C. Authorized Signing Officer and Title: .....

D. [**Seal: .....**]

END OF DOCUMENT 004143

SECTION 005213.12 - AGREEMENT FORM - EJCDC STIPULATED SUM (SINGLE-PRIME CONTRACT)

THIS AGREEMENT is by and between Laguna Madre Water District (Owner) and _____ (Contractor).

Owner and Contractor hereby agree as follows:

ARTICLE 1 – WORK

1.1 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

A. Wastewater Treatment Plants Rehabilitation

PART 2 - THE PROJECT

2.1 The Project, of which the Work under the Contract Documents is a part, is generally described as follows: Installation of Chlorination and Dechlorination Equipment at four wastewater treatment plants; Replace Belt Filter Press control panel at Isla Blanca WWTP; install gates, bypass system, blower upgrade and dissolved oxygen control system, air system repairs, and grit removal from Aeration Basins at Isla Blanca WWTP; air system repairs at Andy Bowie WWTP; Hoists Rehabilitation; Replace Blower at Laguna Vista WWTP.

PART 3 - **ENGINEER**

3.1 The Project has been designed by Laguna Madre Water District and Square E Engineering for Electrical Work.

3.2 The Owner has retained Charles Ortiz, employee, ("Engineer") to act as Owner's representative, assume all duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contact Documents.

PART 4 - **CONTRACT TIMES**

4.1 Time of the essence:

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.2 Contract Times: Dates:

A. The Work will be substantially completed on or before _____, 2017, and completed and ready for final payment in accordance with paragraph 15.06 of the General Conditions on or before _____, 2017.

4.3 Contract Times: Days:

A. The Work will be substantially completed within 150 days after the date when the Contract Times commence to run as provided in paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with paragraph 15.06 of the General Conditions within 180 days after the date when the Contract Times commence to run.

4.4 Liquidated Damages

A. Contractor and Owner recognize that time is of the essence as stated in the above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with the Contract. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):
   1. Substantial Completion: Contractor shall pay Owner $500 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified in this Agreement for Substantial Completion until the Work is substantially complete.
   2. Completion of Remaining Work: After substantial completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $500 for each day that expires after such time until the Work is completed and ready for final payment.
   3. Liquidated damages for failing to timely attain Substantial Completion and final completion and not additive and will not be imposed concurrently.

PART 5 - **CONTRACT PRICE**

5.1 Owner shall pay Contractor for completion of Work in accordance with the Contract Documents the amounts that follow, subject to adjustment under the Contract:

A. For all Unit Price Work, an amount equal to the sum of the extended prices (established for each separately identified item of Unit Price Work by multiplying the unit price times the actual quantity of that item):

UNIT PRICE WORK					
Item Number	Description	Unit	Estimated Quantity	Unit Price	Total Estimated Price $
BASE BID					
1	Mobilization	LS	1		
Isla Blanca Wastewater Treatment Plant					
2	Install 38x48 Waterman Slide Gate	EA	4		
3	Install 30x30 Waterman Slide Gate	EA	1		
4	3 in. SS316 (Sch. 40) Air Supply Line	LF	124		
5	6 in. SS316 (Sch. 40) Air Supply Line	LF	34		
6	6 in. Tap into Exist 14 in. pipe	EA	1		
7	Disconnect 6" Pipe from 14" Air Supply and Replace with 14" Spool Piece	EA	1		
8	8 in. SS316 (Sch. 40) Air Supply Line	LF	34		
9	4”x8” Tee SS316, Sch. 40	EA	1		
10	6”x6” Tee SS316, Sch. 40	EA	1		
11	8”x6” Tee SS316, Sch. 40	EA	2		
12	10”x8” Tee SS316, Sch. 40	EA	1		
13	12”x10” Reducer, SS316, Sch. 40	EA	1		
14	4” – 90 Deg. Bend Air Supply	EA	3		
15	6” – 90 Deg. Bend Air Supply	EA	1		
16	8” – 90 Deg. Bend Air Supply	EA	1		
17	Remove 6” Pipe and install blind flanges as shown on Plan	LS	1		
18	Install 1” G-O Diffuser Assembly	EA	80		

19	12” Butterfly Valve with Electric Actuator	EA	1		
20	14” Butterfly Valve with Electric Actuator	EA	1		
21	3” Butterfly Valve with Manual Actuator	EA	3		
22	4” Butterfly Valve with Manual Actuator	EA	2		
23	6” Butterfly Valve with Manual Actuator	EA	1		
24	10” Butterfly Valve with Manual Actuator	EA	2		
25	Pipe Supports - Air Supply	LS	1		
26	Bypass Operation	LS	1		
27	Grit Removal	CY	1,475		
28	Analyzer Dissolved Oxygen – One Controller with two DO probes	EA	2		
29	Master Control Panel	EA	1		
30	Thermal Mass Flowmeter	EA	2		
31	Turbo Blower Package	EA	2		
32	Positive Displacement IQ-HE Blower Package	EA	1		
33	Furnish and Install Chlorine Feed Equipment	LS	1		
34	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
35	Effluent Weir, Chlorine Contact Chamber “A”	LS	1		
36	Ultrasonic Level Transmitter	EA	3		
37	Refurbish Jib Crane and Replace Hoist and Trolley	EA	2		

38	Isla Blanca WWTP Electrical System	LS	1		
39	Replace Belt Filter Press Control Panel	EA	1		
Subtotal Isla Blanca Wastewater Treatment Plant:					
Andy Bowie Wastewater Treatment Plant					
40	14 in. DI Wall Pipe	LS	1		
41	6 in. Plug Valves	EA	3		
42	12 in. SS316 (Sch. 10) Air Supply Line	LF	44		
43	4 in. SS316 (Sch. 40) Air Supply Line	LF	74		
44	Install 1" G-O Diffuser Assembly	EA	41		
45	4" Butterfly Valve with Manual Actuator	EA	3		
46	Pipe Supports - Air Supply	LS	1		
47	Bypass Operation	LS	1		
48	Grit Removal	CY	194		
49	Furnish and Install Chlorine Feed Equipment	LS	1		
50	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
51	Refurbish Monorail, and Replace Hoist and Trolley (Chlorine)	EA	1		
52	Refurbish Monorail, Restore Festoon Hardware and Wire, and Replace Hoist and Trolley (Sulfur Dioxide)	EA	1		
Subtotal Andy Bowie Wastewater Treatment Plant:					

Port Isabel Wastewater Treatment Plant					
53	Furnish and Install Chlorine Feed Equipment	LS	1		
54	Furnish and Install Sulfur Dioxide Feed Equipment	LS	1		
55	Refurbish Monorail, Furnish and Install New Festoon Hardware and Wire, and Replace Hoist and Trolley	EA	2		
Subtotal Port Isabel Wastewater Treatment Plant:					
Laguna Vista Wastewater Treatment Plant					
56	Turbo Blower Package	EA	1		
57	Furnish and Install Chlorine Feed Equipment	LS	1		
58	Replace Hoist and Trolley	EA	1		
Subtotal Laguna Vista Wastewater Treatment Plant:					
Total of all Extended Prices for Unit Price Work (subject to final adjustment based on actual quantities).					

1. The extended prices for Unit Price Work set forth as of the Effective Date of the Contract are based on estimated quantities. As provided in paragraph 13.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer.

PART 6 - **PAYMENT PROCEDURES**

6.1 Submittal and processing of payments:

A. Contractor shall submit Application for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions and in accordance with Texas Government Code §2252.031 et seq.

6.2 Progress payments; retainage:

A. Owner shall make progress payment on account of the Contract Price on the basis of Contractor's Application for Payment on or about the 15th day of each month during performance of the Work as provided in paragraphs below, provided that such Applications for

Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract:

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract:
    a. 90 percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage.
    b. 90 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).
2. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 95 percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01 of the General Conditions and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.3 Final Payment

A. Upon final completion and acceptance of the Work, in accordance with paragraph 15.06 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer.

PART 7 - **INTEREST**

7.1 No interest will be paid on late payments.

PART 8 - **CONTRACTOR'S REPRESENTATIONS**

8.1 In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and any data and reference items identified in the Bidding Documents.

B. Contractor has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all:
   1. Reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and
   2. Reports and drawings relating to Hazardous Environmental Condition, if any, at or adjacent to the Site which has been identified in the Supplementary Conditions especially with respect to Technical Data in such reports and drawings.

E. Contractor has considered the information known to Contractor itself; information commonly known to Contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the contract Documents, with respect to the effect of such information, observations, and documents on:
   1. The cost, progress, and performance of the Work.
   2. The means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and
   3. Contractor's safety precautions and programs.

F. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract times, and in accordance with the other terms and conditions of the Contract.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

J. Contractor's entry into this Contract constitutes an inconvertible representation by Contractor that without exception, all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

PART 9 - **CONTRACT DOCUMENTS**

9.1 Contents:

A. The Contract Documents consist of the following:
   1. Document 005213.12 – Agreement
   2. Document 006114 – Performance Bond
   3. Document 006115 – Payment Bond
   4. Document 00700 - General Conditions, EJCDC
   5. Document 00800 - Supplementary Conditions, EJCDC
   6. Specifications as listed in the table of contents.

7. Drawings as listed on the sheet index.
8. Addenda (numbers 1 to ____, inclusive).
9. Exhibits to this Agreement (enumerated as follows):
    a. Document 004143 – Bid Form
    b. Conformed Bid
10. The following with may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
    a. Document 005500 – Notice to Proceed
    b. Document 006336 – Field Orders
    c. Document 006349 – Work Change Directives
    d. Document 006363 – Change Orders

B. There are no Contract Documents other than those listed in this Document.

C. The Contract Documents may only be amended, modified, or supplemented as provided in paragraph 3.04 of the General Conditions.

PART 10 - **MISCELLANEOUS**

10.1 Terms:

A. Term used in this Agreement will have the meaning indicated in the General Conditions and the Supplementary Conditions.

10.2 Assignment of Contract:

A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.3 Successors and Assigns:

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.4 Severability:

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.5 Contactor's Certifications:

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract.
   1. "Corrupt practice" means the offering, giving, receiving, or soliciting of any thing of value likely to influence the action of a public official in the bidding process or in the Contract execution;
   2. "Fraudulent practice" means an intentional misrepresentation of facts made:
      a. To influence the bidding process or the execution of the Contract to the detriment of Owner.
      b. To establish Bid or Contract prices at artificial non-competitive levels.
      c. To deprive Owner of the benefits of free and open competition.
   3. "Collusive practice" means a scheme or arrangement between 2 or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels.
   4. "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

10.6 Other Provisions

A. Owner stipulates that if the General Conditions that are made a part of this Contract are based on EJCDC® C-700, Standard General Conditions for the Construction Contract, published by the Engineers Joint Contract Documents Committee®, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, in the Supplementary Conditions.

10.7 Payment Bond:

A. Document 006115 – Construction Payment Bond, is executed pursuant to the provisions of Chapter 2253, Texas Government Code, and all liabilities on this bond shall be determined in accordance with the provisions of said chapter to the same extent as if it were copied at length in this Document.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement. Counterparts have been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or have been identified by Owner and Contractor or on their behalf.

This Agreement will be effective on _____, 2016 (which is the Effective Date of the Agreement).

OWNER:	CONTRACTOR:
_____	_____
By: _____	By: _____
Title: _____	Title: _____ (if Contractor is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)
Attest: _____	Attest: _____
Title:	Title:
Address for giving notices:	Addresses for giving notices:
_____	_____
_____	_____
	License No. _____ (Where applicable)
(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of this Agreement.)	
	Agent for service of process:
	_____
Designated Representative:	Designated Representative:
Name: _____	Name: _____
Title: _____	Title: _____
Address: _____	Address: _____
_____	_____
Phone: _____	Phone: _____

END OF DOCUMENT 005213.12

SECTION 016120 - SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
   3. Other structures or items as specified or indicated on the Drawings.

1.2 REFERENCE STANDARDS

A. American Society of Civil Engineers (ASCE):
   1. 7-05 - Minimum Design Loads for Building and Other Structures.

1.3 SYSTEM DESCRIPTION

A. Design in accordance with the requirements of the building code.

B. Design spectral acceleration at short period, S_{DS}: 0.06g

C. Design of non-structural components and their connections to structures:
   1. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1
   2. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 an d13.6-1
   3. Component importance factor, I_p:

Table 1: Component importance factor, Ip		
Component	**Description**	**Ip**
Electrical	Equipment and appurtenances provided and installed. Refer related sections and drawings	1.5
Notes: 1. Component Importance Factor, Ip = 1.5 for all other equipment and appurtenances.		

D. Seismic Design Category (SDC) for certification of mechanical and electrical equipment as required by ASCE 7:
   1. Wastewater Treatment Facility, All areas: Seismic Design Category A

E. Design requirements: Anchorage of equipment to structures.
   1. Do not use friction to resist sliding die to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or shear on anchors and fasteners.
   2. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.

3. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
4. Anchoring and fastening to concrete and masonry:
    a. Use only cast-in anchors (anchor bolts or welded studs) for anchors at connections that resist seismic forces.
    b. Do not use concrete anchors, flush shells, sleeve anchors, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures specifies requirements for submittals.

B. Shop Drawings and calculations: Complete shop drawings and seismic calculations.

C. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state of Texas.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 260500
ELECTRICAL SPECIFICATIONS

ELECTRICAL

PART 1: GENERAL

1.01 GENERAL

The General Conditions and Requirements, Special Provisions, if applicable are hereby made a part of this section.

A. The Electrical Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the Owner's office and shall be examined by all bidders. Failure to examine all documents shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

B. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents.

C. The Contractor is responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly. Failure to examine all site conditions shall not relieve this responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

D. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

E. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:
1. Underwriters Laboratories

2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

H. The use of the word "*furnish*" or "*Install*" or "*provide*", shall be taken to mean that the item or facility is to be both furnished and installed under this section unless specifically stated to the contrary that the item or facility is to be furnished under another section and installed under this section; furnished under this section and installed under another section; or furnished and installed under another section.

I. The use of the term "as or where Indicated"; "as or where shown"; "as or where specified"; or "as or where scheduled" shall be taken to mean that the reference is made to the contract documents either under the drawings and/or the specifications.

1.02 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. It is the responsibility of the contractor to investigate and identify all required permits, licenses and inspections required and investigate and identify any AHJ. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

D. Determine the exact requirements for **ALL** utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform **ALL** work as required by those utilities.

1.03 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract

Documents. All materials and equipment shall be or the highest quality in order to provide the most reliable end product possible. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)

B. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturer’s Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code
6. National Fire Protection Association

C. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

E. All products shall bear UL labels where standards have been set for listing.

1.04 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings shall be taken to mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

C. Submit for review in sextuplet within fifteen (15) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and submittals are not received in fifty (15) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne by the contractor.

D. Review of submittals or shop drawings shall not remove the responsibility for

furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.

E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's representative and such procedures will not be cause for delay. After final review, supply up to six (3) copies, if requested.

G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each Submittal and/or shop drawing.

H. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.

I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent.

J. Materials to be submitted as required are as follows:

1. Panel Surge Arrestors
2. Lighting fixtures
3. Wire
4. Conduit and Fittings
5. Electrical Panels
6. Wiring Devices
7. Control Panels Xfrmrs/Motor control
8. Equipment/Enclosures
9. Control Components
10. Float Switches

K. Each submittal shall be accompanied with a written statement certifying that the submitted equipment and/or material meet the plans and specifications.

SECTION 260500
ELECTRICAL SPECIFICATIONS

1.05 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within sixty (15) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, the contractor shall assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

E. Energy Efficiency of each item of power consuming equipment shall be considered one of the standards for evaluation.

1.06 EXCAVATION AND BACKFILLING (as required)

A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.

C. All backfilling shall be made with Concrete Backfill.

D. All excavated material not suitable and not used in the backfill shall be removed

offsite at the Contractors expense.

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

G. Any construction involving the opening of trenches and or Sidewalks and Concrete Drives is to be done in an efficient manner so as to reduce the impact of to surrounding areas. Trenches are shall not be left open during periods of rain so as to reduce the impact of the weather to surrounding areas/structures.

1.07 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

G. No cutting of structural elements shall be done without permission of the Engineer.

1.08 WATERPROOFING

A. Interiors of raceways that are likely to have water ingress such as runs to and from J-Boxes, Control Boxes shall have water-stops/sealing hubs etc. installed to prevent water from entering into installations.

1.09 CONSTRUCTION REQUIREMENTS

A. Except where specifically detailed or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary, or desirable, at the time the work is installed. Final locations shall be confirmed with the engineer in advance of construction. Confirmed locations shall be made for the following:

1. Poles
2. Receptacles
3. Rough-ins and connections for equipment furnished under other sections
4. Lighting Fixtures
5. Outlets
6. J-Boxes, Control Panels, and Electrical Panels, Pump Control Panels etc.

B. All work shall be done in the best and most workmanlike manner by qualified careful electricians who are skilled in their trade. The standards of work required throughout shall be of the first class only and electricians whose work is unsatisfactory to the Engineer shall be instantly dismissed from the work upon written notice from the Engineer at no additional cost to the Owner. All work must meet the approval of the Engineer.

D. Unless shown in detail, the drawings are diagrammatic and do not give exact details as to the elevations and routing of conduits, nor do they show all offsets and fittings. Nevertheless, the installation must be made to fit and conform to the structural and mechanical conditions of the construction. Unless locations and routing of exposed conduits are shown, confirm locations and routing prior to installation with Engineer.

E. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with a hole-punch. Cutting openings with a torch or other device that produces a jagged edge, rough cut will not be acceptable.

F. Raceway entry into equipment shall be carefully planned. Cutting of enclosure

framework to accommodate poorly planned raceway placement will not be acceptable. No hole-punch penetrations shall be made on top of any equipment, panel, or Junction box. All hole-punch penetrations shall be properly sealed so as to prevent moisture and gasses from entering the equipment, panel, or Junction Box etc.

G. Cabling inside equipment shall be carefully routed, trained, and laced. Cables so placed that they obstruct equipment devices shall not be acceptable.

H. Equipment, inclusive of supporting devices, shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid tight fitting manner.

1.10 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

E. Interiors of Switchgear, Motor Control Centers, Control Panels, shall be kept clean and dry prior to energization. Maintain heat inside each unit with one 200 watt Lamp located the bottom of each section, or panel. Energizing integral condensation heaters shall be acceptable in place of lamps.

1.11 COOPERATION WITH WORK UNDER OTHER SECTIONS

A. Cooperate with all other trades so as to facilitate the general progress of the work. Allow other trades every reasonable opportunity for then installation of their work and the storage of their materials.

B. The work under this section shall follow the general construction closely. Set all pipe sleeves, inserts, etc., and see that openings for cases, pipes, etc., are provided before any concrete is placed or masonry is installed.

C. Work with other trades in determining exact locations of outlets, conduits,

fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime as required to accomplish these requirements if directed to do so.

1.12 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.13 TESTING AND ENGINEERING STUDIES

A. All cables shall have an insulation test performed using a 1000 Volt Megger tester. Testing shall include the entire length of cable from the source terminal to the load terminal. Testing shall be performed prior to final landing of power cables to equipment. Reports are to be made during the time of the testing and submitted to the Engineer for review. Reports must include time and date, weather conditions, printed names and signatures of tester and at least one witness. Testing must be performed in the presence of the Engineer/Owner Representative. Insulation values of each cable shall be equivalent to or greater than 500,000 ohms. In the event a cable's test value is not equivalent or greater than 500,000 ohms, that cable shall be removed and replaced. Upon reinstallation, **ALL** cables are to be retested. Retesting must result in the same resistance value equal to or greater than 500,000 ohms. Retested and/or replaced cables are required to achieve the proper resistance rating.

B. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner.

1.14 RECORD DRAWINGS

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A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.

B. Show conduit routing and wiring runs as constructed and identify each.

C. Record all deviations from the Contract Documents.

D. Submit set of marked-up drawings for review.

1.16 OPERATIONS AND MAINTENANCE MANUALS

A. Prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.
B. Submit six (3) copies for review.

PART 2 PRODUCTS

2.01 RACEWAYS

A. Above ground rigid metallic conduit shall be schedule 40 Aluminum conduit, Rigid Conduit, or PVC coated plastibond conduit with like fittings as indicated on plans sheets. Conduit couplings shall be threaded Aluminum, Rigid, or PVC coated plastibond as indicated on plansheets. Such conduit shall be Republic, Triangle, Wheatland, or equivalent. EMT Shall be allowed for this project. Please provide full submittal for review and acceptance by Engineer

B. Rigid non-metallic conduit shall be Schedule 40 PVC plastic type DB. Couplings shall be PVC solvent weld type. Such conduit shall be Carlon, or equivalent.

C. 90 degree transitions shall be schedule 80 PVC plastic. Couplings shall be ths same type PVC and solvent weld type. Such conduit shall be Carlon, or equivalent. The Contractor shall use long sweep 90 degree bends as required.

2.02 CONDUIT FITTINGS

A. Rigid metallic conduit locknuts shall be galvanized steel, Aluminum, or PVC coated plastibond as indicated on the plan sheets, in sizes under 2” and galvanized malleable iron on sizes 2 ½” and larger. Sealing locknuts shall also have an integrally

fused thermoplastic gasket so that the locknut is rated NEMA-4. These lock nuts shall have a integral grounding terminal for proper grounding. These fittings and shall be MYERS "SCRU-TITE", or equal.

B. Chase nipples, reducers, enlargers, “Ericksons”, capped els, short els, long els, split couplings and fittings shall be HDG malleable iron threaded type for use with rigid metallic conduit. All such fittings shall be PVC coated where as required.

C. Rigid metallic conduit locknuts shall be galvanized steel in sizes under 2” and galvanized malleable iron on sizes 2 ½” and larger. Sealing locknuts shall have in addition to that specified above, an integrally fused thermoplastic gasket so that the locknut is rated NEMA-4.

D. Rigid metallic conduit insulating bushings shall be molded canvas bakelite type suitable for operation in 100ºC rise over 40ºC ambient. Polyproplyne bushings will not be acceptable.

E. Rigid Metallic Conduit Grounding type bushings shall be Hot Dipped Galvanized steel with threaded steel body insulated throat, and ground lug. Insulated throat shall meet specifications under article D above.

F. Rigid metallic conduit expansion/deflection fittings shall be water-tight with flexible plastic sleeve that allows ¾” movements in all directions. Hubs shall be threaded, hot dipped galvanized (HDG) malleable iron. Clamping bands shall be stainless steel. There shall be on equipment ground bonding jumper, Expansion deflection fittings shall be Crouse-Hinds, OZ, or equivalent.

G. Rigid metallic conduit hubs shall be liquid-tight type with threaded HDG malleable iron female body, with sealing ring on conduit side and threaded make tapered steel body with hardened steel locknut on box side. Plastic jacketed hubs shall have 40 mils PVC coating. Such fittings shall be OCAL “Blue” or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote “Supreme” shall be acceptable.

H. Cadmium and electro-galvanized plated devices and hardware shall not be acceptable.

2.03 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.

B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal.

C. Rigid metallic conduit bodies shall be HDG malleable iron type with threaded hubs, gasketed metal covers, with stailnless steel screws. Plastic jacketed type shall have 40 mils minimum coating of PVC. Such conduit shall be OCAL “Blue” or equivalent. Conduit and fittings such as Robroy Plastibond and Perma-cote “Supreme” shall be acceptable.

C. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.

D. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws.

E. Rigid metallic conduit boxes shall be HDG cast iron, with threaded integrally-cast hubs, cast metal cover, and stainless steel cover screws. Such boxes shall be Crouse Hinds, Appelton, or equivalent. Plastic jacketed type shall have 40 mils minimum coating of PVC.

2.04 WIRE AND CABLE

A. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.

B. All 480V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75ºC. Furnish okonite "Okolon", Rockbestos "Firewall", or equal.

C. All 120/240V conductors shall be insulated with moisture and heat-resistant thermoplastic suitable for use in Dry and Wet locations. All such wire shall be type XHHW rated at 600V for use in 75ºC. Furnish okonite "Okolon", Rockbestos "Firewall", or equal.

D. Factory pigmented insulation color for sizes #6 and smaller for power wiring shall be as follows:

150V to Ground, or less:

Phase	Color
A	Red
B	Black
C	Blue
Grounding Conductor	Green
Grounded Conductor	White

Greater than 150V to ground

Phase	Color
A	Brown
B	Purple
C	Yellow
Grounding Conductor	Green
Grounded Conductor	Gray

E. Bare conductors for grounding purposes shall be hard-drawn stranded copper.

2.05 CONNECTORS

A. Mechanical connectors shall be copper alloy bolted pressure type with bronze hardware.

B. Insulated spring-wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 105º C continuous. Furnished 3M "Hyflex", T&B "PT" or equal.

C. Insulated set-screw connectors shall consist of copper body with flame-retardant 600V plastic insulated shield. Furnished Ideal, T&B, or equal.

D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrel and tin-plated copper ring-tongue style connector. Furnish T&B "Sta-kon", 3M "Scothlok", or equal.

E. Terminal strips shall be channel-mounted type with tin-plated solderless box lugs contained with barriered nylon-insulated separable barriers. Such devices shall be Square D, Cutler Hammer, Allen Bradley, or equivalent.

F. Terminal connectors for flat head terminal screws shall be locking spade type with vinyl insulated compression indent shaft, T&B, Ideal, Amp, or equivalent.

2.06 INSULATING PRODUCTS

A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, F.E., 3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, "slipknot Grey", 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be moisture-proof void filling tape shall be "plysafe", 3M Scotch 23, or equal.

D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be "Plysil #3445", 3M Scotch 70, or equal.

E. Insulation putty filler-tape shall be Plymouth #2074, 3M, or equal. Putty to be used as necessary to keep moisture and gasses from entering raceways.

2.07 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.

B. Numbered marking labels shall be colored vinyl markers, T&B, Brady, or equal.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.

D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking

"BURIED CONDUIT", or similar language, along its length.

E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with white engraving. Attachment means shall be self-tapping stainless steel screws.

2.08 GROUNDING DEVICES

A. Exothermally welded joints shall be made with Enrico "cadweld", Burndy "Thermweld", or equal kits.

B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.

C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.

2.09 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 316 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be good quality Aluminum; 1-5/8" wide x 3-1/4" deep unistrut. Clamp nuts and mounting hardware for use with slotted channels shall be grade 316 stainless steel.

C. Conduit straps for use with slotted channels shall be stainless steel with stainless steel hardware. HDG unistrut and straps shall be acceptable for this project. Please provide full submittal for Engineer review and acceptance.

D. Concrete and Masonry Anchors shall be stainless steel type. Furnish Hilti, or equal.

E. Poles for supporting outdoor control panels shall be Hot Dipped Galvanized, with footings encased in concrete. Tops of poles shall be covered with a Hot Dipped Galvanized conduit cap.

H. "U" bolts shall be stainless steel with Stainless Steel hex-head bolts.

I. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.10 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.

H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

PART 3: INSTALLATION

3.01 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, will not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate

the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of structures. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.

E. Unless otherwise indicated, conduit runs installed below-grade in earth shall be PVC. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that tops of conduits are at least twenty-four (36") inches below finished grade. Support runs on plastic spacers and backfill to three (3") inches above topmost conduits with washed sand. Wash down all sand backfill with water so as to completely fill interstices and to compact sand. Complete backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped.

F. Below-grade to above-grade upturns in non-metallic runs shall be made with Schedule 80 PVC rigid conduit.

G. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.

H. All conduit runs shall be watertight over their lengths of run except where drain fittings are indicated. In which cases, install specified breather-drain fittings.

I. Empty conduits shall have pull-tape installed. Identify each terminus as to location of other end. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Cap exposed ends of empty conduit with plastic caps.

J. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

K. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

L. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, fagged edges, and torn metal.

M. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.

N. Surface mounted conduit and all fittings shall be schedule 40 Aluminum conduit and shall conform to Section, 2.01 RACEWAYS; A. Mounting hardware shall be Aluminum Deep Channel Unistrut with stainless steel hardware including nuts, bolts, anchor bolts and pipe clamps.

3.02 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction. PVC coated fittings shall be used as required.

B. Covers for conduit bodies installed shall be gasketed cast metal type.

C. All conduit boxes installed shall be cast metal type Aluminum as required or indicated. Covers for all such boxes shall be gasketed stainless steel to match box construction.

3.03 RACEWAY SUPPORT

A. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Below-grade conduits shall be supported with plastic saddles.

3.04 WIRING

A. Branch circuits may be spliced for receptacle, lighting and small appliances load inside appropriate junction boxes.

B. Except as otherwise specified, taps and splices with #10 AWG and smaller shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be further insulated with an envelope of stretched piece of EPR tape around each wire to fill the interstices between the wires. Then, apply one-half lapped layer of electrical tape over all.

C. Taps, splices, and connection in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

D. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

E. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

F. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

G. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

H. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

I. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

J. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

3.05 WIRING DEVICES

A. Install wiring devices where indicated. Wiring devices shall be type as indicated.

B. Each wiring device shall be set with axis plumb and installed with yoke screw so as to adequately support device yokes to the box.

C. Device boxes shall be cast metal condulets or equal.

D. Use ganged boxes for ganged devices.

E. Each device box shall be equipped with specified cast metal cover.

3.06 GROUNDING

A. Each item of equipment shall be adequately and thoroughly grounded. Comply with Article 250 of N.E.C., except where higher standards of grounding have been specified.

B. Equipment grounding conductors (EGC) shall be installed where indicated. These wires shall be green colored in sizes #6 AWG and smaller and green banded in larger sizes or as specified.

C. EGC runs into equipment and shall be grounded to equipment bus where available, or to equipment ground lugs.

D. Where grounding type bushings are installed, bond EGC thereto and furthermore ground each bushing lug to equipment ground bus or ground lug, or ground rod.

E. In each motor terminal box, install equipment ground lug and connect EGC thereto.

F. In each area light pole, install ground connector to pole and bond to conduit bushing and to EGC in branch circuit.

3.07 LABELING

In addition to requirements for labeling as specified throughout this section, install as follows:

A. Phase bank each power wire and cable with colored banding tape. Do this at

each termination.

B. Apply numbered wire marking labels to control wires; power wiring in panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.

C. Apply write-on identification labels to wiring sets in each hand-hole to identify function. Use waterproof labels.

D. Apply write-on identification labels to empty conduits to identify each with information as to terminus of other end and also trade size of conduit.

E. Install phenolic nameplates with engraving to identify function of switch/indicating light and/or load served for the following:

1. Electrical Panels, Lighting contactors
2. Stepdown transformers
3. Micarta nameplates shall be attached with industrial grade adhesive.
4. Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.

F. Type circuit directory information on circuit directory cards on all panelboards.

SECTION 260530
ELECTRICAL POWER SYSTEM TESTING AND COORDINATION

PART 1 GENERAL

1.01 ENGINEERING STUDIES

A. The coordination report shall include all portions of the electrical distribution system from the normal power source or sources down to and including each low voltage secondary main breaker. All plant electrical facilities, both new and future, shall be included in the report as indicated on the Overall One Line Diagrams and other pertinent Electrical drawings. Normal system connections and those, which result in maximum and minimum fault conditions, shall be adequately covered in the report. Additional information if necessary may be obtained from the local Utility.

B. The coordination report shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and prior to release of equipment for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

C. The firm performing the work shall be currently involved in high- and low-voltage power system evaluation. The work shall be performed, stamped and signed by a professional engineer currently licensed in the State of Texas. Credentials of the individual(s) performing the work and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of ten (10) years' experience in power system analysis is required for the individual in charge of the project.

D. The firm performing the work shall demonstrate capability and experience to provide assistance during start up as required.

1.02 DATA COLLECTION

A. Any data which is necessary for completion of the studies shall be obtained by the Contractor

B. The Contractor shall expedite completion of the work and submission of the report as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacturing.

PART2 Products

2.01 Short-Circuit and Coordination Report

A. The short-circuit and coordination effort shall be performed using SKM PowerTools , ETAP, or Engineer approved computer software. Contractors shall use latest version of any software proposed. Methods shall be in accordance with the latest applicable IEEE and ANSI standards.

B. In the short-circuit report, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, tabulations of calculation quantities and results, conclusions, and recommendations. Calculate short-circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each switchgear bus, transformer primary and secondary terminals, and other significant overcurrent protective device locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor fault contribution, short circuit kVA and symmetrical and asymmetrical fault currents.

C. In the protective device coordination report, provide time-current curves (TCC) graphically indicating the coordination proposed for the system, centered on conventional, log-log forms 11 inch x 17 inch minimum size. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Use manufacturers application software for microprocessor based relays. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings for all devices in a Microsoft Excel spreadsheet.

D. Include on the TCC curve sheets power company relay and fuse characteristics, medium- voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics of other system load protective devices. In addition, include all devices down to each low voltage secondary main breaker.

Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical fault current to which the device is exposed.

E. Select each primary protective device required for a wye-wye connected transformer so that it's characteristic or operating band is within the transformer characteristics; including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to- ground fault protection. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from downstream device curves by at least a 0.4-second time margin over relays and 0.2 seconds over fuses.

F. Include complete fault calculations as specified herein based on design documents and field survey data.

G. Submit qualifications of engineer(s) who will perform the work for approval prior to commencement of work. Provide reports in conjunction with equipment submittals to verify equipment ratings required. Submit a preliminary report to the Engineer for review and approval prior to delivery of final report. Make all additions or changes as required by the reviewer.

H. Notify the Engineer in writing of any circuit protective devices found to be not properly rated for fault conditions.

I. As part of this report the Contractors shall provide a Harmonic analysis of the entire electrical system is required as a part of this project. This report is intended to show the effects of the VFD's and other Harmonic generating equipment on the electrical system and to verify system conformance with IEEE Std. 519. The point of Common Coupling shall be taken at the interconnection between the Pad Mount transformer and the Main Incoming breaker. The full load amps for the system shall include all motors running (using NEC tables for motor ampacity) with an additional 100A assumed as the MCC load. The testing company should contact the local utility for any additional information required regarding available fault current of the utility system/transformer.

1.) Short-Circuit Analysis shall consist, but not be limited to the following

a. Calculation of the maximum RMS symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.
b. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.

c. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
d. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
e. Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
f. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
g. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
h. Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.

2.) Protective Device Time-Current Coordination Analysis

a. The time-current coordination analysis shall be performed with the aid of computer software intended for this purpose, and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
b. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection considered more important than service continuity.
c. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
d. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
e. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the

equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.

f. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.

h. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.

i. Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer (architect) and recommendations made for improvements as soon as they are identified.

j. The contractor shall be responsible for supplying pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the time-current analysis to be completed prior to final installation.

3.) Load Flow and Voltage Drop Analysis

a. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and include calculations of power flow in all three-phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.

b. The analysis shall provide the calculated maximum values of kVA, kW, kVAr, power factor, and amperes for each power circuit.

c. The calculated power losses in each branch and total system losses shall be provided.

d. A computer printout listing all cables, transformers, loads, and other circuit data shall be included.

e. Provide tabular bus-to-bus computer printouts listing the calculated values.

f. The analysis shall include a computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.

g. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.
Significant deficiencies in loading or voltage levels shall be called to attention of the engineer (architect) and recommendations made for improvements at soon as they are identified.

2.02 FINAL REPORT

A. The results of the power system study shall be summarized in a final report. Four (4) bound copies of the final report shall be submitted.

B. The report shall include the following sections:

1. Description, purpose, basis, and scope of the analysis.
2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
5. SKM electronic files including project, library and report files.
6. Excel electronic files on tabulated protective device settings.

PART 3 EXECUTION

3.01 FIELD SETTINGS

A. Field setting and calibration of protective devices shall be performed in accordance with Section 262600.

B. Necessary adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination report shall be carried out by the Contractor at no additional cost to the City.

END OF SECTION

SECTION 2 60550
GROUNDING

PART 1: GENERAL

1.01 WORK INCLUDED

A. The CONTRACTOR shall supply equipment, labor, and materials to provide the functionality described in this Section.

B. Power system grounding.

C. Communication system grounding.

D. Electrical equipment and raceway grounding and bonding.

1.02 REFERENCES

A. NFPA 70- National Electrical Code, latest edition

B. ANSI/UL 467- Electrical Grounding and Bonding Equipment

C. ANSI/IEEE STD 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems

D. IEEE 81 – Guide for Measuring Earth Receptivity, Ground Impedance and earth Surface Potential of a ground System

E. IEEE 1100 – Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

F. ANSI/TINEIA 607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

1.03 SYSTEM DESCRIPTION

A. Ground the electrical service system neutral at service entrance equipment to grounding electrodes. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operations. Concrete encased electrodes shall be connected as the most effective grounding electrodes. Provide a completely grounded system in accordance with Article 250 of the NEC.

B. Ground each separately-derived system neutral to separate ground buses that are installed in nearest electrical rooms. Transformer, UPS systems, power conditioners, inverters, or other power supplies are separately derived systems. Standby or emergency generators are separately derived systems if the neutral is bonded to the generator frame and if there is no direct connection of the generator neutral conductor to the service neutral conductor.

C. Provide communications system grounding conductor connected to separate electrode (ground bus) that is installed in each IT room.

D. Bond together system neutrals, service equipment enclosures, exposed non- current carrying metal parts of electrical equipment, metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath, ground bus in electrical rooms and IT rooms, metal frame of the building or structure, ground ring, lightning down lead conductor, grounding conductor in raceways and cables, receptacle ground connectors, and metal underground water pipe.

E. Bonding jumpers shall be installed around non-metal fittings or insulating joints to ensure electrical continuity. Bonding shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

F. Supplementary Grounding Electrode: Use driven ground rod on exterior of building. Install ground rod in suitable recessed well; fill with gravel after connection is made. Use minimum of 20 feet No. 4 bare copper wire embedded in concrete foundation.

G. Use minimum 6 AWG copper conductors for communications service grounding conductor. Leave 10 feet slack conductor at termination cabinet.

1.04 SUBMITTALS

Provide submittals in accordance with specifications.

PART2. PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A Grounding system components shall be as required to comply with the design and construction of the system indicated. Components shall be as indicated in manufacturer's submittal data.

B. Ground conductors shall be stranded tinned, annealed copper cable of the sizes indicated on drawings. Bond grounding conductors at both ends of metallic conduit.

C. Grounding clips shall be Steel City Type G, or equal.

D. Ground Rods shall be copper-encased steel, 3/4" diameter, minimum length 10 feet.

PART 3.

PART 3-- **EXECUTION**

3.01 INSTALLATION

A Install ground system as indicated, in accordance with the applicable requirements of the National Electrical Code and the National Electrical Contractors Association's "Standard of Installation".

B. Install grounding conductors continuous, without splice or connection, between equipment and grounding electrodes. Install test wells as required per drawings.

C. In feeder and branch circuits, provide a separate, insulated equipment grounding conductor. Terminate each end on a grounding lug, bus, or bushing.

D. Connect grounding electrode conductors to metal water pipe where metal pipe is available and accessible using suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

E. Install fusion welded ground connectors where they are concealed or inaccessible.

F. Ground each outlet by the use of an approved grounding clip attached to the junction box in such a position to be readily inspected on removal of the cover plate; or by the use of an approved grounding yoke type receptacle.

G. No strap grounding clamps shall be used; connections requiring bolting shall be made up with monel metal bolts, washers and nuts. Connections shall be made only after surfaces have been cleaned, or ground to expose virgin metal.

H. Install external ground wire on liquid tight flexible metal conduit with grounding bushings.

I. Conductor connections shall be made by means of solderless connectors such as serrated bolted clamps or split bolt and nut type connectors. .

J. The neutral of each transformer shall be bonded to system ground at one point only. This point shall be ahead of the first secondary protective device.

K. Connect grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection points below finished grade. Below grade connection shall be exothermic-welded type connectors as manufactured by Cadweld, Thermoweld, or equal. In manhole, install ground rods with 4 to 6 inches above the floor with connections of grounding conductors fully visible and accessible.

L. Isolated Grounding Systems: Use insulated equipment grounding conductor and connect only to separate grounding bus.

M. Provide grounding and bonding at Utility Company's metering equipment and pad-mounted transformer in accordance with Utility Company's requirements.

3.02 FIELD QUALITY CONTROL

A Inspect grounding and bonding system conductors and connections for tightness and proper installation.

B. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 10 ohms. Provide additional ground rod as required until resistance reading is 10 ohms or less.

END OF SECTION

MOTOR CONTROL CENTERS – LOW VOLTAGE (FREEDOM)

SECTION 262482

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the contract drawings.

1.02 REFERENCES

A. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.

1.03 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:
   1. Master drawing index
   2. Front view elevation
   3. Floor plan
   4. Top view
   5. Unit wiring diagrams
   6. Nameplate schedule
   7. Starter and component schedule
   8. Conduit entry/exit locations
   9. Assembly ratings including:
      a. Short-circuit rating
      b. Voltage
      c. Continuous current
   10. Major component ratings including:
      a. Voltage
      b. Continuous current
      c. Interrupting ratings
   11. Cable terminal sizes
   12. Product data sheets

B. Where applicable the following information shall be submitted to the Engineer:
   1. Busway connection
   2. Connection details between close-coupled assemblies
   3. Key interlock scheme drawing and sequence of operations

1.04 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:
   1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process

2. Unit wiring diagrams
3. Certified production test reports
4. Installation information
5. Seismic certification and equipment anchorage details as specified

1.05 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The motor control centers shall bear a UL label.

1.06 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.07 OPERATION AND MAINTENANCE MANUALS

A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton products (Eaton / Cutler Hammer Products) or

B. Square D/Schneider Electric

C. Approved equal.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the engineer ten (10) days prior to bid date.

THE ENGINEER MAY ACCEPT FOR REVIEW "OR EQUAL" MANUFACTURERS MEETING THE CONDITIONS OF THE SUBSTITUTE AND "OR EQUAL" ITEMS OF THE INSTRUCTION TO BIDDERS AND UNDER THE FOLLOWING CONDITIONS UNDER THE FOLLOWING CONDITIONS:

- All other requirements regarding substitutions in the plans and specifications including but not limited to USDA General and Supplemental conditions of the specifications are followed.
- All equipment substations shall meet as a minimum the requirements in the plans and specifications

- All equipment substitutions must fit in the allotted space specified in the plan sheets in each building
- Required additions to buildings slabs etc., shall be the responsibility of the Contractor and shall not be means for additional pay.
- Any additions to buildings slabs etc., shall be closely coordinated with the Owner/Engineer

2.02 RATINGS

A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a three-phase, 60 Hz system. The system operating voltage and number of wires shall be as indicated on the drawings.

2.03 CONSTRUCTION

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. They shall be 90 inches high and [21 inches] deep for front-mounted units and 21 inches deep for back-to-back mounted units. Structures shall contain a horizontal wireway at the top [9] inches tall, isolated from the horizontal bus via metal barriers and shall be readily accessible through a hinged cover. Structures shall also contain a horizontal wireway at the bottom [3] inches tall that is open to the full rear of the structure. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

B. Compartments for mounting control units shall be incrementally arranged such that not more than [six (6) Size 1 or Size 2 starters for front-mounted only] can be mounted within each vertical structure. Guide rails shall be provided.

C. A vertical wireway with minimum of 35 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.

D. All full voltage starter units through NEMA Size 5 and all feeder breakers through 400 Amp shall be of the draw-out type. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend outside of the draw-out unit. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be draw-out and shall be located in the [bottom] wireway, readily accessible through a hinged cover. All control wire to be [14 gauge] minimum.

E. All draw-out units shall be secured by a spring-loaded, quarter turn, indicating type fastening device located at the top front of the unit. With the exception of the dual-mounted units, each unit compartment shall be provided with an individual front door.

F. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access, unless the disconnect is in the “OFF” position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or reinsertion of the unit while in the “ON” position. Padlocking facilities shall be provided to positively lock the disconnect in the “OFF” position with up to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.04 BUS

A. Each structure shall contain a main horizontal as shown on the drawings. The horizontal bus shall be rated at [65] degrees C temperature rise over a 40 degrees C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating as shown on the drawings. Both vertical and horizontal bus shall be fully rated; but shall not be tapered. Vertical bus shall not be reduced rated via center feeding, and be fully rated, top and bottom, from centerline bus.

B. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism that will allow the unit stabs to engage the vertical bus every 6 inches and provide complete isolation of the vertical bus when a unit is removed.

C. Buses shall be braced for [100,000] amperes RMS symmetrical.

D. A [tin-plated] copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the motor control center. The ground bus shall be located in the [bottom] horizontal wireway.

2.05 WIRING/TERMINATIONS

A. Wiring shall be NEMA Class [II], Type [B].

2.06 MOTOR CONTROLLERS

A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize MCC Manufacturer’s type Motor Circuit Protectors.

1. Each combination unit shall be rated [100,000] AIC symmetrical at 480 Volt or as indicated in the accompanying drawings. The MCP shall provide adjustable magnetic protection and be adjustable to 1700% motor nameplate full load current to comply with NEC requirements. All MCP combination starter units shall have a “tripped” position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors through size 4 shall include transient override feature for motor inrush current.
2. Solid-State Overload Relay C440
   a. Provide a solid-state overload relay for protection of the motors where indicated
   b. The overload relay shall provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
   c. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.
   d. The overload relay shall have the following features:
      1. Self-powered
      2. Class 10A, 10, 20, or 30 selectable tripping characteristics
      3. Manual or automatic reset
      4. Available 24 VDC, 24 VAC, or 120 Vac Electronic reset
      5. Reset capabilities through onboard fieldbus

6. Selectable (On/Off) Phase loss protection. The relay shall trip in 10 seconds or less under phase loss condition
7. Selectable (On/Off) Phase Imbalance protection. The relay shall trip in 10 seconds or less under phase imbalance condition.
8. Visible trip indication
9. One normally open and one normally closed isolated auxiliary contact
10. Test button that operates the normally closed contact
11. Test trip function that trips both the normally and normally closed contacts
12. A current adjustment range of 5:1 or greater
13. Available embedded, selectable (On/Off)Ground fault protection. Relay shall trip when ground fault is detected at 50% of full load ampere setting
14. An LED that provides self-diagnostic information
15. An LED that aids in commissioning by indicating running current is too high compared to the FLA dial
16. Available Modbus, DeviceNet, Modbus TCP, EtherNet/IP or Profibus Communication
17. Available additional Inputs and Outputs (4 in and 2 out additional). Inputs shall be 120 Vac, or 24 VDC, and outputs shall be discrete relay outputs
18. Diagnostic Trip Information indicating a specific trip on either ground fault, phase loss, phase imbalance, or thermal
19. When using any of the available fieldbus the relay shall be capable of providing the following data monitoring:
    a. Individual Phase Currents
    b. Average RMS Current
    c. Thermal Capacity
    d. % Phase unbalance
    e. GF Current
    f. Line Frequency
    g. Relay settings
    h. Contactor Status

3. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed

B. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, Hand-Off-Auto (HOA) selector switch, and two (2) normally open contacts, unless otherwise scheduled on the drawings. A unit-mounted device panel shall have space to accommodate six (6) 30 mm oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters. In order to improve maintenance capabilities, the device panel shall withdraw with the unit. Door-mounted pilot devices are not acceptable.

C. Solid-state reduced-voltage starters, shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. ∃Each solid-state reduced voltage starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open network to either a personal computer

or Logic Controller via network translator to DeviceNet, MODBUS 485, MODBUS/TCP / ETHERNET/IP, or PROFIBUS DP.

D. Adjustable frequency drives shall be provided in MCC(s) where scheduled. Adjustable frequency drives shall be r variable or constant torque loads as specified. Drives for variable torque loads shall be rated a minimum of 110% over-current for one (1) minute. Drives larger than [1] horsepower shall have identical keypads, control terminals and programmable parameters. Drives shall be capable of providing 200% starting torque. Drives over 150 horsepower shall be located next to the main section to reduce bus loading and heating. All controllers shall be combination type and shall include options as specified. Drives shall have communication cards capable of communication using [DeviceNet] Drives shall be capable of using a V/Hz, open loop vector, or closed loop vector control architecture.

2.07 OVERCURRENT DEVICES

A. Circuit Breakers

1. Individual feeder breakers shall have a minimum interrupting capacity of [100] kAIC at rated voltage or as scheduled on the drawings

2.08 AUTOMATIC INSULATION TESTER

A. Automatic insulation testers shall be provided for individual MCC motor starter units where indicated on contract documents. The insulation tester shall be rated for 600 VAC, 60 Hz, motor circuits. When equipment motor is de-energized, the automatic insulation tester shall automatically apply a 500VDC potential at a current-limited, operator-safe, maximum amperage of 200 micro-amperes to “megger” the insulation of the motor windings and the insulation of the circuit between the automatic insulation tester and the motor. The automatic insulation tester shall have a 10-second time delay before alarm circuit will activate. The insulation tester shall have an input of 120 VAC, 60 Hz and be interlocked with the starter such that the insulation tester will continuously monitor the integrity of the insulation during the period that the equipment motor is de-energized, and upon detection of a leakage current to ground the insulation tester shall provide a visual alarm indication. When the equipment motor is energized, the insulation tester shall be interlocked with the starter to automatically stop testing and be automatically disconnected from the circuit. Insulation tester shall be equipped with 1 (one) Form C latching alarm contact for remote alarm status. Insulation tester shall be provided with a manual reset button and a “test-on” and “alarm” LED display.

2.09 VOLTAGE PRESENCE INDICATOR

A. Voltage Presence Indicators shall be provided on the unit door of MCC starter and feeder units as per contract documents. The voltage presence indicator shall be a hardwired voltmeter or voltage detector connected to the load side of the main incoming disconnect, and shall provide a “through-door” visual indication at the MCC unit door of any voltage presence in any individual phase to enable operators to “pre-verify” voltage presence while the MCC unit door is safely closed. The voltage presence indicator shall be equipped with an adapter to enable installation in a 30mm device-panel on the MCC unit or any other standard 30mm pilot device knockout. The voltage presence indicator shall be of potted construction with 6-foot leads and equipped with dual redundant circuitry to ensure reliability. The voltage presence indicator shall also be phase insensitive, UL type 4X listed and have immunity to high surges.

2.10 N/A

2.11 MISCELLANEOUS DEVICES

2.12 INCOMING FEEDER TERMINATIONS AND DEVICE

A. Incoming [cable] shall terminate within the control center on a [main breaker] termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be [standard mechanical screw] with anti-turn feature. Main breakers shall be provided as indicated on the drawings and shall be [molded case]/[power circuit breakers].

2.13 OWNER METERING

A. Where indicated on the drawings, provide a separate, owner metering compartment with front hinged door.

B. Provide as a minimum of four (4) current transformers for each meter including Nuetral current meter. Current transformers shall be wired to shorting-type terminal blocks.

C. Provide [potential transformers} including primary and secondary fuses with disconnecting means] for metering.

D. Microprocessor-Based Metering System.

E. Web-Enabled Communications

1. Where indicated on the drawings, provide a separate compartment with a front facing hinged door as a central point of connection for all internally located communicating devices to an external Ethernet network and allow close monitoring of the power infrastructure with real-time, web-enabled data.

2. The compartment shall have a lockable, hinged door with a functional through-the-door RJ45 network access port. Power for the components in the compartment shall be supplied by a pre-wired, bus-connected control transformer in the compartment that is fused and has a disconnecting means.

3. The included communications components shall be a [Power Xpert Ethernet Switch(es)] as required.

2.14 ENCLOSURES

A. The type of enclosure shall be in accordance with NEMA standards for [type 1A with gasketed doors]. All enclosing sheet steel, wireways and unit doors shall be gasketed.

2.15 NAMEPLATES

A. Each unit will have a 1.0 x 2.5-inch engraved nameplate. The lettering shall be 3/16-inch high, black on a white background.

2.16 FINISH

A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer’s standard color shall be used. All structural steel and panels will be painted.

B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

2.17 MOTOR CONTROL CENTER (AS INDICATED ON PLAN SHEETS)

A. The Motor Control Center shall consist of an integral harmonic correction unit for the attenuation of harmonics induced by nonlinear loads such as ac Adjustable Frequency Drives.

B. The harmonic correction unit for the Clean Motor Control Center shall be in a totally enclosed dead-front, free-standing MCC assembly. Structures shall be 90 inches high and 21 inches deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus by metal barriers and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

C. An operating mechanism shall be mounted on the primary of each harmonic correction unit. It shall be mechanically interlocked with the door to prevent access unless the disconnect is in the “OFF” position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. Padlocking facilities shall be provided to positively lock the disconnect in the “OFF” position with from one (1) to three (3) padlocks with the door open or closed.

D. Harmonic Correction Units shall be disconnected from the power source by a molded case switch. All units shall include 200,000 AIC rated fuses with Class T actuation. All units shall be provided with a grounding lug. Grounding by the contractor shall be performed according to local and national standards.

E. The harmonic correction units shall be sized to meet 5% total harmonic current distortion {THD (I)}, 5% total demand distortion (TDD), and <5% total harmonic voltage distortion {THD (V)} levels as defined by IEEE 519-1992 at [system Point of Common Coupling as defined in IEEE519].

F. The harmonic correction unit shall be designed in accordance with the applicable sections of the following standards. Where a conflict arises between these standards and this specification, this specification shall govern.

1. ANSI IEEE standard C62.41-1991 [Surge Withstand Capacity]
2. CSA 22.2, No. 14 & 66 [CSA requirements for power electronics]
3. FCC Part 15, Sub Part J, Class A [RFI/EMI emission standards]
4. ANSI IEEE standard 519-1992 [Harmonic limits]
5. UL 508C [UL requirements for power conversion equipment]

G. The motor control center manufacturer shall install the harmonic correction unit in the motor control center. The harmonic correction unit shall be approved by UL or CSA for installation in the motor control center.

H. Modes of Operation

1. The harmonic correction unit shall be designed to electronically inject harmonic current to cancel load produced harmonic current such that the upstream power harmonic current and voltage are reduced to below 5% TDD and 5% THD (V) as defined by ANSI IEEE standard 519-1992 for load demand and voltage distortion limits. TDD as used herein refers to the total load demand of the applied circuit. The applied circuit may be a single nonlinear load, an entire distribution bus load, or the facility load at the Point-of-Common Coupling (PCC)
2. Reactive current compensation (displacement power factor correction) shall be activated via a digital keypad/display mounted on the door of the enclosure. When reactive

current compensation is activated, the harmonic correction unit shall first perform harmonic current correction and then use the remaining capacity to inject reactive current compensation to the specified level herein defined

I. Design

1. Each unit of the harmonic correction units shall meet FCC Part 15, Sub Part J, Class A requirements for both radiated and conducted EMI
2. All harmonic correction units shall be defined as a power electronic device consisting of power semiconductors that switch into the AC lines to modulate its output to cancel detrimental harmonic and/or reactive currents. A DC bus shall store power for power semiconductor switching. A microprocessor shall control the operation of the power converter
3. Each unit shall be designed with a current limiting function to protect the semiconductors. When this level is attained, a message shall be displayed indicating the output capacity is at-maximum capacity and actuate the at-maximum capacity relay. Operation shall continue indefinitely at this level without trip off or destruction of the power correction unit
4. Two distinct levels of faults shall be employed. Non-critical level faults will provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action
   a. Faults such as ac line over-voltage, AC line under-voltage, AC line power loss, and AC line phase imbalance shall be automatically restarted. Upon removal of these fault conditions, the power correction system shall restart without user action. Automatic restart will not occur if 5 faults have occurred in less than 5 minutes. During the fault condition, except line loss, the display shall state the type of fault and indicate that automatic restart will occur. The run relay and run LED shall be disabled. The fault relay shall not be enabled unless time out occurs. Upon AC line loss, the power-on relay shall be disabled and no display shall be provided.
   b. All other types of faults shall be considered critical and stop the power correction system. The display shall indicate the fault condition and “STOP.” The run LED and relay shall be disabled and the fault relay enabled. User shall be required to initiate a power reset (turn power OFF and ON) to restart the power correction system.
5. The logic of the harmonic correction unit shall monitor the load current by utilizing two (2) current transformers (CT’s) mounted on phases A and B to direct the function of the power electronic converter. A third current transformer is required if single-phase or three-phase line-to-neutral connected loads are present downstream from the location of the CT’s. The ratio of the CT’s must be entered into the logic via the digital keypad/display to calibrate the operation of the power correction system. The output of the current transformers shall be 5 amperes
6. Up to three (3) harmonic correction units may be installed in parallel to inject current according to the information received from one set of CT’s. The units will function independently. If one unit is stopped or faulted, the remaining units will adjust accordingly to maintain optimum harmonic cancellation levels up to the capacity of the remaining units

J. Performance Requirements

1. Input Power:
   a. Voltage: 480 Volt, 3-phase, 3-wire, plus ground

b. Voltage Tolerance: +/- 10% of nominal
c. Frequency: 60 Hz, +/- 5%
d. Current Limit: 100% of rating
e. Surge Withstand Capability: ANSI/IEEE std. C62.41-1991 without damage
f. Input Fuses: Rated at 200 kAIC, Class J.

K. Output Performance
1. Performance of the harmonic correction unit shall be independent of the impedance of the power source. All performance levels shall be attained whether on the ac lines or backup generator or output of the uninterruptible power supply (UPS)
2. Harmonic Correction:
a. Limit 2nd through 50th order harmonic current to <5% TDD as defined in ANSI/IEEE STD 519-1992 at each installed location. Harmonic levels for individual harmonic orders shall comply with respective levels established in ANSI/IEEE STD 519-1992.
b. Limit the THD (V) added to the electrical system immediately upstream of the power correction system location(s) to less than or equal to 5% as defined in ANSI/IEEE STD 519-1992. The power correction system shall not correct for utility supplied voltage distortion levels.
3. Reactive Current Compensation: to .90 lagging displacement power factor. Leading power factor is not permitted

L. Environmental Conditions
1. The harmonic correction unit shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics or life
a. Operating Ambient Temperature: 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F).
b. Storage Temperature: -40 degrees C (-40 degrees F) to 65 degrees C (149 degrees F).
c. Relative Humidity: 0 to 95%, non-condensing.
d. Altitude: Operating to 2000 meters (6500 ft). Derated for higher elevations.
e. Audible Noise: Generated by power correction system not to exceed 65 dbA measured 1 meter from surface of unit.
f. Vibration: Seismic Zone 4.

M. Current Transformers
1. Split core type current transformers shall be installed as defined herein and shown in the electrical drawings. Current transformers shall be rated for the total rated RMS current of the total load at each installed location
2. Two current transformers per power correction system location shall be provided and shall be mounted on phases A and B. A third current transformer shall be provided if single or three-phase line-to-neutral connected loads are present downstream from the location of the CT’s
3. Each current transformer shall have a current output of 5 amperes. Current capacity of each current transformer shall be 5000, 3000, 1000 or 500, as required for the electrical system where installed. No other ratings are acceptable
4. Each current transformer shall be rated for 400 Hz

N. Operator Controls and Interface

1. All units shall include a digital interface model (DIM) that includes an alphanumeric display consisting of 2-lines with 20 characters per line. All information shall be in English. Operators include run, stop, setup, enter, and up/down scroll
2. The display shall provide operating data while functioning. Standard operating parameters available for display are ac line voltage, total RMS load current, harmonic current of load, reactive current of load, output harmonic and reactive current of power correction system
3. When the output of the power correction unit is at full rated capacity, the display shall indicate at-maximum capacity and actuate an at-maximum capacity relay
4. All fault conditions shall be displayed as they occur. Diagnostic information shall be provided in English and clearly indicate the nature of the fault
5. The run pushbutton shall include a green LED. LED shall be lighted when unit is running
6. Contacts shall be provided for operator information for power-on, run, fault and at-maximum capacity. Each contact shall be rated for 1 ampere at 120/240 volts. One Form C contact shall be provided for each relay
7. An RS-485 serial communication port shall be provided for remote control and diagnostic information.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. Representative motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.

B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.

C. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.02 FIELD QUALITY CONTROL

A. Provide the services of a qualified factory-trained manufacturer’s representative to assist the contractor in installation and startup of the equipment specified under this section for a period of 5 working days. The manufacturer’s representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer’s service representative:

1. Rig the MCC assembly into final location and install on level surface
2. Check all removable cells and starter units for easy removal and insertion
3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus
4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source
5. Torque all bolted connections made in the field and verify all factory bolted connections

6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives

C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.

B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

A. The Contractor shall provide a training session for up to five (5) owner's representatives for 3 normal workdays at the job site or other office location chosen by the owner.

B. A manufacturer's qualified representative shall conduct the training session.

C. The training program shall consist of the following:

1. Review of the MCC one-line drawings and schedules
2. Review of the factory record shop drawings and placement of the various cells
3. Review of each type of starter cell, components within, control, and power wiring
4. Review contactor coil replacement and contact replacement procedures
5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program
6. Provide three-ring binders to participants complete with copies of drawings and other course material covered

3.05 EXAMINATION

A. Contractor shall fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.

B. Contractor shall supply overload relay heater ratings that are properly sized and coordinated for each motor starter unit.

C. Contractor shall verify NEC clearances as dictated on the contract drawings prior to installation. Verify UL labeling of the assembly prior to installation.

3.06 INSTALLATION

A. Contractor shall follow the installation instructions supplied by the manufacturer.

B. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

C. As Shown on the contract drawing, Contractor is to provide all DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps external to the MCC.

3.07 FIELD ADJUSTMENTS

A. The Contractor shall perform field adjustments of the short circuit and overload devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, protective device coordination study, manufacturer's instruction leaflets, and the contract documents.

3.08 FIELD TESTING

A. Contractor is responsible for generation of a field report on tests performed, test values experienced, etc., and make the report available to owner upon request.

SECTION 226600
ELECTRICAL ACCEPTANCE TESTING

PART 1 GENERAL

1.01 SCOPE:

A. Perform acceptance testing of electrical apparatus and circuits described herein to determine suitability for energization and operation. It is the intent of these specifications to assure that the completed electrical installation is installed in accordance with the design drawings and specifications and is operational with industry and manufacturer's tolerance.

B. Provide all material, equipment, labor and technical supervision to perform tests and inspections as described herein.

1.02 REFERENCES:

A. All inspections and field tests shall be in accordance with the latest edition of the following codes, standards, and specifications except as provided otherwise herein.

1. American National Standards Institute- ANSI

2. American Society for Testing and Materials- ASTM

ASTM 877. *Test Method for Dielectric Breakdown Voltage of Insulating Liquids using Disk Electrodes.*

ASTM D 923. *Test Method for Sampling Electrical Insulating Liquids.*

ASTM D 971. *Test Method for Interfacial Tension of Oil Against Water by the Ring Method.*

ASTM D 974. *Test Method for Acid and Base Number by Co/or-Indicator Titration.*

ASTM D 1500. *Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).*

ASTM D 1524. *Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.*

ASTM D 1533. *Test Methods for Water in Insulating Liquids (Karl Fischer Reaction Method).*

ASTM D 1816. *Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.*

3. Institute of Electrical and Electronic Engineers- IEEE

ANSI/IEEE C2, *National Electrical Safety Code*

ANSI/IEEE C37, *Guides and Standards for Circuit Breakers,*

Switchgear, Relays, Substations, and Fuses.

ANSI/IEEE C57, *Distribution, Power and Regulating Transformers.*

ANSI/IEEE C62, *Surge Protection*

ANSI/IEEE Std. 43. *IEEE Recommended Practice for Testing InsulationResistance of Rotating Machinery.*

ANSI/IEEE Std. 48. *IEEE Standard Test Procedures and Requirements for High- Voltage AC Cable Terminations*

ANSI/IEEE Std. 81. *IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of* a *Ground System.*

ANSI/IEEE Std. 95. *IEEE Recommended Practice for Insulation Testing of Large AC Rotating Machinery with High Direct Voltage.*

ANSI/IEEE Std. 141. *IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants (IEEE Red Book).*

ANSI/IEEE Std. 142. *IEEE Recommended Practice for Grounding of Industrial and Commercial Power* Systems *(IEEE Green Book).*

ANSI/IEEE Std. 241. *IEEE Recommended Practice for Electric Power* Systems *in Commercial Buildings (Gray Book).*

ANSI/IEEE Std. 242. *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power* Systems *(Buff Book).*

ANSI/IEEE Std. 399. *IEEE Recommended Practice for Power* Systems *Analysis (Brown Book).*

ANSI/IEEE Std. 400. *IEEE Guide for Making High-Direct-Voltage* Tests *on Power Cable* Systems *in the Field.*

ANSI/IEEE Std. 421B. *IEEE Standard for High-Potential-Test Requirements for Excitation* Systems *for Synchronous Machines.*

ANSI/IEEE Std. 446. *IEEE Recommended Practice for Emergency and Standby Power* Systems *for Industrial and Commercial Applications (Orange Book).*

ANSI/IEEE Std. 450. *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations.*

ANSI/IEEE Std. 493. *IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power* Systems *(Gold Book).*

ANSI/IEEE Std. 602. *IEEE Recommended Practice for Electric* Systems *inHealth Care Facilities (White Book).*

ANSI/IEEE Std. 637. *IEEE Guide for the Reclamation of Insulating Oil and Criteria for Its Use.*

ANSI/IEEE Std. 739. *IEEE Recommended Practice for Energy Conservation and Cost-Effective Planning in Industrial Facilities (Orange Book).*

ANSI/IEEE Std. 1100. *IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).*

ANSI/IEEE Std. 1106. *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations.*

4. Insulated Cable Engineers Association – ICEA

5. InterNational Electrical Testing Association- NETA

Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

6. National Electrical Manufacturer's Association- NEMA
NEMA Standard for Publication No. AB4: *Guidelines for Inspection and Preventive Maintenance of Molded-Case Circuit Breakers Used in Commercial and Industrial Applications.*
NEMA Publication MG1: *Motors and Generators*

7. National Fire Protection Association- NFPA ANSI/NFPA

70: *National Electrical Code.*

ANSI/NFPA 708: *Recommended Practice for Electric*

Equipment Maintenance. ANSI/NFPA 70E: *Electrical*

Safety Requirements for Employee Workplaces.

ANSI/NFPA 780: *Lightning Protection Code.*

8. Occupational Safety and Health Administration- OSHA

9. State and local codes and ordinances

10. Underwriters Laboratory- UL

1.03 QUALIFICATIONS OF TESTING PERSONNEL:

A. Use only properly trained and qualified personnel for proper testing of complete

1.04 TEST EQUIPMENT:

A. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.

2. Split-core current transformers and clamp-on or tongue-type ammeters require careful consideration of the following in regard to accuracy:

a. Position of the conductor within the core.

b. Clean, tight fit of the core pole faces.

c. Presence of external fields.

d. Accuracy of the current transformer ratio in addition to the accuracy of the secondary meter.

3. Selection of metering equipment should be based on a knowledge of the waveform of the variable being measured. Digital multi-meters may be average or RMS sensing and may include or exclude the dc component. When the variable contains harmonics or de offset and, in general, any deviation from a pure sine wave, average sensing, RMS scaled meters may be misleading.

4. Field test metering used to check power system meter calibration must have accuracy higher than that of the instrument being checked.

5. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of two percent of the scale used.

6. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

B. Test Instrument Calibration

1. The testing form shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy.

2. The accuracy shall be directly traceable to the National Institute of Standards and Technology. (NIST)

3. Instruments shall be calibrated in accordance with the following frequency schedule:

a. Field instruments: Analog, 6 months maximum; Digital, 12 months maximum

b. Laboratory instruments: 12 months

c. Leased specialty equipment: 12 months where accuracy is guaranteed by lessor.

d. Dated calibration labels shall be visible on all test equipment.

e. Records, which show date and results of instruments calibrated or tested, must be up-to-date and shall be submitted in accordance with Par. 1.06.

f. Up-to-date instrument calibration instructions and procedures shall be maintained for each test instrument.

g. Calibrating standard shall be of higher accuracy than that of the instrument tested.

SECTION 226600
ELECTRICAL ACCEPTANCE TESTING

1.05 N/A

1.06 SUBMITTALS- FOR APPROVAL:

A Qualifications Statement:

1. Experience record on proposed testing firm to include client contact names and telephone numbers.

2. Experience record on technicians who will perform testing work.

B. Test Equipment

1. Schedule of test equipment to be used for project.

2. Calibration records for each item of test equipment.

1.07 SUBMITTALS- FOR CLOSE OUT

A Field Test Reports- Submit the following data bound and indexed in a 3 ring loose leaf binder.

1. Summary of project.

2. Description of equipment tested and nameplate data.

3. Description of tests.

4. Test results.

5. List of deficiencies observed and corrective action taken, if any.

6. Analysis and recommendations.

PART 2 PRODUCTS- NOT USED

PART 3 EXECUTION

3.01 FIELD TESTS

A. Perform field tests and listed herein. Test procedures shall be in accordance with NETA Acceptance Testing Specifications. Dielectric test voltages applied to circuits and to equipment shall not exceed values or duration recommended by the equipment manufacturer.

B. Low Voltage Motor Starters:

SECTION 226600
ELECTRICAL ACCEPTANCE TESTING

1. Visual and Mechanical Inspection
   a. Compare equipment nameplate data with drawings and specifications.
   b. Inspect physical and mechanical condition.
   c. Inspect and adjust contact gap, wipe, alignment, and pressure in accordance with manufacturer's published data.
   d. Motor-Running Protection
      1) Compare overload element rating with motor full-load current rating to verify correct sizing.
      2) If power-factor correction capacitors are connected on the load side of the overload protection, include the effect of the capacitive reactance in determining appropriate overload element size.
      3) If motor-running protection is provided by fuses, verify correct rating considering motor characteristics and power-factor correction capacitors.
   e. Inspect all bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
      3) Perform thermographic survey.
2. Electrical Tests
   a. Insulation Tests
      1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
      2) Measure insulation resistance of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts closed and the protective device open. Refer to manufacturer's instructions for devices with solid-state components.
      3) Measure insulation resistance of each control circuit-to-ground.
      4) Perform an insulation resistance test at 1000 volts dc on all control wiring. For units with solid-state components, follow manufacturer's recommendations.

   b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
      NOTE: Test times for thermal trip units will, in general, be longer than manufacturer's curve if single-pole testing is performed. Optionally test with all poles in series for time test and each pole separately for comparison. (Refer to ANSI/NEMA ICS 2, Part 4.)
   c. Test circuit breakers, including motor circuit protectors, in accordance with Section 7.6.1.1.
   d. Perform operational tests by initiating control devices.

3. Test Values
   a. Compare bolted connection resistance to values of similar connections.
   b. Bolt-torque levels should be in accordance with values specified by manufacturer.
   c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
   d. Insulation-resistance values shall be in accordance with accepted values.
   e. Control wiring insulation test resistance should be a minimum of two megohms.
   f. Overload trip times shall be in accordance with manufacturer's published data.

C. Cables - Low-Voltage, 600 Volt Maximum

1. Visual and Mechanical Inspection
   a. Compare cable data with drawings and specifications.
   b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
   c. Inspect all bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
   d. Perform thermographic survey.
   e. Inspect compression-applied connectors for correct cable match and indentation.
   f. Verify cable color coding with applicable specifications and the National Electrical Code.

2. Electrical Tests
   a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc. Test duration shall be one minute.
   b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
   c. Perform continuity test to insure correct cable connection.

3. Test Values
   a. Compare bolted connection resistance to values of similar connections.
   b. Bolt-torque levels should be in accordance with values specified by the manufacturer.
   c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
   d. Minimum insulation-resistance values should not be less than 50 megohms.
   e. Investigate deviations between adjacent phases.

D. Switchgear and Switchboard Assemblies

1. Visual and Mechanical Inspection
   a. Compare equipment nameplate data with drawings and specifications. b. Inspect physical and mechanical condition.
   c. Verify appropriate anchorage, required area clearances, physical damage, and correct alignment
   d. Inspect all doors, panels, and sections for corrosion, dents, scratches, fit, and missing hardware.
   e. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.
   f. Inspect all bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque- wrench method in accordance with manufacturer's published data.
      3) Perform thermographic survey.
   g. Verify that current and potential transformer ratios correspond to drawings.
   h. Compare equipment nameplate data with latest one-line diagram when available.
   i. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
      1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.

2) Make key exchange with devices operated in off-normal positions.

j. Thoroughly clean switchgear prior to testing.

k. Lubrication

1) Verify appropriate contact lubricant on moving current-carrying parts.

2) Verify appropriate lubrication on moving and sliding surfaces

l. Inspect insulators for evidence of physical damage or contaminated surfaces.

m. Verify correct barrier and shutter installation and operation.

n. Exercise all active components.

o. Inspect all mechanical indicating devices for correct operation.

p. Verify that filters are in place and/or vents are clear.

q. Perform visual and mechanical inspection on all instrument transformers.

r. Inspect control power transformers.

1) Inspect physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse ratings or circuit breakers match drawings.

3) Verify correct functioning of draw out disconnecting and grounding contacts and interlocks

2. Electrical Tests

a. Perform tests on all instrument transformers.

b. Perform ground-resistance tests.

c. Perform resistance tests through all bus joints with a low-resistance ohmmeter, if applicable.

d. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute.

e. Perform an over potential test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data. The test voltage shall be applied for one minute.

f. Perform insulation-resistance tests at 1000 volts de on all control wiring. For units with solid-state components, follow manufacturer's recommendations.

g. Perform control wiring performance test.

h. Perform current injection tests on the entire current circuit in each section of switchgear.

1) Perform current tests by primary injection, where possible, with magnitudes such that a minimum of 1.0 ampere flows in the secondary circuit.

2) Where primary injection is impractical, utilize secondary injection with a minimum current of 1.0 ampere.

3) Test current at each device.

i. Determine accuracy of all meters and calibrate watthour meters. Verify multipliers.

j. Perform phasing check on double-ended switchgear to insure correct bus phasing from each source.

k. Control Power Transformers

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.

2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to correct secondary voltage. Confirm potential at all devices.

3) Verify correct secondary voltage by energizing primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.

4) Verify correct function of control transfer relays located in switchgear with multiple power sources.

l. Voltage Transformers

1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground.
2) Perform secondary wiring integrity test. Confirm correct potential at all devices.
3) Verify secondary voltages.

m. Verify operation of switchgear/switchboard heaters.

3. Test Values

a. Compare bus connection resistances to values of similar connections.
b. Bolt-torque levels shall be in accordance those specified by manufacturer.
c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar bus by more than 50 percent of the lowest value.
d. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with manufacturer's published data. Values of insulation resistance less than manufacturer's minimum shall be investigated. Over potential tests should not proceed until insulation- resistance levels are raised above minimum values.
e. The insulation shall withstand the over potential test voltage applied.

E. Circuit Breakers - Low-Voltage - Insulated Case/Molded Case

1. Visual and Mechanical Inspection

a. Compare nameplate data with drawings and specifications.
b. Inspect circuit breaker for correct mounting.
c. Operate circuit breaker to insure smooth operation.
d. Inspect case for cracks or other defects.
e. Inspect all bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
3) Perform thermographic survey.
f. Inspect mechanism contacts and arc chutes in unsealed units.

2. Electrical Tests

a. Perform a contact-resistance test.
b. Perform an insulation-resistance test at 1000 volts de from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase
d. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
e. Perform insulation resistance tests at 1000 volts de on all control wiring. Do not perform the test on wiring connected to solid state components.
f. Perform adjustments for final settings in accordance with coordination study supplied by owner.
g. Perform long-time delay time-current characteristic tests by passing 300 percent rated primary current through each pole separately unless series testing is required to defeat ground fault functions.
h. Determine short-time pickup and delay by primary current injection.
i. Determine ground-fault pickup and time delay by primary current injection.
j. Determine instantaneous pickup current by primary injection using run-up or pulse method.

k. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.

l. Verify the calibration of all functions of the trip unit by means of secondary injection.

3. Test Values

a. Compare bolted connection resistance to values of similar connections.

b. Bolt-torque levels should be in accordance those specified by manufacturer

c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

d. Circuit breaker insulation resistance should be in accordance manufacturer's published data.

e. 5. Control wiring insulation resistance should be a minimum of two megohms.

f. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors. Circuit breakers exceeding specified trip time at 300 percent of pickup shall be tagged defective.

g. Instantaneous pickup values of molded-case circuit breakers shall be within tolerances.

F. AC Motors

1. Visual and Mechanical Inspection

a. Compare equipment nameplate data with drawings and specifications.

b. Inspect physical and mechanical condition.

c. Confirm correct application of manufacturer's recommended lubricants.

d. Inspect anchorage, and grounding.

e. Inspect all bolted electrical connections for high resistance using one of the following methods:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

3) Perform thermographic survey.

f. When applicable, perform special tests such as air gap spacing and pedestal alignment.

g. Verify the absence of unusual mechanical or electrical noise or signs of overheating during initial test run.

2. Electrical Tests- Induction Motors

a. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

b. Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43.

1) Motors larger than 200 horsepower: Test duration shall be for ten minutes. Calculate polarization index.

2) Motors 200 horsepower and less: Test duration shall be for one minute. Calculate the dielectric-absorption ratio.

c. Perform the over potential tests on motors in accordance with ANSI/IEEE Standard 95.

d. Perform insulation power-factor or dissipation-factor tests.

e. Perform surge comparison tests.

f. Perform insulation-resistance test on pedestal in accordance with manufacturer's published data.
g. Test surge protection devices.
h. Test motor starter.
i. Verify that resistance temperature detector (RTD) circuits conform to drawings. Verify that metering or relaying devices using the RTD's have the correct rating.
j. Verify that the motor space heater is functional.
k. Perform a rotation test to insure correct shaft direction.
l. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

3. N/A

4. Test Values
   a. Compare bolted connection resistance to values of similar connections.
   b. Bolt-torque levels should be in accordance with values specified by manufacturer.
   c. Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available investigate any values which deviate from similar connections by more than 50 percent of the lowest value.
   d. Insulation-resistance test results shall be in accordance with manufacturer' published data. Investigate dielectric absorption ratios less than 1.4 and polarization index ratio less than 2.0 for Class B insulation and Class F insulation.
      NOTE: Over potential, and surge comparison tests shall not be made on motors having values lower than those indicated above.
   e. Stator winding de over potential test voltage shall be in accordance with NEMA publication MG 1, paragraph 3.01. Test results are dependent on ambient conditions, and evaluation is on a withstand basis. If phase windings can be separately tested, values of leakage current may be compared for similar windings.
   f. Vibration amplitudes shall not exceed values shown in manufacturer's published data.
   g. Salient pole voltage drop shall be equal for each pole
      NOTE: For de tests each pole (or pair of poles) shall not vary more than two percent from the average. An AC test is more sensitive than a de test in determining shorted turns. A pole with shorted turns will have a substantially lower voltage than sound coils. Coils adjacent to coils with shorted turns will exhibit slightly lower voltage.
   h. The measured resistance values of motor-field windings, exciter-stator windings, exciter-rotor windings, and field-discharge resistors shall be compared to manufacturer's recommended values.

G. N/A.

H. Grounding Systems
   1. Visual and Mechanical Inspection
      Verify ground system is in compliance with drawings and specifications.
   2. Electrical Tests
      a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values
   a. The resistance between the main grounding electrode and ground should be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference: ANSI/IEEE Standard 142.)
   b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. N/A

SURGE PROTECTIVE DEVICES (SPDs)

LOW VOLTAGE AC SURGE PROTECTION FOR ELECTRICAL DISTRIBUTION SYSTEMS

SECTION 262671

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.02 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.03 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
2. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

B. Where applicable the following additional information shall be submitted to the engineer:

1. Descriptive bulletins
2. Product sheets

1.04 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Section 1.04 and shall incorporate all changes made during the manufacturing process

1.05 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.06 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.07 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton / Cutler-Hammer products

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●

Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
      i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. ∃Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection
   a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.
8. Safety Requirements
   a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.03 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.04 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   3. The panelboard shall be capable of re-energizing upon removal of the SPD.

4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.

B. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)
1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

C. Switchgear, Switchboard, MCC and Busway Requirements
1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
3. The SPD shall be factory installed inside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
6. The SPD shall be integral to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.05 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment

due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)

3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 EXECUTION

3.01 EXAMINATION

3.02 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.03 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.04 WARRANTY

A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

SECTION 407055 - MASTER CONTROL PANEL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Master Control Panel – General requirements for a Master Control Panel (MCP) designed to monitor and control all local control panels for each turbo blower and field instruments required for a complete package control system.

1.2 REFERENCE STANDARDS

A. National Electrical Manufacturers Association (NEMA):
   1. ICS 4 - <Document Title>.
   2. ICS 6 - Enclosures for Industrial Controls and Systems.
   3. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. National Electric Code (NEC).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures specifies requirements for submittals.

B. Shop Drawings:
   1. Scaled panel face, interior layout, and nameplate layout drawings.
   2. Panel and subpanel materials of construction.
   3. Panel and subpanel dimensions.
   4. Panel access openings.
   5. Internal wiring and terminal block drawings.
   6. Nameplate text.
   7. Scaled layouts of any graphic panels.

C. Operation and Maintenance Manuals.

1.4 QUALITY ASSURANCE

A. Prior to placement of conduit feeds, assure approved control panel layouts are available.

PART 2 PRODUCTS

2.1 ENCLOSURES

A. Standard MCP Panel shall be approximately 36” wide 12” deep and 48” high wall mountable. Larger sizes may be used for aeration control system control as noted elsewhere.

B. Enclosure shall be rated Nema 4/12.

C. Enclosure shall be as manufactured by Saginaw or equal.

2.2 MAINTENANCE MATERIALS

A. Spare Parts:
   1. Replacement Fuses. Provide minimum of 3 fuses for all sizes and types of control fuses provided within the control panel.

2.3 FABRICATION

A. General:
   1. Panel shall be constructed in a UL 508 (CUL) panel shop and shall be serialized as such.

B. Wall Mounted Panels:
   1. Seams continuously welded and ground smooth.
   2. Body stiffeners for extra rigidity if either height or width exceeds 28".
   3. Rolled lip around all sides of enclosure door opening.
   4. Gasketed dust tight.
   5. After cutouts have been made, finish opening edges to smooth and true surface condition.
   6. Front full opening door.
   7. Brackets for wall mounting.
   8. Maximum size shall be 12" deep 60" tall 36" wide. All larger panels shall be supplied as free standing.

C. Panel Wiring and Piping:
   1. Factory pipe and wire panels to identified terminal blocks equipped with screw type terminals.
   2. Install all wiring without splicing in factory in raceways:
      a. Raceways shall have removable covers.
   3. Arrange circuits on terminal blocks plus any spare conductors on adjacent terminals.
   4. Provide necessary power supplies for control equipment.
   5. Equip each panel with a main circuit breaker. Limit load to maximum of 80 percent of circuit breaker rating.
   6. Assure each panel mounted device is bonded or otherwise grounded to panel or panel grounding system by means of locknuts or pressure mounting methods.
      a. Equip panel with grounding terminals.
   7. Arrange wiring with sufficient clearance for all leads.
   8. Identify all wires with plastic sleeve type wire markers at each end. Markers shall:
      a. Identify circuit numbers.
      b. Match provided schematics.
   9. Termination requirements:
      a. Terminals shall facilitate wire sizes as follows:
         1) 120 V AC applications: Wire size 12 AWG and smaller.
         2) Other: Wire size 14 AWG and smaller.
      b. Provide terminal blocks with continuous marking strip.
      c. Tag each I/O terminal to indicate tag number of the connected device.
      d. Provide terminals for individual termination of each signal shield.

D. Panel Lighting and Power:
    1. Receptacles:
        a. Panels less than 4 feet wide and less than 16” deep:
            1) One electrical outlet marked for test equipment only on a 5 amp fuse.
        b. Panels wider than 4 feet long or deeper than 16”:
            1) One electrical outlet marked for test equipment only on a 5 amp fuse per 4’ of panel width.
            2) Continuous fluorescent lighting strip with door switch and separate circuit breakers.

E. Environmental Controls:
    1. None provided. Panel intended for indoor installation.

2.4 ACCESSORIES

A. Furnish electrical equipment, devices, and accessories as required for a complete and operable control panel. This is to include the following as a minimum:
    1. Programmable Logic Controller:
        a. Allen Bradley Compact Logix L24.
    2. Operator Interface:
        a. Allen Bradley Panel View Plus 10”
    3. Network Switch:
        a. Phoenix Contact 5 or 8 port DC powered.
        b. Communications between the blowers and the MCP shall be Ethernet IP. Contractor shall provide cat5e shielded cable between the blowers and the MCP.
        c. Communications between the MCP and the owners interface shall be Ethernet IP. Contractor shall provide cat5e shielded cable between the owners interface and the MCP.
    4. Panel terminals and accessories:
        a. Fuse blocks shall be Allen Bradley or equal.
        b. Terminal blocks shall be Allen Bradley or equal.
        c. Relays shall be Allen Bradley or equal.

2.5 PANEL OPERATION

A. The MCP shall control all the blowers using the “Constant Speed” control mode of the blower.

B. All starting, Stopping, Speed Control, and Monitoring of the blower units will be VIA the Ethernet IP network.

C. The following points shall be monitored from each blower and displayed on the MCP Operator interface as a minimum:
    1. Rotor Speed
    2. Suction Temperature
    3. Calculated Suction Flow Rate
    4. Filter Differential Pressure
    5. Rotor Vibration (If equipped)
    6. Bearing Temperature
    7. Motor Temperature

8. Discharge Temperature
9. Discharge Pressure
10. Motor Power
11. Remote/Local Mode
12. Control Mode
13. Operation Status
14. Fault Code
15. Total Run hours
16. Current Run Hours

D. The blower MCP shall accept the following inputs from the User SCADA system via the Ethernet IP network. (Hardwired I/O are also available.)
   1. Start/Stop blower system
   2. Blower Control Mode (Manual, Constant Flow, Constant Pressure, DO)
   3. Command Reference (hardwired only)
   4. Command Signal (Network only)

E. The blower MCP shall make available the following outputs to the User SCADA system via the Ethernet IP network. (Hardwired I/O are also available.)
   1. All Blower Parameters listed above in section C.
   2. Alarm Conditions.
   3. All process variables available on the HMI Screen shall be available.

F. Operator interface shall be programmed in a manner that is consistent with the individual blower LCP units. Color schemes and programming shall be in conformance.

G. In Manual mode, the blower will be completely controlled from the user SCADA interface or the Operator interface on the touch screen. The user will be able to manually select the following for each blower:
   1. Start/Stop command
   2. Speed Command

H. In flow control mode, the blowers will be operated automatically by the MCP.
   1. The SCADA or Operator interface will give the flow set point.
   2. The blowers will automatically start and stop based upon a pre-determined sequence from the MCP panel.
   3. The suction flow rate will be totalized from all operating blowers and the suction flow rate will be used for the flow control method.
   4. The set point will be in suction CFM.
   5. The calculation will be based on a PID controller.
   6. All blowers will operate together at the same speed to achieve the pre-determined flow rate.
   7. When the blowers are operating at a pre-determined high speed for a pre-set time, another blower will start.
   8. When the blowers are operating at a pre-determined low speed for a pre-set time, one of the blowers will stop.

I. In pressure control mode, the blowers will be operated automatically by the MCP.
   1. The SCADA or Operator interface will give the pressure set point.

2. The blowers will automatically start and stop based upon a pre-determined sequence based on operating hours from the MCP panel.
3. The average discharge pressure from the operating blower units will be used for the pressure control method (Unless a discharge pressure transmitter is required to be wired into the MCP panel. Then the discharge header pressure transmitter shall be used).
4. The set point will be in PSI.
5. The calculation will be based on a PID controller.
6. All blowers will operate together at the same speed to achieve the pre-determined flow rate.
7. When the blowers are operating at a pre-determined high speed for a pre-set time, another blower will start.
8. When the blowers are operating at a pre-determined low speed for a pre-set time, one of the blowers will stop.

J. In DO control mode, the blowers will be operated automatically by the MCP.
1. The SCADA or Operator interface will give the DO set point.
2. The blowers will automatically start and stop based upon a pre-determined sequence based on operating hours from the MCP panel.
3. The hardwired 4-20ma signal from a DO probe will be used for the control method if one is provided. Otherwise a network DO value may be written to the MCP panel.
4. The set point will be in mg/l.
5. The calculation will be based on a PID controller.
6. All blowers will operate together at the same speed to achieve the pre-determined flow rate.
7. When the blowers are operating at a pre-determined high speed for a pre-set time, another blower will start.
8. When the blowers are operating at a pre-determined low speed for a pre-set time, one of the blowers will stop.

2.6 AERATION CONTROL:

A. Each Aeration zone control loop shall consist of the following:
1. DO Probe
   a. Hach LDO probe with SC100 Controller or approved equal. See Section 407506.
   b. SC100 controller may be used for up to two DO probes.
2. Air Flow Meter
   a. FCI with mounting hardware
   b. Sierra Instruments with mounting hardware
   c. Approved equal; See Section 407305.
3. Modulating Air valve
   a. Bray with Bray valve or approved equal; See Section 400564.
   b. Limitorq; See Section 403447.
   c. Rotork; See Section 403447.
4. The operator shall be able to set a DO (or air flow where DO probes are not used) setpoint for each aeration zone. This setpoint will be used to calculate the air flow required for the aeration zone.
5. When the system starts, all valves will be in the full open position.
6. The zone with the highest air flow requirement will maintain the modulating valve in the full open position. All other valves will modulate their respective positions to control the air flow to the air flow requirement.

7. The sum of the air flow requirements will be used in the MCP for the flow control mode setpoint. The sum of the air flows from the air flow meters will be used as the control variable in the control loop.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install free-standing panels on concrete housekeeping pads as detailed on the Drawings.

B. Anchor panel fronts rigidly into wall system with approved anchoring devices.

END OF SECTION

SECTION 407305 - FLOW MEASUREMENT: THERMAL MASS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Thermal mass flow measurement.

B. Related Requirements:
   1. Section 013300 – Submittal Procedures.
   2. Section 407506 - Analyzers: Dissolved Oxygen (DO) and Common Work Results for Process Control and Instrumentation Systems.

C. Provide all instruments identified in the Contract Documents.

1.2 DEFINITIONS

A. As specified in Section 407506.

B. Specific definitions:
   1. Surface mount technology: The practice and method of attaching leaded and non-leaded electrical components to the surface of a conductive pattern that does not utilize leads in feed-through holes. This technology reduces power requirements for the thermal flow instruments.
   2. Retract mechanism: A device also includes a mechanism that enables the plant maintenance staff to remove the probe easily for cleaning and other maintenance needed. This device also enables the plant maintenance staff to re-insert the sensor probe back into its original position without leakage for measurement service again.

1.3 REFERENCE STANDARDS

A. As specified in Section 407506.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures specifies requirements for submittals.

B. Delegated Design Submittals: Submit design calculations for flow modeling.

C. Provide complete documentation covering the traceability of all calibration instruments.

1.5 QUALITY ASSURANCE

A. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:

a. Installation and mounting requirements.
b. Location within the process.
c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

B. Notify the District Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements specifies requirements for transporting, handling, storing, and protecting products.

B. As specified in Section 407506.

1.7 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, humidity, and process and ambient temperatures.

1.8 EXISTING CONDITIONS

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

1.9 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Thermal mass flowmeters:
1. Provide one of the following:
a. Kurz Instruments, Inc. – Model No. 454 series with thermal mass flow element, remote transmitter, and probe sensor.
b. Sierra Instruments, Inc. – Model No. 640S thermal mass flow sensor; remote transmitter, and probe sensor.
c. Fluid Components International LLC (FCI®) – Model No. ST50 with thermal dispersion flow element, remote transmitter, and a balance retract mechanism for the probe sensor.
2. Substitutions: Specified in Section 01 60 00 - Product Requirements.

2.2 MANUFACTURED UNITS

A. Thermal mass flowmeter:
   1. General:
      a. Thermal mass flowmeters measure airflow, industrial, and process gas mass flows by detecting the heat transfer from a heated RTD sensor referenced to the temperature of the ambient gas stream sensor.
      b. The electronic circuitry shall either maintain a constant differential temperature between the gas temperature and the heated element or a constant power.
      c. The electronic circuitry shall deliver a linear signal 4 to 20 mA DC output proportional to the process fluid flow.
   2. Performance requirements:
      a. Accuracy:
         1) 1.5 percent of full scale for velocities over 2 feet per second.
      b. Repeatability:
         1) 0.5 percent of full scale.
   3. Element:
      a. Sensor with terminal enclosure:
      b. Utilize a sensor with 3/4 –inch male NPT process connection.
      c. No overheat at zero flow.
   4. Transmitter:
      a. Microprocessor-based.
      b. Enclosure: NEMA Type 4X.
      c. Power supply:
         1) 120 VAC.
         2) Power consumption: 50 VA maximum.
      d. Outputs:
         1) Isolated 4 to 20 mA DC with HART communication protocol.
      e. Alphanumeric display flow rate.
      f. Ambient operating temperature limits: 0 to 150 degrees Fahrenheit.
   5. Components:
      a. Signal cable between insertion probe and transmitter:
         1) Abrasive-resistant, polyurethane jacket.
         2) Sensor cable permanently bonded to sensor.
         3) Provide enough length of cable to allow removal and inspection of insertion element.

2.3 ACCESSORIES

A. Software (if available as either a standard or an option) for fully validation on instrument performances.

B. Provide sunshade for outdoor installations.

2.4 SOURCE QUALITY CONTROL

A. As specified in Section 407506.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. Installation Standards: Install Work as specified in Section 407506.

B. Install digester gas flowmeters 45 degrees below the horizontal to prevent condensation from building up on the tip.

3.4 FIELD QUALITY CONTROL

A. As specified in Section 407506.

B. Provide manufacturer's services to perform installation inspection services.

3.5 ADJUSTING

A. As specified in Section 407506.

3.6 CLEANING

A. As specified in Section 407506.

3.7 PROTECTION

A. As specified in Section 407506.

3.8 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Document:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

		THERMAL MASS FLOWMETERS							
		1	Service		Aeration Blower		Aeration Blower		
		2	Quantity (Each)		1		1		
ELEMENT	CONN	3	Line Size / Schedule		14 inch		12 inch		
		4	Connection Type		Insertion		Insertion		
		5	Connection Materials		Mfr. Recommended		Mfr. Recommended		
	PROBE	6	Type		Thermal		Thermal		
		7	Probe Material		Mfr. Recommended		Mfr. Recommended		
		8	Enclosure Class		NEMA 4X		NEMA 4X		
		9	Balance Retract Mech.		No		No		
	FLUID	10	Fluid		Air		Air		
		11	Max Flow Units		CFM		CFM		
		12	Max Velocity Units						
		13	Norm Flow	Min Flow	3000	0	3000	0	
TRANSMITTER		14	Mounting		Integral		Integral		
		15	Enclosure Class		NEMA 4X		NEMA 4X		
		16	Type Span Adjustment		Mfr. Std.		Mfr. Std.		
		17	Power Supply		115VAC, 60Hz		115VAC, 60Hz		
		18	Transmitter Output		4-20 mA		4-20 mA		
		19	Accuracy		0.75% of full scale		0.75% of full scale		
		20	Display Scale Size	Range	16 Char. LCD	Adjustable	16 Char. LCD	Adjustable	
		21	Alarm Contact No.	Form	Mfr. Std.	Mfr. Std.	Mfr. Std.	Mfr. Std.	

SECTION 407506 - ANALYZERS: DISSOLVED OXYGEN (DO) AND COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dissolved oxygen (DO) analyzer.
   2. General requirements applicable to all Process Control and Instrumentation Work.

B. Related Requirements:
   1. Section 013300 - Submittal Procedures.
   2. Section 407055 – Master Control Panel

1.2 DEFINITIONS

A. NEMA: Type 6P enclosure in accordance with NEMA 250.

B. DO – Dissolved oxygen.

C. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically information is displayed in a graphical format.

D. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.

E. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.

F. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.

G. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator interface functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.

H. NEC: National Electrical Code.

I. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Instrumentation and Control Work specified and depicted on the Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.

J. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.

K. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.

L. PLC: Programmable logic controller.

M. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.

N. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.

O. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.

1.3 REFERENCE STANDARDS

A. American National Standards Institute (ANSI).

B. American Petroleum Institute (API):
   1. RP 550 – Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
   2. RP 551 – Process Measurement Instrumentation.

C. International Organization for Standardization (ISO):
   1. 9001 – Quality Management Systems – Requirements.

D. International Society of Automation (ISA):
   1. 5.1 – Instrumentation Symbols and Identification.
   2. 5.4 – Instrument Loop diagrams.
   3. 20 – Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

F. National Fire Protection Association (NFPA).

G. National Institute of Standards and Technology (NIST).

H. Underwriters Laboratories, Inc. (UL):
   1. 508 – Standard of Safety for Industrial Control Equipment.
   2. 508A – Standard of Safety for Industrial Control Panels.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures specifies requirements for submittals.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.5 QUALITY ASSURANCE

A. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

B. Notify the District Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

C. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements specifies requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging including application instructions.

C. Inspection: Accept products on Site in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label. Inspect for damage.

D. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction of the Owner's operations.

E. Protect Dissolved Oxygen Monitoring System from damage, dust, and moisture by packing in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting.

1.7 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturer List:
   1. Hach LDO probe with Hach SC100 controller.
   2. Series Q46D as manufactured by Analytical Technology, Inc.
   3. Substitutions: Specified in Section 016000 - Product Requirements.

B. Description: Dissolved oxygen analyzer:
   1. General:
      a. Dissolved oxygen analyzer for continuous monitoring of dissolved oxygen in liquid.
   2. Performance requirements:
      a. Measuring range: 0 to 20 parts per million (ppm).
      b. Sensor accuracy:
         1) Within 0.2 ppm for values shown above 1 ppm.
         2) Within 0.1 ppm for values below 1 ppm.
      c. Repeatability: Within 0.5 percent of span.
      d. Response time:
         1) 90 percent value: Less than 40 seconds.
         2) 95 percent value: Less than 60 seconds.
   3. Element:
      a. Optical type that measures the fluorescence or luminescence of a ruthenium or platinum coated sensor.
      b. Using no membrane, electrodes, or electrolyte.
      c. Drift: less than 1 percent per year.
      d. Automatic self-diagnostics.
      e. Integral temperature sensor.
      f. Maximum pressure: 150 pounds per square inch.
      g. Power supply: From transmitter through sensor cable.
      h. Enclosure: NEMA Type 6P.
   4. Transmitter:
      a. Power supply:
         1) 120 VAC.
         2) Power consumption: 75 VA maximum.
      b. Outputs:
         1) Isolated 4 to 20 milliamperes DC with HART communication protocol.
         2) Relay outputs:
            a) 3 Form C contracts.
            b) Rated 5 amps at 120 VAC.
            c) Programmable.
      c. Microprocessor based with features resident in non-volatile memory.
      d. Display dissolved oxygen content with 0.01 ppm resolution over a range of 0.00 to 9.99 ppm and 0.1 ppm resolution over a range of 10.0 to 20.0 ppm.
      e. Display temperature with 0.2 degree Celsius accuracy.
      f. Enclosure rating: NEMA Type 4X.
      g. Automatic temperature compensation.
   5. Components:
      a. Manufacturer’s cable for sensor to transmitter connection.

2.2 ACCESSORIES

A. Calibration equipment: Provide components recommended by the manufacturer to verify calibration.

B. Provide sunshade for outdoor installations.

C. Provide a pole mount kit for mounting the sensor.

D. Provide head assembly for air cleaning.

2.3 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST.
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements specifies requirements for installation examination.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.2 PREPARATION (NOT USED)

3.3 INSTALLATION

A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions as indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all information indicated on the Drawings, including mechanical and electrical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
   3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.

B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.

C. The PCIS configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where Project conditions require, make reasonable changes in locations and arrangements.

D. Field instruments installation:

1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
    a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
    b. Provide sun shields for all field electronic instruments exposed to direct sunlight.
3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
    a. Type of flexible conduit required as specified in Electrical Specifications.
    b. Maximum length of 18 inches.
4. Connect field instruments with cable as specified in the Electrical Specifications, except where the manufacturer requires the use of special cable, or otherwise specified in this Section:
    a. Special cable applications shall be in accordance with the NEC.
5. Verify the correctness of each installation:
    a. Polarity of electric power and signal connections.
    b. Ensure all process connections are free of leaks.

E. Process sensing lines and air tubing:
1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
2. Provide supports for rigid tubing at intervals of not more than 3 feet.
3. Slope horizontal runs of instrument tubing at a minimum of $1/16^{th}$ inch per foot to allow for draining of any condensate.
4. Bends:
    a. Use proper tool.
    b. Make bends for parallel lines symmetrical.
    c. Make bends without deforming or thinning the walls of the tubing.
5. Square-cut and clean al lends of tubing before being inserted in the fittings.
6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
    a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.

F. Conduit, cables, and field wiring:
1. Provide all PCS equipment cables, and process LAN communication networks under this specification.
2. Provide terminations and wire identification as specified in the Electrical Specifications.
3. Protect all wiring from sharp edges and corners.
4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of the Electrical Specifications.

G. Equipment tie-downs:
1. Anchor all instruments, control panels, and equipment by methods that comply with wind bracing requirements, which apply to the Site.
2. All control panels, VCPs, LCPs, RTUs, PCMs, etc. shall be permanently mounted and tied down to structures.

H. Existing instrumentation:
    1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.

I. Cable and conductor termination:
    1. Terminate all cables and conductors on terminal blocks.
    2. Terminal block enclosures:
        a. Suitable for the area as described in Electrical specifications.

J. Surge protection:
    1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments.
    2. Individually fuse each 4 to 20 milliamperes direct current loop with a 1/16 ampere fuse between power supplies and receiver surge protectors.
    3. Provide voltage surge protection for 4 wire transmitters and analyzers:
        a. Protect both power source and signal loop.

3.4 FIELD QUALITY CONTROL

A. Inspection:
    1. Allow for inspection of PCIS installation.
    2. Provide any assistance necessary to support inspection activities.
    3. Engineer inspections may include, but are not limited to, the following:
        a. Inspect equipment and materials for physical damage.
        b. Inspect installation for compliance with Drawings and Specifications.
        c. Inspect installation for obstructions and adequate clearance around equipment.
        d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
        e. Inspect equipment nameplate data to verify compliance with design requirements.
        f. Inspect cable terminations.
        g. Inspect/witness instrument calibrations/verifications.

B. Instrument Installation Inspection:
    1. Provide any assistance necessary to support inspection activities.
    2. Inspections may include, but are not limited to, the following:
        a. Inspect equipment and materials for physical damage.
        b. Inspect the installed arrangement, lay lengths, orientation, piping obstructions, etc. that could affect the instruments accuracy or repeatability.
        c. Inspect installation for compliance with Drawings and Specifications.
        d. Inspect installation for obstructions and adequate clearances around equipment.
        e. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
        f. Inspect equipment nameplate data to verify compliance with design requirements.
        g. Inspect cable terminations.
        h. Inspect/witness instrument calibrations/verifications.

C. Installation supervision:
    1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
        a. Installation resources:

1) Coordinate with the Contractor regarding installation requirements of the Contract Documents.

b. Provide technical assistance to installation personnel by telephone:
   1) Furnish installation personnel with at least one copy of the accepted submittals, including all installation details.
c. Periodic inspection during the construction period.
d. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
e. Field verify accuracy and calibration of all instruments

D. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.5 ADJUSTING

A. Section 017000 - Execution and Closeout Requirements specifies requirements for starting and adjusting.

B. It is understood that the Contractor knows and agrees that changes will be required in the control system software during the Source Testing, Functional Testing, Process Operational Period, Process Start-up and during the Project Correction Period.

3.6 CLEANING

A. Supply a DO Analyzer with an integral system for automatically cleaning the sensor while still immersed in the aeration tank. The frequency of cleaning shall be programmable in the electronic monitor from once every hour to once every 24 hours. The system shall perform automatic sensor cleaning using a high pressure air jet to scour the sensor face of accumulated deposits, with the analog and digital outputs unaffected by the cleaning process. The air cleaning nozzle assembly shall not protrude outside the overall sensor diameter so that fibrous material will not snag on the cleaning assembly, and all air tubing shall run inside the mounting pipe to further avoid fouling problems. Sensors with tubing and cable running up the outside of the mounting pipe are not acceptable as "equal" to the specified equipment. The cleaning procedure shall not require an operator to activate, but shall be designed so that an operator can manually start the cleaning sequence if desired.

B. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.

C. Clean all panel surfaces.

D. Return to new condition any scratches and/or defects.

E. Wipe all instrument faces and enclosures clean.

F. Leave wiring in panels, manholes, boxes, and other location in a neat, clean, and organized manner:
   1. Neatly coil and label all spare wiring lengths.

2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

3.7 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements specifies requirements for protecting finished Work.

B. Protect all Work from damage or degradation until date of Substantial Completion.

3.8 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

GEN	ANALYZERS – DISSOLVED OXYGEN (DO)		
	1	Service	Aeration Basins
	2	Quantity (Each)	2 Transmitters, 4 Sensors
SENSOR	3	Type	Luminescent, Immersion type
	4	Operating Temperature Range	32 to 122 degrees Fahrenheit
	5	Resolution	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
	6	Sensitivity	±0.5% of span
	7	Repeatability	±0.5% of span
	8	Accuracy	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span
CABLE	9	Style	Mfr Std.
TRANSMITTER	10	Type	Microprocessor-based
	11	Enclosure	NEMA 4X
	12	Mounting	Remote
	13	Range	0-10 mg/l
	14	Repeatability	±0.05% of range
	15	Power Requirements	120VAC-1P
	16	Display	Graphic dot matrix LCD with LED backlighting
	17	Resolution	240 x 160 pixels
	18	Number of sensor input channels	Dual Sensor
	19	Outputs	4-20 mA HART
	20	Ambient Operating Temperature	-4 to 140 degrees Fahrenheit
	21	Relays	4 SPDT type
OPT	22	Mounting Kit	Pole Mounting Kit
	23	Cleaning	Head Assembly

SECTION 461371

DIRECT DRIVE HIGH-SPEED TURBO BLOWER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. General:
1. The MANUFACTURER shall furnish blowers to provide aeration. The blowers shall include, but not be limited to the following primary components:
    a. Direct drive high-speed turbo Blower Units (Blowers), each unit containing:
        1) High-speed turbo blower with air bearing or electromagnetic bearing and direct drive motor.
        2) Variable frequency drive to vary the speed of the motor/blower unit.
        3) Harmonic filter.
        4) Variable diffuser vanes (if applicable).
        5) Inlet air filtration system.
        6) Discharge cone/silencer.
        7) Blow-off and isolation valves and actuators.
        8) Discharge check-valve.
        9) Flexible connectors.
        10) Blow-off silencer.
        11) Blower instrumentation system (pressure, temperature, flow, and vibration monitoring devices).
        12) Blower cooling system (if applicable).
        13) Blower unit enclosure.
        14) Blower vendor control panel (VCP).
        15) Blower unit miscellaneous appurtenances.
    b. Main air header temperature transmitter.
    c. Main air header pressure transmitter.
    d. Custom software for blower system controls.
    e. Anchoring feet and bracing of blower units and appurtenances. Contractor to provide anchor bolts.
    f. All other appurtenances and custom designed software necessary for complete and automated blower systems.
2. Blower units, instrumentation, controls, and appurtenances shall be provided as specified herein for complete and automated blower systems.
3. All equipment, instrumentation, and accessories specified in this Section and shall be furnished by the MANUFACTURER, who shall be responsible for the suitability and compatibility of all included equipment.
4. Any additional components or accessories not included in the MANUFACTURER's scope of supply and required for complete systems shall be provided by the CONTRACTOR. MANUFACTURER shall provide a complete list of all equipment, lubricants, hardware, gaskets, and any other accessories not included in their scope of supply, which are required to provide workable, operational, and complete systems.
5. All equipment specified shall be installed by the CONTRACTOR.

1.02 REFERENCES

A. American National Standard Institute (ANSI)/American Society of Mechanical Engineers (ASME)
   1. PTC-10, Power Test Code for Centrifugal Compressors and Exhausters.
   2. B16.1 – Gray Iron Pipe Flanges and Flange Fittings: Classes 25, 125, and 250.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A 48 – Specification for Gray Iron Casting.
   2. ASTM A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. ASTM A 276 – Standard Specification for Stainless Steel Bars and Shapes.
   4. ASTM A 278 – Specification for Gray Iron Castings.
   5. ASTM A 536 – Standard Specification for Ductile Iron Castings.
   6. ASTM A 564 – Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

C. American Petroleum Institute (API):
   1. Standard 617 – Centrifugal Compressors for General Refinery Service.

D. National Electric Manufacturers Association (NEMA).

E. Institute of Electrical and Electronic Engineering (IEEE):
   1. IEEE 4, Standard Technique for High-Voltage Testing.
   2. IEEE 43, Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   3. IEEE 85 – Test Procedure for Airborne Noise Measurements on Rotating Electric Machinery.
   4. IEEE 118, Standard Test Code for Resistance Measurement.
   5. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

F. International Organization for Standardization (ISO):
   1. ISO 9001 – Quality Management Systems – Requirements.

1.03 SYSTEM DESCRIPTION

A. The blower units will be used for providing variable airflows to Activated Sludge Basins. Vendor Control Panel (VCP), system software, instrumentation, and accessories shall optimize blower system operation. All items specified in this Section shall be supplied by the MANUFACTURER.

B. The control and instrumentation systems for the blower units shall be furnished by the MANUFACTURER. The MANUFACTURER shall be responsible for the factory testing, coordination, communication, system operation, system debugging, and final system calibration for equipment, instrumentation, and controls for the complete blower systems.

C. The MANUFACTURER shall provide and set all blower unit protection settings.

1.04 SUBMITTALS

A. General:
   1. All products required for submittal under this Section shall be furnished in one complete package.
   2. All submittal dimensions, calculations and other information to be in USA English units of measure.

B. MANUFACTURER's Qualifications:
   1. General:
      a. Installation List: Include a comprehensive list of all installed units, with North American installations clearly identified. List must include equipment model and service application.
      b. Submittal shall identify the individual that will serve as the point-of-contact for the procurement, service, and warranty of the blower system.
   2. Service Network:
      a. MANUFACTURER shall describe their current service network, by listing the nearest factory authorized service center and/or qualified service representative. Identify service technicians and include pertinent certifications to substantiate their knowledge and expertise.
   3. Start-Up and Training Capabilities: MANUFACTURER shall describe and demonstrate their approach to field start-up and training.
      a. Start-Up: Include description and sample test procedure for field start-up.
      b. Factory Training: Include a description of the factory training facility and sample outline for typical factory training that will be available to the OWNER. Identify the trainer and associated qualifications, including resume and/or training certifications.
      c. Field Training: Include a description of the typical field training and sample outline that will be available to the OWNER, as specified in this Section. Identify the trainer and associated qualifications, including resume and/or training certifications.

C. Quality of Construction:
   1. Proof of UL Certification: Submit proof of UL certification on applicable blower components. Certification shall include at least the blower local control panel, integral VFD, and other electrical components within the package and shall be based on the same model and size of the components proposed. UL certification must be demonstrated prior to acceptance of proposed equipment. Failure to meet this requirement will result in immediate rejection.
   2. Statement of conformance letter stating conformance to the specifications with all exceptions noted. Statement of conformance must be signed by an individual authorized to make such statements.
   3. Bill of Materials: Complete bill of materials of all components and equipment supplied. Bill of materials shall include make and model number and replacement cost of the primary components including, but not limited to the following:
      a. VFD - KEV Manufacturer or Approved Equal.
      b. PLC – Allen Bradley L 24 or Approved Equal.
      c. Harmonic filter – Mirus or Approved Equal.
      d. Sensors (temperature, pressure, vibration, etc.).
      e. Air filters.
      f. Control transformers.

D. Spare Parts:
   1. Include a list of recommended spare parts and nearest supplier (identify suppliers name and address, and other pertinent contact information). Include a statement of availability of all parts.

E. Warranty and Service Agreements: Submit a detailed description of the MANUFACTURER's warranty and service agreement options.
   1. Standard Warranty: Include a detailed description of the MANUFACTURER's standard warranty.
      a. MANUFACTURER to modify warranty as required to meet the project requirements.
   2. Extended Warranty: Include a detailed description of the MANUFACTURER's extended warranty options. Description shall include pricing structure.
   3. Service Agreements: Include a detailed description of the MANUFACTURER's service options. Description shall include pricing structure.
   4. Tech Support: Provide contact information for local service and tech support.

F. Product Data:
   1. Blower characteristics, specifications, and performance.
      a. Descriptive brochures and blower data.
      b. Predicted performance curves indicating speed, capacity, horsepower, input wire KW, and efficiency, over the range of operation.
      c. Complete bill of materials and catalog information showing the details of blower construction.
      d. Outline installation drawings for each unit.
      e. Blower unit weight and weights of each separate equipment items.
   2. LCPs:
      a. Proposed layout of mounted devices and terminals with dimensions within LCP.
      b. Proposed LCP PLC programming printout with I/O listing.
      c. Proposed LCP HMI graphic display printouts.
      d. Operating description for LCP: Include detailed descriptions of all logic and sequences of operation of control loops within the LCP controller, points monitored, available local and automatic control functions, and alarms. Provide a more detailed description of these functions than is described in these Specifications.
   3. Motor characteristics, specifications, and performance.
      a. Motor data sheets and descriptive bulletins.
      b. Outline drawings with dimensions.
      c. Cut-away and exploded view drawings.
      d. Parts list with material designations.
      e. Nameplate data.
      f. Description of insulation system.
      g. Service factor.
      h. Efficiency at 1/2, 3/4, and full load.
      i. Power factor at 1/2, 3/4, and full load.
      j. Current and power factor vs. speed curves at 100-percent rated voltage.
      k. Special features including condensation heaters and winding temperature detectors.
         1) Type and rating.
   4. Flexible Connectors (Expansion Joints or Outlet Flexible Joint):
      a. Expansion joint label.

b. Materials of construction.
c. Dimensions.
d. Temperature ratings.
e. Pressure ratings.
f. Pipe size and service.
g. Contract Drawing Number.
h. Layout Drawing Number.
i. Rated concurrent movements (inches):
    1) Lateral movement.
    2) Compression movement.
    3) Extension movement.
    4) Angular movement.
j. Maximum axial and lateral spring forces, pounds.
k. Test pressure, psig.

G. Shop Drawings:
1. Certified dimensional drawings of the blower unit, including cutaway views.
2. Certified anchor bolt layout drawings.
3. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
4. Any necessary dimensioned drawings to coordinate piping layout with structural, architectural, electrical, and/or other mechanical work.
5. Certified drawings of the local control and master control panels.
    a. Interconnects to all components outside the panel.
    b. Preliminary I/O listings for all control panel PLCs.
    c. Door layout.
    d. Interior layout.
    e. Printout of operator Interface screens.
6. Harmonic filter dimensional drawings and schematics.

H. Quality Control Submittals:
1. General:
    a. Test Reports: Submit after fabrication, but prior to delivery of equipment to jobsite location.
    b. Results of Each Required Test: Summarized in a separate, certified, written report.
    c. Reports: Organized and clearly present testing methods and procedures, testing equipment, test data, calculations and analyses, conclusions and recommendations.
    d. Test reports shall be signed and sealed by the MANUFACTURER's engineer in charge of the testing.
    e. Certified written test reports shall be submitted to OWNER for review and acceptance. Test reports shall have been reviewed and accepted by OWNER prior to jobsite delivery of equipment.
    f. If the certified factory test reports indicate noncompliance with the requirements of the Contract Documents, the blowers shall be reworked and retested until compliance with the specifications is attained.
2. Certified Factory Test Results:
    a. Certified acoustical test results for each blower package.
    b. Certified pressure test results for each blower.
    c. Certified report of dynamic balancing and maximum vibration amplitude.
3. Certified Blower Performance Test:

a. Submit a detailed test plan with complete piping and instrumentation configuration diagram per ASME PTC 10 showing inlet and discharge air test pipe size. The location, type, and quantity of all major instruments necessary for performance data, with corresponding distances from reference points, shall be identified per ASME PTC 10 requirements. As a minimum, the detailed test plan shall include:
    1) Quality control procedures.
    2) ASME PTC 10 test procedure and method of calculating results.
4. Functional testing of entire aeration air system package, instrumentation, ancillary components, and LCPs.

I. Closeout Submittals:
1. Operation and Maintenance Manuals:
    a. Prepare operation and maintenance manuals for both blower systems, including appurtenances included in this Section.
    b. Operating and maintenance manuals and maintenance summary sheets for the equipment specified herein shall conform to the provisions as specified in this Section.
    c. Provide Project Record Documents showing as-built dimensions, as-built wiring and control diagrams, as-built logic diagrams and design information for supplied parts and equipment.
    d. PLC and HMI Programs:
        1) Provide complete electronic copies of the PLC and HMI programs and configuration files for all equipment in both the master blower control panel and individual blower control panels, in the native file format of each device, along with any supporting files. Programs shall be fully accessible for use by the OWNER – programs that are locked, restricted, or contain hidden materials are not permitted.
    e. Provide a detailed description of control systems.
    f. Provide panel drawings, wiring diagrams, specifications, and a detailed description of the local panels and master control panel.
2. Maintenance agreement as included in this Section.

1.05 OPERATION AND MAINTENANCE MANUALS

A. All dimensions, calculations, and other information to be in USA English units of measure.

B. Provide a list of components and catalog cut sheets fully describing all items:
1. Mechanical and structural components.
2. Instruments.
3. Programmable Logic Controllers (PLCs).
4. Operator Interface/machine monitors.
5. Electrical components.

C. General description of blower with all performance data, blower curves, and model. Provide detailed information on structural, mechanical, electrical, or other changes or modifications necessary to adapt non-specified materials to the arrangement or details shown. Include the actual ASME PTC 10 test report.

D. Mechanical Drawings with general arrangement showing enclosure dimensions, overall weights, weights of largest components requiring removal for maintenance,

and clearances required around unit for maintenance access. Indicate surface preparation and paint specifications.

E. Description of process control logic and process and instrumentation diagrams.

F. Drawings of all control panels to include:
   1. Electrical ladder diagram.
   2. Interconnect to all components outside the panel.
   3. Door layout.
   4. Interior layout.
   5. Sample Operator Interface screens for the local panels and master control panel.

G. Operating description for local panels and master control panel. Provide a copy of the software ladder logic covering all logic and sequences of operation. Provide a soft copy of all documented PLC code on CD. Provide OWNER with one software license of any PLC or touch screen OIT software that is used. Provide a list of instrument settings.

H. Provide a detailed description of the data acquisition, monitoring, and predicted preventative maintenance software. Provide typical Operator Interface screens with detailed descriptions, the various tattletale monitors, preventative maintenance items, and data logging features.

I. Provide input/output (I/O) listing for all control panel programmable logic controllers (PLC).

J. Indicate all scheduled maintenance requirements and routine inspections. Include maintenance summary forms.

K. Provide list of recommended spare parts and lubricants.

L. Provide a troubleshooting guide.

M. Provide the local sales representative contact information with the company name, contact person, phone number, and address.

1.06 TOOLS AND SPARE PARTS

A. The MANUFACTURER shall furnish all special tools and appliances necessary to disassemble, service, repair, and adjust the equipment and appurtenances of the blower units, except for the air filters.

B. The following spare parts shall be furnished:
   1. One complete set of all sensors.
   2. One set of maintenance tools.
   3. One water cooling pump for each blower size (if applicable).
   4. One set of enclosure bolts and locks.
   5. One complete set of air filters for each blower as specified in this Section.

C. All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers. Tools and spare parts (except for the air filters) shall be supplied in a tool chest for long-term storage and marked with MANUFACTURER's name, along with a complete description on contents.

D. MANUFACTURER shall warrant that, after substantial completion, an entire replacement to the blower systems or any submodule needed for repair shall be delivered to the project site within 36 hours of notification.

1.07 QUALITY ASSURANCE

A. MANUFACTURER shall provide complete aeration air systems, including blower units, motors, VFDs, harmonic filters, control panels, controls, and all appurtenances to form integrated systems.

B. MANUFACTURER shall assume full responsibility for compatibility of all components furnished, and control systems as specified.

C. MANUFACTURER Qualifications:
   1. MANUFACTURER shall be experienced in manufacturing high-speed turbo blowers similar to those specified in this Section and have a record of successful in-service performance in North America for similar municipal wastewater treatment applications.
   2. MANUFACTURER must have a minimum of two blower systems permanently installed and operational in wastewater treatment facilities in North America.
   3. MANUFACTURER shall have a history of manufacturing and providing this equipment for at least 2 years (can include non-North American experience). A list of similar installations shall be furnished with the shop drawing submittal, including names and telephone numbers of contacts.

D. MANUFACTURER’s authorized field representative qualifications:
   1. MANUFACTURER’s authorized field representative must be trained and approved for conducting field start-ups, testing and training for blowers and aeration air systems similar to system required for this Project. Submit resume data for MANUFACTURER’s authorized field representative.

E. Equipment which is a "standard product" with the MANUFACTURER shall be modified, redesigned from the standard mode, if necessary, or furnished with special features, accessories, materials, or finishes as may be necessary to conform to the detailed requirements of these Specifications.

F. The blower MANUFACTURER’s machining and assembly shops must be ISO 9001 certified.

1.08 NOISE LEVEL RESTRICTIONS

A. The maximum sound pressure level at any point at a distance of 3 feet or more from any blower enclosure unit surface shall not exceed 85 dBA (free field) plus or minus the accuracy of the sound meter used, with the blower running at any capacity and limited to the components supplied by the MANUFACTURER as described below. The accuracy of the sound meter shall be based on the calibration data sheets from the sound meter MANUFACTURER.

1. The specified maximum sound pressure level of 85 dBA includes the noise emitted from any possible source from the blower system components in the blower room from the upstream side of the inlet to the discharge side of the discharge cone, including but not limited to: the noise from motor, blower, inlet piping and fittings between the inlet silencer and the blower inlet, and discharge piping and fittings between the blower volute discharge flange and the discharge silencer.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the blower units and equipment are ready for operation.

B. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

C. Shipment is not to be made until the MANUFACTURER coordinates shipment to the jobsite with the OWNER, ensuring that the equipment will be properly received and stored.

1.10 ENVIRONMENTAL CONDITIONS

A. The equipment to be provided under this Section shall be suitable for installation and operation under the following conditions:

Characteristic	Units	Value
Type of Installation	Indoor/Outdoor	Indoor
Maximum Temperature	Degrees F	110
Minimum Temperature	Degrees F	20
Site Elevation	Feet	0

1.11 WARRANTY

A. Warranty: Warrant equipment to be free of defects in material and workmanship for a minimum of two (2) years from the date of delivery, cover parts, shipping, travel expenses and labor.

B. MANUFACTURER’s warranty shall be issued in the OWNER's name.

C. Warrant the control systems and all software for 2 years from date of delivery to the OWNER.
   1. License all software to the OWNER.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Blower Manufacturers:
   1. Basis of Bid:

a. APG-Neuros, Model NX150-C060 at Isla Blanca WWTP, NX30-C050 at Laguna Vista WWTP
b. Piller-TSC, of Schenectady, NY.
c. Sulzer-ABS.
d. Substitutions: Specified in Section 016000 – Product Requirements.

B. The blower system layout provided in drawings is preliminary and subject to revision during Submittal phase.

2.02 GENERAL

A. Blower units shall be direct drive high-speed turbo blower type units complete with a high-speed motor, VFD, harmonic filter, and instrumentation and controls system all provide within an enclosure. Each blower unit shall be provided with an inlet (if applicable) and discharge flanged connection. Louvered inlet is acceptable at Laguna Vista WWTP. Harmonic filter may be provided in separate enclosure due to blower limited room.

B. All items specified in this Section shall be furnished by a single MANUFACTURER to provide sole source responsibility for complete and properly functioning blower and aeration air systems.

C. The MANUFACTURER shall furnish, coordinate, start up, and calibrate all items specified in this Section.

D. No special foundations shall be required for installation.

2.03 BLOWER DESIGN CRITERIA

A. With the exception of pressure, the stagnation inlet conditions specified herein refer to conditions at the inlet connections of the blower enclosures. The stagnation inlet pressure specified herein refer to conditions immediately downstream of the intake louvers of the blower room and do not account for losses due to the inlet transition, inlet ducting, and air filters. The blower MANUFACTURER shall determine the corresponding stagnation inlet conditions at the blower core (as defined in ASME PTC-10 – 1997 Performance Test Code (re-affirmed in 2003) by accounting for pressure losses of the inlet system with fouled air intake filter as specified in Table 1 and any additional pressure losses within the blower enclosure and by accounting for any internal heat gains such as those due to cooling of the VFD, harmonic filter, and motor as applicable. The blower MANUFACTURER shall size the inlet transition duct and associated inlet piping such that including the fouled filter pressure drop the total inlet pressure drop to the blower does not exceed what is shown in Table 1. The blower MANUFACTURER shall clearly indicate, as part of the blower submittals how the inlet conditions at the blower core have been determined and shall provide calculations and/or product data as necessary to justify the pressure losses and heat gains used in this determination. The discharge conditions specified in Table 1 refer to discharge stagnation pressures as defined in ASME PTC-10 and which exist at the discharge flange of the blower or the discharge cone. Each of the aeration blowers shall be sized and designed for the following rated conditions in Table 1:

Table 1: Blower Sizing and Design Criteria		
	Blowers	**Blowers**
Site Location	Isla Blanca WWTP	Laguna Vista WWTP
Quantity (Each)	2	1
Gas Handled	Filtered air	Filtered air
Site Elevation Above Mean Sea Level	5 feet	10.5 feet
Barometric Pressure	14.7 psia	14.7 psia
Pressure Loss in Blower Inlet System (Air Filtration System, Inlet Transition, and Associated Inlet ducting)	0.20 psi	0.20 psi
Design Discharge Pressure (PSIG)	6.8 psig	6.8 psig
System Design Maximum Flow at Maximum Inlet Air Temperature and Design Discharge Pressure (CFM)	8,000 cfm	726 cfm
System Design Minimum Flow at Maximum Inlet Air Temperature and Design Discharge Pressure (CFM)	1,600 cfm	346 cfm
Design Blower Flow Rate (CFM)	4,000 cfm	600 cfm
Discharge Flange Size (ANSI 150 lb.) (in)	12	8
Stagnation Inlet Conditions (see definitions above):		
a. Pressure	14.65 psia	14.65 psia
b. Temperature	110 degrees F	110 degrees F
c. Coincident RH, %	80%	80%
d. Molecular Weight	28.625	28.625
Discharge Stagnation Pressure	21.45 psia	21.45 psia
Motor Characteristics:		
a. Motor Output Power, Horsepower	150	30
b. Voltage/Hz/Ph	480/60/3	480/60/3

Table 1: Blower Sizing and Design Criteria		
	Blowers	**Blowers**
The following range of conditions will occur. Blowers shall not surge or exceed the nameplate motor rating at or between any of the combinations of these conditions, with clean or fouled air intake filter, and for operating points specified in the power guarantee section of these Specifications.		
Barometric Pressure	14.65 psia	14.65 psia
Stagnation Inlet Conditions (see definitions above):		
a. Pressure	14.65 psia	14.65 psia
b. Temperature	20 degrees F to 110 degrees F	20 degrees F to 110 degrees F
c. Relative Humidity	0 percent to 100 percent	0 percent to 100 percent

B. The blower shall be capable of delivering the rated flow at the rated discharge pressure when operating at the maximum inlet air temperature, lowest listed barometric pressure, and with the maximum listed pressure loss to the blower inlet.

C. The blowers shall have a rising pressure characteristic curve from minimum flow to the surge point. The blowers shall be capable of operating continuously and satisfactorily at any point between the minimum and the maximum airflows, pressures, and temperatures without surge, vibration, hunting, or excessive heating of the bearings.

D. Operation of several blowers in parallel shall be possible without special requirements. The condition of several units running in parallel with different airflow settings shall be met and the safety margin between required discharge pressure and surge pressure shall be maintained at the same value for each machine operating in parallel.

E. If the blower is supplied without dual-point independent head and flow control or has a characteristically steep diagonal curve, the blower shall maintain a minimum rise-to-surge of 3.0 psig across the entire blower operating range from maximum to minimum flow. If the blower is supplied with dual-point independent head and flow control the minimum rise-to-surge shall be 0.50 psig at maximum head and any flow within the operating range. The blowers shall be capable of operating continuously and satisfactorily at any point between the minimum and the maximum flows without surge, vibration, hunting, or excessive heating of the bearings. Rise-to-surge shall be demonstrated at each specified operating point in Tables 2 and 3 of this Section.

F. The condition of several units running in parallel with different airflow settings shall be met and the safety margin between delivery pressure and surge pressure shall be maintained at the same value for each machine operating in parallel. If blowers are supplied with dual point independent head and flow control, a cascade sequencing control strategy may be allowed.

2.04 POWER GUARANTEE

A. Blower Manufacturers shall submit guaranteed wire-to-air (“wire”) KW values during shop drawing submittal. Wire KW shall include all losses associated with the blower system at all specified operating points including those due to blower, motor, harmonic filter, intake filter/silencer, VFD or inverter, and cooling system (if used). Guaranteed wire-to-air KW values of each blower unit shall not exceed values given in Tables 2 and 3. Failure to meet this requirement will result in immediate rejection. To provide a more accurate cost of operation calculation, estimate that Isla Blanca WWTP will operate at Design Point 1 5% of the time, Design Point 2 90% of the time, and Design Point 3 5% of the time. The District does not include any power penalties in the specification, and it does not plan to implement penalties.

Table 2. Guaranteed Wire To Air Power for Isla Blanca WWTP									
Design Points	Number Of Blowers Operating	Blower Airflow Rate	Total System Airflow Rate	Discharge Pressure	Inlet Temperature	Inlet Pressure	Relative Humidity	Blower Wire to Air Power	Total System Wire to Air Power
		CFM	CFM	PSIG	Deg. F	PSIA	%	kW	kW
1	1	4000	4000	6.8	110	14.7	65	129	129
2	2	2250	4500	6.8	110	14.7	65	63.3	126.6
3	2	4000	8000	6.8	110	14.7	65	129	258
Note: Performance data is based on ASME PTC 10 Type 2 test.									

Table 3. Guaranteed Wire To Air Power for Laguna Vista WWTP									
Design Point	Number Of Blowers Operating	Blower Airflow Rate	Total System Airflow Rate	Discharge Pressure	Inlet Temperature	Inlet Pressure	Relative Humidity	Blower Wire to Air Power	Total System Wire to Air Power
		CFM	CFM	PSIG	Deg. F	PSIA	%	kW	kW
1	1	600	600	6.8	100	14.7	85	18.6	18.6
Note: Performance data is based on ASME PTC 10 Type 2 test.									

2.05 ENCLOSURES

A. The sound enclosure must be designed with no use of rivets or screws. The enclosure must provide access for easy inspection and maintenance of all blower package components. Hinged doors shall provide easy and quick access for routine maintenance of the blower and the package components. Doors shall use frame, reinforcements, and supporting elements as required.

B. Electrical components, instrumentation, and instrument connections shall not be mounted or interface with the enclosure doors.

C. Blower and integral VFD shall not require any external cooling devices such as external cooling fans or external liquid cooling systems. All cooling devices shall be internal to the blower enclosure. No exemption will be allowed.

D. Each blower core shall be supplied with built-in vibration isolating mounts. Blower MANUFACTURER shall be responsible for attenuating noise and vibration in the blower package installation such that no special installation base shall be required nor shall any vibration from the blower package be transmitted to the floor or intake and discharge base or the piping.

E. The enclosure shall have a rigid structural steel skid designed for forklift pick-up. No special foundations shall be required for installation.

F. Walls of the enclosure shall be constructed of steel panels lined with barrier-type sound-deadening material.

G. Adequate ventilation shall be provided with filtered intake air to remove heat as required. The currently designed blower system layout is based on blowers that do not require separate exhaust connections for ventilation air. To minimize power consumption, Contractor shall provide a duct out of the building for blowers that require separate exhausts for ventilation air.

H. The enclosure shall house the blower/motor and all internal accessories including inlet filter/silencer, VFD/chokes/filters, instrumentation, control panel, harmonic filter, and cooling system.

I. A color HMI touch screen operator interface shall be provided on the outside wall of the enclosure. An emergency stop button shall be located on the enclosure near the HMI Touch screen in accordance with NEC.
   1. Provide HMI hardware and software.
   2. The HMI shall provide access to all status and control functions for operations personnel. With password access to limit change options dependant on authority. It shall also provide access to diagnostic information, e.g., I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.

J. The CONTRACTOR shall provide and wire the 480 VAC to the enclosure.

K. The sound enclosure shall limit the maximum sound pressure level at any point at a distance of 3 feet or more from the enclosure surface to a maximum of 85 dBA with the blower running at any speed.

2.06 SEISMIC BRACING AND ANCHORAGE SYSTEM

A. Each blower shall be supplied with all support systems necessary to meet seismic requirements as specified in Section 016120. Blowers shall be anchored to the pad using Type 316 stainless steel anchor bolts or threaded rods. CONTRACTOR shall provide the specification for anchor bolt or threaded rod for the OWNER's information.

2.07 BLOWERS

A. Blowers shall be air bearing, or electromagnetic bearing, type turbo blowers and shall not require oils or lubricants for adequate operation. Blowers shall be capable of variable speed and output operation.

B. Blower casing shall have a maximum continuous duty design temperature of 400 degrees F, and a design pressure of 50 psig.

C. Blower impellers shall be of the backswept three-dimensional high-efficiency configuration designed using Computational Fluid Dynamics (CFD) with two stages in one (axial and centrifugal), milled from forged aluminum alloy, and with first lateral critical speed at least 120 percent of maximum allowable operating speed. Cast and

fabricated impellers shall not be acceptable. Impeller shall be mounted directly to the motor shaft and shall be statically and dynamically balanced.

D. Regardless of theoretical bearing life calculations, the bearings shall be sized for a minimum of expected 10 years between major overhauls. Bearings that fail before the 10-year period shall be replaced by the Blower MANUFACTURER at no cost to the OWNER.

2.08 DUCTED INLET AND INLET FILTERS

A. Provide for each blower designed for maximum airflow with a minimum pressure drop. Each blower shall be provided with a ducted inlet designed for maximum airflow at absolute minimum pressure drop, and connected directly to the inlet of the blower via a flexible connection.

B. Filters shall be removable through easily accessible doors. A two-stage filter panel system shall be supplied. The coarse pre-filter shall have a removal efficiency of 93 percent on 10 micron. The final filter element shall have a removal efficiency of 99.5 percent on 3 micron. The filters shall be sized for a maximum face velocity of 500 feet per minute at peak airflow.

C. Maximum clean pressure loss across the filter shall be less than 0.12 psig.

D. The inlet filter shall be suitable for indoor installation and shall be integrally mounted inside of the blower enclosure. The filter shall be removable without disconnecting the inlet duct.

E. Control power for the instruments integral to the blower inlet shall be derived from the associated VCP.

2.09 FLEXIBLE CONNECTOR/EXPANSION JOINTS

A. Provide each blower with either a stainless steel or an EPDM bellows discharge expansion joint capable of withstanding the vacuum, pressure, and temperature under all operating conditions. The expansion joint shall be provided with control rods and carbon steel flanges drilled for ASME/ANSI B16.5, Class 150 bolt pattern.

B. Provide expansion joints at each blower's connecting discharge piping with the following minimum movement ranges and spring rates. Movement ranges shown are based on the listed axial and lateral movements occurring concurrently. Submit calculations demonstrating the adjustment of the proposed expansion joint's non-concurrent axial and lateral ratings to meet the listed requirements.
   1. Movement ranges:
      a. Axial: Not less than 0.35 inches.
      b. Lateral: Not less than 0.35 inches.
   2. Spring rates:
      a. Axial: Not more than 1,000 lb/inch.
      b. Lateral: Not more than 5,000 lb/inch.

C. Provide expansion joints with tie rods.

2.10 DISCHARGE CONE/SILENCER (IF REQUIRED)

A. MANUFACTURER shall provide a discharge cone/silencer (Evasé stack) to increase the blower outlet size to the larger diameter air discharge piping. Maximum sidewall angle increase shall be 7 degrees per side (14 degrees total). A bypass flange shall be provided on the side of the cone/silencer for blow-off valve connection. Instrument connections shall be provided at the outlet of the cone/silencer. The o*u*tlet flange shall be rotatable to facilitate connection with discharge pipe.

B. If required to meet noise intensity requirements, the inside of the discharge cone/silencer may be lined with deep layers of sound absorbing material, resistant to high temperatures, covered by fiberglass cloth and a perforated steel plate, so as to form sandwiched layers of the external cone/silencer surface, acoustical material, and internal perforated steel plate.

2.11 BLOWER BLOW-OFF (BYPASS) VALVE AND SILENCER

A. Blow-Off (Bypass) Valves:
   1. Each blower shall be provided with a blow-off/pressure relief valve on the discharge side of the blower mounted on or after the discharge cone and before the check valve. The valve shall be set to protect the blower from exceeding its maximum pressure rating, and to allow unloaded start-up and stop.
   2. The valve shall be actuated by an electric or pneumatic actuator. Provide limit switches for indication of valve open and closed status. Controls for the valve shall be mounted in the blower LCP.
   3. Blower Blow-Off Valve Silencer:
      a. A carbon steel blow off silencer shall be provided for the blow-off (bypass) valves per the MANUFACTURER's standard. The blow-off silencer shall be an integral unit, fitted with 1 flange for direct bolting to the blow-off valve. Silencer sound attenuation shall be not less than 20 dB.

2.12 DISCHARGE VALVES

A. Provide each blower with a flanged industrial class discharge butterfly valve suitable for operating temperatures up to 300 degrees F. Size shall be as required by blower system and determined by the blower MANUFACTURER. Operation shall be controlled manually. Size shall be as required by blower system and determined by the blower MANUFACTURER.

2.13 CHECK VALVES

A. Provide each blower with a flanged discharge check valve of the dual, flat plate type with center hinge, spring closure, cast iron body, Viton® B seal and 316 stainless steel plates and trims, Inkonel 600 springs, and rated for temperatures up to 400 degrees F. The valves shall have flat surfaces with the resilient seat facing on the body. The two plates shall be independently supported on the hinge pin and have separate closure springs. Seating shall be against a flat recess within the valve body, and valves wherein seating is against the cylindrical inner bore of the body will not be allowed. Check valves should be suitable for installation in the horizontal or vertical position. Valves shall be manufactured by Crane, Duo-Check II model, or equal.

B. Check valves shall be especially designed and suitable for use with centrifugal blowers, and shall retain positive sealing capability at 300 degrees F.

2.14 ELECTRICAL

A. Provide an electrical distribution cabinet integrally mounted on the blower package. The electrical panel shall consist of main disconnect, control power transformer, fuses and breakers, blower VFD including harmonic filter and output filter, motor starters for ancillary motors, and support electrical components required for a complete, operable system.

B. Variable Frequency Drive:
   1. General:
      a. Furnish each blower with a variable frequency drive (VFD).
      b. VFD shall be selected and sized by the blower MANUFACTURER and coordinated with the blower motor.
   2. VFD MANUFACTURER:
      a. Shall have production factory and support located in the United States (USA). VACON VFD's manufactured in Finland are acceptable with the condition that they are fully supported in the USA under the trade name Cutler Hammer.
      b. Shall have been manufacturing VFDs for a minimum of 10 years.
   3. VFD:
      a. 480V, 3-phase, 60 hertz input power.
      b. Efficiency: 97-percent minimum at full load and speed.
      c. UL listed.
      d. Furnish with a sine wave (LC) output filter.
      e. 3-percent input line reactor.
      f. Provide control of VFD via touch screen control panel and PLC.
      g. Furnish each VFD with a passive harmonic filter.
         1) Filter shall reduce total harmonic current distortion to 5 percent at the input terminals to the blower electrical distribution cabinet.
         2) Passive filter shall be installed inside the blower enclosure.

C. Passive Harmonic Filter:
   1. Furnish each VFD with a passive harmonic filter.
      a. Filter shall reduce total harmonic distortion to 5 percent Total Harmonic Current Distortion at the terminals of the blower package with only the blower operating across the entire operating range.
      b. Passive filter shall be supplied and sized by the blower MANUFACTURER.
   2. Harmonic Filters shall be as manufactured by Arteche Power Quality, Low Pass Harmonic Filter, or equal, mounted in a NEMA 1 enclosure, 480V, 3-phase, 60 hertz input power.
   3. Harmonic filter's capacitive components shall be interlocked with the VFD to be removed from the power circuit when the VFD is not running or when they cause the blower package power factor to go leading.
   4. Standard Harmonic Filters manufactured by MTE Corp. are an acceptable alternate.

D. Motor:
   1. Each blower shall be provided with a high-efficiency permanent magnet synchronous motor (PMSM), 1.15 service factor, with horsepower equal to, or

in excess of, maximum normal load that will be imposed at any point in the operating range of the design conditions specified. The motor shall be an integral part of the blower core assembly with corrected power factor losses.

2. All motors shall be suitable for operation on 460V/60 hertz/3-phase power for at least the maximum ambient air temperatures specified on this project as well as any additional heat gains inside the blower enclosure, and at 25 feet above sea level.
3. Each blower motor shall be of the permanent magnet synchronous motor (PMSM) type, which has no physical connection between stator and shaft, therefore, eliminating brushes, slip rings, and break resistors.
4. Each motor shall be provided in its own environmentally protected enclosure and must be cooled using air or closed loop glycol cooling system fully enclosed inside the blower enclosure.
5. Additional requirements for the blower motors include:
    a. Insulation: Epoxy coated Class F rated – NEMA Class H insulation.
    b. Motor temperature protection per NEC 430.126.
    c. Maximum Ambient Temperature: As specified.
    d. Minimum Ambient Temperature: 10 degrees F.
    e. Duty: Continuous.
    f. Shall be UL certified.
    g. Ground Pad: There shall be a grounding pad near the base of the motor.
    h. Space heater or provisions to control moisture and prevent condensation from forming on motor windings. (if applicable)
    i. Motor temperature protection per NEC 430.126.

2.15 INSTRUMENTATION

A. The MANUFACTURER shall provide the blower instrumentation described in this Section. Instruments shall be as specified in this Section. These components shall be mounted within the enclosure except as noted.
    1. Each blower shall be equipped with a dedicated PLC.
        a. Provide PLC hardware in accordance with Section 407720.
            1) Programming - Provide Allen-Bradley Rockwell Software RSLogix 5000 or equal.
    2. Each blower shall be equipped with an integral touch screen HMI.
        a. All information to be in USA English units of measurement.
        b. Provide HMI hardware.
        c. The HMI shall provide access to all status and control functions for operations personnel. With password access to limit change options dependant on authority. It shall also provide access to diagnostic information, e.g., I/O status, and all PID and control functions for the commissioning engineer to allow changes to be made with appropriate password without the need for a programming terminal.

B. Blower Shall Include the Following Control Components:
    1. Real time monitoring via discharge pressure vs. suction airflow graph indicating current operating point and boundaries.
    2. Each blower shall have the ability to be controlled in three different modes: constant speed, constant pressure, or constant flow.
    3. Blower controls shall include intuitive, user-friendly fault menus for ease of monitoring diagnostics and troubleshooting.
    4. Each blower shall include built in automatic surge protection.

5. Integrated control system shall control the blow-off valve for each blower.

C. Instrumentation for each blower shall include, as a minimum:
   1. Inlet air temperature gauge.
   2. Inlet air temperature transmitter 4-20 mA.
   3. Inlet air filter differential pressure switches:
      a. Measure differential pressure across the inlet filter.
      b. Set switch at 5.0 in. of W.C. (alarm).
   4. Surge switch (if applicable).
   5. Vibration sensor.
   6. Vibration transmitter.
   7. Discharge air pressure gauge.
   8. Discharge air pressure transmitter.
   9. Differential pressure (inlet/discharge) transmitter 4-20 mA.
   10. Blow-off valve limit switches (open/closed).
   11. Discharge valve limit switches (open/closed).
   12. The RTD monitoring system shall monitor and display actual winding temperatures at the VCP. A high temperature (as determined by the blower MANUFACTURER) shuts down the blower and gives an alarm. The PLC shall receive, and the Operator Interface shall graphically display the RTD signals. The alarm/shutdown shall be displayed until reset. Provide necessary hardware for direct communication between RTDs, PLC, and Operator Interface.

D. VCP Controls, Indicators, and Alarms:
   1. Operator Interface: Provide the following indicators on the operator interface at the VCP:
      a. Blower Status (RUN/STOPPED).
      b. System pressure selection.
      c. System pressure display.
      d. Blower RUN-STOP-AUTO Control.
      e. Blower Enable/Not in Remote Status.
      f. Blower Speed Indication Status.
      g. Blower Run Times (hours).
      h. Blower Amp Draw (amps).
      i. System Pressure (0 to 20 psi).
      j. System Flow (calculated).
      k. Variable Diffuser Vane Position (applicable to dual-point control).
   2. Operator Interface Device (HMI):
      a. The Device Shall Include the Following Displays:
         1) Events: Displays the last 254 sequential alarms with date and time of occurrence.
         2) Status: One-touch access to display current system operating status. When the system is running, the display shall show the setpoint pressure, actual pressure, flow, and speed (0 to 100 percent), and variable diffuser position (applicable to dual-point control).
         3) Alarm Information: Last three alarms recorded in memory and are displayed with related detailed information on the alarm, time of occurrence, date, and blower's main operating parameters at time of alarm and how to correct the alarm condition. Each log shall include individual blower run status, VFD mode, flow, and alarm type.
         4) One-touch access to an Alarm List of all possible alarms and their current status.

5) Daily Log/Total: Display the following: individual equipment run times, run times since last reset, total flow, and total flow since last reset.
6) Scroll Key. Used to scroll up and down through data.
7) Provide Setup Menu system for adjusting all alarm setpoints, deadband, delays, etc. Display and adjust flow and pressure set points and time delays. Set equipment alternation to manual or automatic. Set the hour of the day for automatic alternation. Restore all factory defaults. Protect adjustable settings with a password.

3. Alarm Systems:
   a. Local indication of alarm conditions shall be provided on the face of the control panel via a general red alarm light. Specific alarm messages shall be provided on the operator interface screen.
   b. All alarm conditions shall be displayed at the operator terminal. Provide output capability to display all alarm conditions.
   c. Alarms shall include the following at a minimum:
      1) High filter pressure drop.
      2) High suction temperature.
      3) High discharge temperature.
      4) High bearing temperature.
      5) High motor temperature.
      6) Blower fault.
      7) Abnormal vibration.
      8) Blower surge.
      9) Blower high discharge pressure.
4. Operating description for VCP: Shall operate as described in the Blower Controls Description in this Specification Section. Provide the following:
   a. An electronic copy of all PLC programs complete with tag descriptions and rung comments in the native software format.
   b. Provide OWNER with 1 PLC programming software package (licensed to the OWNER) of any PLC that is used.
   c. An electronic copy of all HMI application files in the native software format for all HMI that are used.
   d. Provide OWNER with 1 HMI programming software package (licensed to the OWNER) of any HMI that is used.
   e. Provide a list of all initial PLC/HMI software configurations and register settings.

E. Coordinate with the OWNER's programmer to get sample screens to mimic layout and color and general operating philosophies.

F. Provide Networking Layout drawing upon completion of the project and provide IP addresses for each component.

2.16 CONTROL PANEL DESIGN AND TESTING LOCAL CONTROL PANELS

A. The blower VCP shall be a PLC-based control panel with processor, I/O cards, communications interfaces, operator display, power supply, and other components required for a complete, functioning blower control system. This requirement is not applicable if it results in redundant equipment for blower operation.

B. The blower vendor control panel (VCP) shall be provided by the blower MANUFACTURER. The VCP shall control individual blowers in order to achieve the

desired setpoint. This requirement is not applicable if it results in redundant equipment for blower operation. Only one pressure and temperature transmitter is needed for the Isla Blanca WWTP site.

C. Provide PLC hardware.

D. Provide HMI software and hardware.

E. The VCPs will be fed with one 480 VAC, 3 phase power connection. VCPs shall contain distribution components, power supplies and transformers, as required, to derive power for all instruments and equipment provided as part of the blower package.

F. The VCP design, construction, and testing shall be completed in an UL certified shop by the blower MANUFACTURER.

G. Provide wire tags on every conductor. Provide slip-on or heat shrink sleeve markers. Tags using adhesives are unacceptable.

2.17 BLOWER CONTROL DESCRIPTION

A. Provide each blower's VCP with the required hardware components and software programming to meet the blower and aeration system operating description described in this Article.

B. Vendor Control Panel (VCP):
   1. The VCP shall be programmed to accept input and output signals and requests including status and alarm signals. The VCP shall also provide all local interlocks, surge control, power control, local capacity control, and alarming for the associated blower.
   2. At the VCP, the operator shall be able to select between local and remote control modes for the blower.
      a. Local Control Mode:
         1) In this control mode, the blower start/stop and capacity control shall be adjustable via the VCP HMI panel interface.
         2) Capacity control options shall include constant speed, constant pressure, and constant flow. Capacity control type and control setpoints shall be operator selectable at the VCP HMI.
         3) In all local capacity control modes other than constant speed, the blower shall control the output speed or variable diffuser vanes of the blower to achieve the desired level of the selected control variable (pressure or flow) using a PID algorithm to calculate the error in the control variable and adjust the speed or variable diffuser vanes to meet the control setpoint.
      b. Remote Control Mode: In this control mode, the local start and stop pushbuttons shall be disabled, and the capacity, start, and stop commands shall be issued over a future VCP-MCP (Master Control Panel) communications network. All commands shall be operator enterable from either MCP HMI or from SCADA. In this case, a communications watchdog shall be active between the MCP and each VCP. The VCP shall be configured to continue operation at the last known capacity command, or to shut down after a pre-set duration of communications loss. Once a blower is shutdown due to communications

loss with the MCP, the blower may be operated locally from its VCP until communications are re-established and all alarms have been acknowledged.

3. Each VCP shall report to the future MCP and the MCP shall report to the SCADA (as required in this Specification Section) it's associated blower's status, limits, operating conditions, control mode, surge status, total run hours, and current run hours. Elapsed run time hours shall be totaled at the VCP.
4. Each VCP shall control the startup and shutdown sequence of the blower associated with it. If the blower fails for any reason, operator intervention shall be required to clear the failed status.

2.18 ADDITIONAL INSTRUMENTATION FOR BLOWER SYSTEM

A. Two (one duty/one standby) main air header pressure indicating transmitters located in the main air header. Power and analog feedback for the transmitters shall report to/from the MCP.

B. Two (one duty/one standby) main air header temperature indicating transmitters located in the main air header. Power and analog feedback for the transmitters shall report to/from the MCP.

2.19 SURFACE PREPARATION AND SHOP PAINTING

A. All carbon steel or iron surfaces shall be prepared, shop primed, and finish painted with two finish coats of epoxy paint system.

B. Machine surfaces that are not painted shall be protected by coating with a corrosive protective compound.

2.20 SOURCE QUALITY CONTROL

A. At a minimum, each blower and motor skid shall be factory tested for a duration of not less than 8 hours at maximum load and maximum temperature.

B. The entire system of all blowers, blow-off valves, discharge valves, and LCPs shall be tested as an operational system before shipment. The LCPs and MCP shall be connected to all enclosure instruments, electric valves, and appurtenances. All start/stop and running sequences and all safety and alarm systems shall be tested. The MANUFACTURER shall provide the test procedure and results, certifying that the assembled blowers, auxiliaries, blow-off valves, discharge valves, and LCP were tested together, as a system, in the MANUFACTURER's shop.

C. Each blower shall be performance tested in accordance with the ASME PTC 10 – 1997 Performance Test Code on Compressors and Exhausters (re-affirmed in 2003). All tests shall be conducted at the constant pressure as shown on the performance tables contained in these Specifications. Tests shall be conducted using the job motor.

D. A calibrated wattmeter shall measure the electrical shaft power input to the motor drive (as applicable). Measured power shall include wire-to-air and include all losses associated with electrical shaft power, including, but not limited to the motor and inverter.

E. Net delivered flow rate and discharge pressure shall be guaranteed with no negative tolerance. There shall be no tolerances or measuring uncertainties used in reporting test results (i.e., the tests shall be reported with ± zero percent tolerance using the measured values).

F. The MANUFACTURER shall sign each copy of the test data log sheet certifying that the required tests were performed in strict accordance with these specifications and the ASME PTC 10 Codes, modified to permit zero tolerance for flow and power.
   1. The capacity of the blower shall be defined as per Paragraph 4.26 of the ASME PTC 10 Power Test Code. Airflow shall be measured on the discharge side of the compressor at zero percent tolerance.
   2. All test equipment shall be calibrated and certified by an independent test agency no more than 12 months prior to the test date. Certificates shall show the stability of calibration over a period of at least 1 year per ISO 9001, Paragraph 4.11.
   3. Velocity vibration versus frequency levels shall be recorded within 10-1,000 and 10-10,000 Hz frequency range. Report vibration in velocity versus frequency.

G. The blower test report shall present computations in exact accordance with Section 5, 6, and 7 of ASME PTC 10 Code with performance curves showing capacity, pressure, and horsepower inputs.

H. Test results of the motors and blowers shall be included in the Operations and Maintenance Manual.

I. Motor Tests:
   1. Motor insulation systems shall be tested in conformance with NEMA Standard MG1-20.49.
   2. Stator temperature attainment may be accomplished by restricting cooling airflow or by other industry standard methods, but all effects of the method of testing shall be evaluated.
   3. Motor during test shall be complete including accessories and have nothing removed for convenience except the power lead conduit box. No extra devices shall be used except those required to measure or monitor variables.
   4. All test variables shall conform to actual field values and shall be maintained throughout tests.
   5. Motors shall be given complete tests at 100, 75, 50, and 25 percent full load, power factors at 100, 75, 50, and 25 percent of full load, winding resistances, high potential, and bearing inspection. Certified motor test data sheets shall be submitted for review and acceptance. Data sheets shall give the observed and nameplate temperature and results of dielectric tests in addition to the above data. The sheets shall be marked to indicate motor application, MANUFACTURER, type, frame size, bearing type, enclosure type, and motor serial number.
   6. Additional motor tests as recommended by the blower MANUFACTURER shall be performed and submitted for review and acceptance.

PART 3 EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All blower equipment shall be enclosure mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during the time between shipment and installation.

B. Securely bolted fiberboard blank flanges shall protect finished surfaces of all exposed flanges.

C. Shipment is not to be made until the MANUFACTURER coordinates shipment to the jobsite with OWNER.

D. Equipment shall be stored in strict accordance with MANUFACTURER's instructions.

E. The space heaters in the motors shall be immediately connected and energized by OWNER upon receipt of the blower skid at the jobsite.

3.02 INSTALLATION

A. Each blower skid unit shall be mounted on a flat and level concrete pad (±1 degree) in accordance with the recommendations of the MANUFACTURER.

B. The process startup shall be executed in conjunction with OWNER's personnel to coordinate loop-tuning activities so that the entire aeration system works in harmony.

3.03 FIELD TESTING

A. At a minimum, each blower and motor skid shall be field tested for a duration of not less than 24 hours at maximum load.

B. Noise Level:
   1. The MANUFACTURER shall include all necessary provisions for reducing noise to meet the maximum sound pressure level requirements of this Section.
   2. The maximum sound pressure level at any point at a distance of 3 feet or more from any blower/motor surface shall not exceed 85 dBA with the blower running at any speed.
      a. The specified maximum sound pressure level of 85 dBA includes the noise emitted from any possible source in the Blower Room related to delivery of air, including but not limited to, the noise from the motor; the blower; inlet and discharge piping, fittings, valves and silencers; and any reflected noise.
   3. The sound pressure level shall be measured during the preliminary equipment tests of field testing after installation in the Blower Room and with one blower running.
   4. If it is found that the actual sound pressure level 3 feet away from the blower exceeds the maximum specified sound pressure level, the MANUFACTURER shall make such modifications and additions as approved by OWNER as are necessary to limit the noise to 85 dBA.

3.04 BLOWER MANUFACTURER'S FIELD SERVICES

A. The MANUFACTURER shall furnish experienced start-up service personnel to inspect the final installation and supervise the field start-up tests of the equipment and software. The services of the representative shall be provided for a minimum of one 8-hour day for each blower and blower control system adjustment and optimization. If there are difficulties in operation of the equipment due to the MANUFACTURER's fabrication and programming, additional service shall be provided at no extra cost to OWNER.
   1. Provide, as a minimum, the following field services: Provide written documentation for check out including who performed the work, when performed, what was final setting or tolerance, and who witnessed the final settings.
      a. Verify proper connection of piping and installation of accessories.
      b. Check leveling of blower enclosure.
      c. Confirm proper wiring of all instruments and field wired items.
   2. A minimum 4 hour, for each blower, field acceptance test shall demonstrate that, under all conditions of operation, each unit:
      a. Has not been damaged by transportation or installation.
      b. Has been properly installed.
      c. Has no mechanical defects.
      d. Has fully functional instrumentation that are properly calibrated and set.
      e. Will start, run, and stop in the prescribed manner.
      f. Will run through the entire range of specified pressure and flow.
      g. Has the proper shutdown sequence of standard stop, soft stop, and emergency stop.
      h. Is free of overheating of any parts.
      i. Is free of objectionable vibration and noise.
      j. Is free of overloading of any parts.
   3. Conduct a minimum of 8-hour field acceptance test of the aeration system instrumentation, controls, and valves. The test shall demonstrate the following:
      a. The air header pressure control loop will automatically control online blowers without hunting.
      b. The entire blower system and instrumentation operates in a stable fashion, without hunting, maintains main air header pressure setpoint.
   4. Field acceptance testing shall be conducted after the installation of all equipment has been completed, all instrumentation has been calibrated and is working as intended, and the equipment has operated for a sufficient period to make all desirable corrections and adjustments.

B. The MANUFACTURER shall furnish the services of the programmer responsible for programming and integrating the blower control system described in this Section. The services of the programmer shall be provided for a minimum of two 8-hour days to assist OWNER's programmer with integrating the blower system software programs. The programmer must have complete knowledge of proper blower operation and of the blower and aeration system software programs supplied in this Section.

C. The MANUFACTURER shall include an allowance to provide an experienced start-up/service factory representative to be present during the start-up and testing.
   1. Phase 1 – Start-Up: During this phase, the services of the representative shall be provided for one 8-hour day.

END OF SECTION

SECTION 461372 - POSITIVE DISPLACEMENT WITH ROTARY SCREW BLOWER SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Provide a blower package of the positive displacement type, dual splash lubricated, with the blower assembly, accessories, controls and other components packaged and supplied by a single manufacturer, who shall be responsible for the compatibility of all included equipment. Depending on performance requirements, the blower package shall include a blower described in more detail below of a Rotary Screw type. The package to be fully enclosed, horizontal blower configuration, and factory tested prior to shipment. At Isla Blanca WWTP, blower shall deliver 1,800 SCFM at operating design conditions of free air when operating at 78 BHP and against 6.8 PSIG discharge pressure. At Laguna Vista WWTP, alternate blower shall deliver 600 SCFM at operating design conditions of free air when operating at 40 BHP and against 6.8 PSIG discharge pressure.

1.2 REFERENCES

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

1. ASTM A322 – 13 – Standard Specification for Steel Bars, Alloy, Standard Grades
2. ASTM A 48 – Specification for Gray Iron Casting.
3. ASTM A 536 – Standard Specification for Ductile Iron Castings.

B. National Electric Manufacturers Association (NEMA).

C. International Organization for Standardization (ISO):

1. ISO 9001 – Quality Management Systems – Requirements.

1.3 SITE MOBILIZATION MEETING

A. Section 01 30 00 - Administrative Requirements specifies requirements for a site mobilization meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures specifies requirements for submittals.

B. General:

1. All products required for submittal under this Section shall be furnished in one complete package.
2. All submittal dimensions, calculations and other information to be in USA English units of measure.

C. MANUFACTURER's Qualifications:
    1. General:
        a. Installation List: Include a comprehensive list of all installed units, with North American installations clearly identified. List must include equipment model and service application.
        b. Submittal shall identify the individual that will serve as the point-of-contact for the procurement, service, and warranty of the blower system.
    2. Service Network:
        a. MANUFACTURER shall describe their current service network, by listing the nearest factory authorized service center and/or qualified service representative. Identify service technicians and include pertinent certifications to substantiate their knowledge and expertise.
    3. Start-Up and Training Capabilities: MANUFACTURER shall describe and demonstrate their approach to field start-up and training.
        a. Start-Up: Include description and sample test procedure for field start-up.
        b. Factory Training: Include a description of the factory training facility and sample outline for typical factory training that will be available to the OWNER. Identify the trainer and associated qualifications, including resume and/or training certifications.
        c. Field Training: Include a description of the typical field training and sample outline that will be available to the OWNER, as specified in this Section. Identify the trainer and associated qualifications, including resume and/or training certifications.

D. Quality of Construction:
    1. Proof of UL Certification: Submit proof of UL certification on applicable blower components. Certification shall include at least the blower local control panel, integral VFD, and other electrical components within the package and shall be based on the same model and size of the components proposed. UL certification must be demonstrated prior to acceptance of proposed equipment. Failure to meet this requirement will result in immediate rejection.
    2. Bill of Materials: Complete bill of materials of all components and equipment supplied. Bill of materials shall include make and model number and replacement cost of the primary components including, but not limited to the following:
        a. VFD.
        b. PLC.
        c. Harmonic filter (if applicable).
        d. Sensors (temperature, pressure, vibration, etc.).
        e. Air filters.
        f. Main header blow-off valve with actuator and silencer.
        g. Control transformers.

E. Spare Parts:
    1. Include a list of recommended spare parts and nearest supplier (identify suppliers name and address, and other pertinent contact information). Include a statement of availability of all parts.

F. Warranty and Service Agreements: Submit a detailed description of the MANUFACTURER's warranty and service agreement options.

1. Standard Warranty: Include a detailed description of the MANUFACTURER's standard warranty.
    a. MANUFACTURER to modify warranty as required to meet the project requirements.
2. Extended Warranty: Include a detailed description of the MANUFACTURER's extended warranty options. Description shall include pricing structure.
3. Service Agreements: Include a detailed description of the MANUFACTURER's service options. Description shall include pricing structure.
4. Tech Support: Provide contact information for local service and tech support.

G. Product Data:
1. Blower characteristics, specifications, and performance.
    a. Descriptive brochures and blower data.
    b. Predicted performance curves indicating speed, capacity, horsepower, input wire KW, and efficiency, over the range of operation.
    c. Complete bill of materials and catalog information showing the details of blower construction.
    d. Outline installation drawings for each unit.
    e. Blower unit weight and weights of each separate equipment items.
2. Controller:
    a. Factory Installed PLC - Air Smart Controller
    b. Operating description for LCP: Include detailed descriptions of all logic and sequences of operation of control loops within the LCP controller, points monitored, available local and automatic control functions, and alarms. Provide a more detailed description of these functions than is described in these Specifications.
3. Motor characteristics, specifications, and performance.
    a. Motor data sheets and descriptive bulletins.
    b. Outline drawings with dimensions.
    c. Cut-away and exploded view drawings.
    d. Parts list with material designations.
    e. Nameplate data.
    f. Description of insulation system.
    g. Service factor.
    h. Efficiency at 1/2, 3/4, and full load.
    i. Power factor at 1/2, 3/4, and full load.
    j. Current and power factor vs. speed curves at 100-percent rated voltage.
    k. Special features including condensation heaters and winding temperature detectors.
        1) Type and rating.
4. Flexible Connectors (Expansion Joints):
    a. Expansion joint label.
    b. Materials of construction.
    c. Dimensions.
    d. Temperature ratings.
    e. Pressure ratings.
    f. Pipe size and service.
    g. Contract Drawing Number.
    h. Layout Drawing Number.

5. Blower Discharge Butterfly Valves
    a. Descriptive bulletins from valve.
    b. Submit detailed technical information relating to the valve including description of component parts, materials of construction, performance dimensions, and weights.
    c. Outline drawings with dimensions.
    d. Weights of each separate item of equipment.

H. Shop Drawings:
1. Certified dimensional drawings of the blower unit, including cutaway views.
2. Certified anchor bolt layout drawings.
3. Instrumentation and control system schematics, tubing and conduit details, and wiring diagrams for electrical and control components furnished.
4. Any necessary dimensioned drawings to coordinate piping layout with structural, architectural, electrical, and/or other mechanical work.
5. Certified drawings of the local control.
    a. Electrical ladder diagram.
    b. Interconnects to all components outside the panel.
    c. Preliminary I/O listings for all control panel PLCs.
    d. Printout of operator Interface screens.
6. Harmonic filter dimensional drawings and schematics.

I. Quality Control Submittals:
1. General:
    a. Test Reports: Submit after fabrication, but prior to delivery of equipment to jobsite location.
    b. Results of Each Required Test: Summarized in a separate, certified, written report.
    c. Reports: Organized and clearly present testing methods and procedures, testing equipment, test data, calculations and analyses, conclusions and recommendations.
    d. Certified written test reports shall be submitted to OWNER for review and acceptance. Test reports shall have been reviewed and accepted by OWNER prior to jobsite delivery of equipment.
    e. If the certified factory test reports indicate noncompliance with the requirements of the Contract Documents, the blowers shall be reworked and retested until compliance with the specifications is attained.
2. Screw Blower Test:
    a. Mechanical Run Test
3. Functional testing of entire aeration air system package, instrumentation, ancillary components, and LCPs.

J. Closeout Submittals:
1. Operation and Maintenance Manuals:
    a. Prepare operation and maintenance manuals for both blower systems, including appurtenances included in this Section.

b. Operating and maintenance manuals and maintenance summary sheets for the equipment specified herein shall conform to the provisions as specified in this Section.
c. Provide Project Record Documents showing as-built dimensions, as-built wiring and control diagrams, as-built logic diagrams and design information for supplied parts and equipment.
d. Control Panel:
    1) Provide complete electronic copies of the PLC programs and configuration files for all equipment in both the master blower control panel and individual blower control panels, in the native file format of each device, along with any supporting files. Programs shall be fully accessible for use by the OWNER – programs that are locked, restricted, or contain hidden materials are not permitted.
e. Provide a detailed description of control systems.
f. Provide panel drawings, wiring diagrams, specifications, and a detailed description of the local panels and master control panel.

1.5 OPERATION AND MAINTENANCE MANUALS

A. All dimensions, calculations, and other information to be in USA English units of measure.

B. Provide a list of components and catalog cut sheets fully describing all items:
    1. Mechanical and structural components.
    2. Instruments.
    3. Programmable Logic Controllers (PLCs).
    4. Operator Interface/machine monitors.
    5. Electrical components.

C. General description of blower with all performance data, blower curves, and model.

D. Mechanical Drawings with general arrangement showing enclosure dimensions, overall weights, weights of largest components requiring removal for maintenance, and clearances required around unit for maintenance access. Indicate surface preparation and paint specifications.

E. Description of process control logic and process and instrumentation diagrams.

F. Drawings of all control panels to include:
    1. Electrical ladder diagram.
    2. Interconnect to all components outside the panel.
    3. Interior layout.
    4. Sample Operator Interface screens for the local panels.

G. Provide a detailed description of the data acquisition, monitoring, and predicted preventative maintenance software. Provide typical Operator Interface screens with detailed descriptions, the various tattletale monitors, preventative maintenance items, and data logging features.

H. Provide input/output (I/O) listing for all control panel programmable logic controllers (PLC).

I. Indicate all scheduled maintenance requirements and routine inspections. Include maintenance summary forms.

J. Provide list of recommended spare parts and lubricants.

K. Provide a troubleshooting guide.

L. Provide the local sales representative contact information with the company name, contact person, phone number, and address.

1.6 TOOLS AND SPARE PARTS

A. The following spare parts shall be furnished:
   1. One complete set of all sensors.
   2. One set of enclosure key.
   3. One complete set of air filters for each blower as specified in this Section.

B. All spare parts shall be suitably packaged and clearly identified with indelible marking on the containers. Tools and spare parts (except for the air filters) shall be supplied in a tool chest for long-term storage and marked with MANUFACTURER's name, along with a complete description on contents.

C. MANUFACTURER warranty shall apply.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements specifies requirements for transporting, handling, storing, and protecting products.

B. All equipment shall be skid mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the blower units and equipment are ready for operation.

C. Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

D. Shipment is not to be made until the MANUFACTURER coordinates shipment to the jobsite with the OWNER, ensuring that the equipment will be properly received and stored.

1.8 EXISTING CONDITIONS

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

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements specifies requirements for warranties.

B. Equipment supplier shall also be a factory authorized warranty and repair center. The blower package shall come with a full 24 month from date of startup or 30 month from date of shipment factory warranty with an optional 5 year extended warranty.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturer List:
1. Gardner Denver IQHE Blower Package
2. Substitutions: Specified in Section 01 60 00 - Product Requirements.

B. COMPRESSOR
1. High efficiency screw compressor to convey atmospheric air free of oil
2. Rotors with ratio 3:5 and a high addendum patented profile, statically and dynamically balanced and manufactured in carbon steel C40 EN 10083/1, ground and coated in PTFE against corrosion Shafts integrated with the rotors built in steel C40 EN 10083/1.
3. Anti-friction bearings calculated to last over 100.000 h under maximum conditions of speed at 36psig (L10). Maximum peripheral speed of the head of the lobes less than 70 m/s, for lower turbulences in the compression chamber.
4. Timing gears with helical casehardened teeth and ground involute profile, built in cement steel 16 Mn Cr 5, coupled to the shafts by means of a forced coupling and that can be disassembled with oil in pressure.
5. Labyrinth gas seals without sliding elements and without wear, and with vent holes to limit the pressure inside the oil sump.
6. Visco-dynamic oil seal free of contact and wear.
7. Visco-dynamic oil seal on drive shaft free of contact and wear, and with dust shielding ring with protective jacket.
8. Splash lubrication of bearings (N°4) on pressure side and timing gear with oil-spreading ring on drive shaft (full load of the machine).
9. Lubrication of bearings (N°2) on suction side with grease and re-greasing nipple (bearings without pressure and trust loads, just with journal purpose in order to keep the right axial rotors position).
10. Maximum compressor speed <7000rpm, this implies low speed, lower friction and high efficiency.
11. Highly resistant Silicone painting, RAL 5009

C. BASEFRAME
1. Compact base frame supporting both the compressor and the electric motor, integrated with the inlet silencer and transmission belt-tensioning device, made in high strength steel plates.

2. Anti-vibration mounts capable of withstanding compression and shear loads with vibration damping level > 80%.
3. Can be supplied with integrated noise enclosure

D. INLET SILENCER

1. Inlet silencer with sound absorption material with wide reduction of the sound energy
2. Maximum pressure drop 0.3 psi.

E. SUCTION FILTER

1. Suction filter integrated with the inlet silencer.
2. Filtering element placed downstream of the sound absorbing material of the inlet silencer to prevent any contamination of the conveyed air and protect the compressor.
3. Efficiency of the filtering element 93% on particles >= 10 micron.
4. Inspection cover for easy replacement of the filter element.
5. Limited losses of pressure:
   Maximum pressure drop with new filtering element DP = 0.75 psi
   Maximum pressure drop with clogged filtering element DP = 0.5 psi

F. DISCHARGE SILENCER

1. Combined Reactive +Absorbing silencer, designed in accordance with PED directive 97/23/CE, to eliminate sound pressure released on frequencies above 500 Hz, this silencer segregates the airflow from the absorption item, a triple separating layer prevent any kind of contact between air flow and absorption material, therefore any time of contamination of the gas conveyed towards customer's process system
2. Maximum pressure drop DP = 0.145 psi, always included in package selection tool calculation
3. Reactive silencer available upon request (with vessel PED certificate)

G. CHECK VALVE

1. Double-leaf check valve after the outlet silencer to prevent counter-rotation of the compressor when it stops (heavy duty and high efficiency flaps).
2. Body and leaves in casted ductile iron, stem and spring in Stainless Steel with NBR, EPDM, FPM (Viton) seals.
3. High resistance elastomer for maximum operating temperature T2 = 300° F.
4. Pressure range 0 to 0.232 psig.
5. High efficiency (air passage with reduced turbulences)

H. STARTING/SAFETY VALVE

1. Fully automatic operation, does not require external power supply.
2. Closing time can be adjusted between 2 and 15 seconds.

3. Seat seal in high strength rubber for a maximum operating temperature of 300° F.
4. Pilot valve for operation as safety valve.
5. Maximum pressure adjustable to 16 psig.
6. Fine tuning of the maximum overpressure on opening at full capacity (tolerance 0.44 psig).

I. PIPING

1. The compressor and silencer are directly connected to each other with flanges, without connecting pipes so as to reduce overall dimensions and pressure losses.
2. The valves are directly fitted onto the discharge silencer.
3. Connection to the system pipes by means of flexible connectors fitted at the outlet nozzle of the discharge silencer to compensate the pipes thermal expansion and to reduce the vibration transmission.
4. Flexible connector in rubber reinforced with fabric inserts and suitable for operation up to 29 psi and temperatures up to 300° C, held in position with pipe clamp straps.

J. BELT DRIVE AND PULLEYS

1. High efficiency belt with single inextensible POLY-V or TOOTHED rib, requiring no maintenance or periodical tensioning (3-5% more efficient than a conventional V-Belt multiple set).
2. Service factor > 1.4 on the power installed
3. Special device for adjustment of the belt that allows for its replacement while keeping pulleys aligned

K. MOTOR

1. Asynchronous three phase electric motor with squirrel cage rotor built according to NEMA standards.
2. Power supply 460V +/- 10% at 60 Hz
3. Efficiency class IE3 or higher (EISA Certified for the US market).
4. Minimum protection grade IP 55.
5. Cooling system IC 41 (TEFC case cooled by external fan on the shaft).
6. Assembly arrangement IM B3 (with terminal box at the top).
7. Insulation class F.
8. Over-temperature class B.
9. Drive side bearing to support the radial load induced by the V-belt transmission.

L. NOISE ENCLOSURE

1. Noise enclosure with noise generated by electric compressor unit lowered to no less than 23 dB(A).
2. Enclosure made up of modular self-supporting panels in galvanized steel sheet and coated suitable for installation outdoors (under a Canopy in order to be sheltered from heavy rains and direct sunlight).
3. Sound-absorbing material consisting of open cell polyurethane foam

thickness 50 mm with profiled finish, fire resistant according to ISO 3795 (MVSS TN 302).

4. Perimeter panels supported directly on the ground and detached from the structure of the blower package to eliminate the transmission of vibrations (noise) from the package to the panels.
5. Seal between panels by means of special rubber joints to ensure airtight closure in order to allow outdoor installation.
6. Enclosure ventilation with auxiliary motor fan, 115V, singe phase 60 Hz, ensuring the extraction of hot air from inside the hood independently of the rotation speed of the compressor and even after the compressor stops.
7. Fresh Air inlet segregated and insulated, allows optimizing of the volumetric efficiency through the reduction of the intake air temperature.
8. Enclosure air inlet and outlet ducts silenced with a lined single-chamber plenum and lined bends.
9. Compressor discharge pipe on opposite side to the front.
10. Access for routine maintenance operations from the front side of the hood.
11. Enclosure can be arranged side by side or against a wall, minimum distance required of 4 inches (100 mm) to reduce compressor room area.

M. CONTROLLER (Enclosed only)

1. AirSmart G2Controller
2. AirSmart G2 Controller shall be included for intelligent digital monitoring with features, such as:
   a. Inlet/Discharge Temperature Indication and Protection
   b. Excessive Filter Differential Indication and Protection
   c. Differential Temperature Protection
   d. Inlet/Discharge Pressure/Vacuum Indication and Protection
   e. Excessive Enclosure Temperature Protection
   f. Service Information (air filter, oil change, hour meter)
   g. Multiple Languages (English, Spanish, French, Italian, Portuguese, German, Czech, Russian)

N. PERFORMANCE AND DESIGN CRITIRIA:

1 Isla Blanca WWTP site:

- Altitude 3’ Elevation
- Atmospheric pressure 14.7 PSIA
- Max atmospheric temperature 110 °F
- Relative humidity 80 %

Design parameters

- FAD flow (Q1) 2083 ICFM Volumetric flow (Q2) 1800 SCFM
- Discharge pressure 6.8 PSIG
- Motor HP 100 HP

2 Laguna Vista WWTP site:

- Altitude 10.5’ Elevation
- Atmospheric pressure 14.7 PSIA
- Max atmospheric temperature 110 °F
- Relative humidity 80 %

- Design parameters
  - FAD flow (Q1) 844 ICFM Volumetric flow (Q2) 600 SCFM
  - Discharge pressure 6.8 PSIG
  - Motor HP 40 HP

Q1: F.A.D. (free air delivery) it is the delivered air flow recalculated in suction port conditions by considering suction pressure and temperature exactly as per the specific selection parameters, therefore in the consistent way compared to actual operating conditions.

Q2: It is the dry normalized flow calculated according to DIN 1343 standards. In WWT processes this flow represents essential parameters as it is related to the actual amount of O2 transferred to the biological aeration process.

O. SELECTION OF THE COMPRESSOR

1. Specific sizing tool prepared and guaranteed by the manufacturer
2. Integrating performance curves of the compressor in the actual conditions related to the selected duty point
3. Integrating the sizing of the best fitting IE3 NEMA motor
4. Integrating the sizing of high efficiency drive

P. TESTING

1. A package test is performed testing voltage, frequency, rpm, pressure, temperature, kW and overall functionality.

2.2 ACCESSORIES

A. Variable Frequency Drive and Harmonic Filter.

B. Provide an automatic pneumatically operated unloader valve for reduced motor amps during startups.

C. Provide a premium efficiency TEFC motor.

2.3 AESTHETIC AND DECALS

A. All equipment shall be factory painted. Warning and danger decals shall be standard ISO symbols. Product decals shall be the current standard product decal and package logo.

2.4 SOURCE QUALITY CONTROL

A. Testing: Package shall have a mechanical run validation test done prior to shipment. Each blower shall have a slip and hot test performed prior to shipment.

B. The District Engineer shall receive a copy of the test procedure and results, which must certify that the assembled blowers, auxiliaries, blow-off valves, discharge valves, and LCP were tested together, as a system, in the MANUFACTURER's shop.

C. Net delivered flow rate and discharge pressure shall be +/- 5% from Manufacture provided performance curves.

D. Test results of the motors and blowers shall be included in the Operations and Maintenance Manual.

E. Motor Tests:
   1. Motor insulation systems shall be tested in conformance with NEMA Standard MG1-20.49.
   2. Stator temperature attainment may be accomplished by restricting cooling airflow or by other industry standard methods, but all effects of the method of testing shall be evaluated.
   3. Motor during test shall be complete including accessories and have nothing removed for convenience except the power lead conduit box. No extra devices shall be used except those required to measure or monitor variables.
   4. All test variables shall conform to actual field values and shall be maintained throughout tests.
   5. Motors shall be given complete tests of 100, 75, 50, and 25 percent full load, power factors at 100, 75, 50, and 25 percent of full load, winding resistances, high potential, and bearing inspection. Certified motor test data sheets shall be submitted for review and acceptance. Data sheets shall give the observed and nameplate temperature and results of dielectric tests in addition to the above data. The sheets shall be marked to indicate motor application, MANUFACTURER, type, frame size, bearing type, enclosure type, and motor serial number.
   6. Additional motor tests as recommended by the blower MANUFACTURER shall be performed and submitted for review and acceptance.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements specifies requirements for installation examination.

3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All blower equipment shall be enclosure mounted or crated to protect against damage during shipment. All parts shall be properly protected so that no damage or deterioration will occur during the time between shipment and installation.

B. Securely bolted fiberboard blank flanges shall protect finished surfaces of all exposed flanges.

C. Shipment is not to be made until the MANUFACTURER coordinates shipment to the jobsite with OWNER.

D. Equipment shall be stored in strict accordance with MANUFACTURER’s instructions.

E. The space heaters in the motors shall be immediately connected and energized by OWNER upon receipt of the blower skid at the jobsite.

F. Documentation: Units shall ship with operator's manuals, PLC Controller manual, Quick Start Guide and parts list in hard copy and/or CD ROM format. Provide PowerPoint training presentation, brochures, and performance curves.

3.3 INSTALLATION

A. Installation Standards: Install Work according to manufacturer's instructions and standards.

B. Each blower skid unit shall be mounted on a flat and level concrete pad ($\pm$1 degree) in accordance with the recommendation of the MANUFACTUER.

C. The process startup shall be executed in conjunction with OWNER's personnel to coordinate loop-tuning activities so that the entire activated sludge treatment process works in harmony.

3.4 FIELD TESTING

A. At a minimum, each blower and motor skid shall be field tested for a duration of not less than 24 hours at maximum load.

3.5 BLOWER MANUFACTUER'S FIELD SERVICES

A. The MANUFACTURER shall furnish experienced start-up service personnel to inspect the final installation and supervise the field start-up tests of the equipment and software. The services of the representative shall be provided for a minimum of one 8-hour day for each blower. If there are difficulties in operation of the equipment due to the MANUFACTURER's fabrication and programming, additional service shall be provided at no extra cost to OWNER.
   1. Provide, as a minimum, the following field services: Provide written documentation for check out including who performed the work, when performed, what was final setting or tolerance, and who witnessed the final settings.
      a. Verify proper connection of piping and installation of accessories.
      b. Check leveling of blower enclosure.
      c. Confirm proper wiring of all instruments and field wired items.
   2. A minimum 4 hours, for each blower, field acceptance test shall demonstrate that, under all conditions of operation, each unit:
      a. Has not been damaged by transportation or installation.
      b. Has been properly installed.
      c. Has no mechanical defects.
      d. Has fully functional instrumentation that are properly calibrated and set.
      e. Will start, run, and stop in the prescribed manner.
      f. Will run through the entire range of specified pressure and flow.
      g. Has the proper shutdown sequence of standard stop, soft stop, and emergency stop.
      h. Is free of overheating of any parts.
      i. Is free of objectionable vibration and noise.
      j. Is free of overloading of any parts.

3. Field acceptance testing shall be conducted after the installation of all equipment has been completed, all instrumentation has been calibrated and is working as intended, and the equipment has operated for a sufficient period to make all desirable corrections and adjustments.

B. The MANUFACTURER shall include an allowance to provide an experienced start-up / service factory representative to be present during the start-up and testing.
   1. Phase 1 – Start-Up: During this phase, the services of the representative shall be provided for one 8-hour day.

END OF SECTION

SECTION 463111 - CHLORINE GAS FEED EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Vacuum-regulated, gas-feed, manual-switchover, fully automatic-type chlorination controls.

B. Related Requirements:
   1. Section 400513 - Common Work Results for Process Piping: Piping components, appurtenances, and administrative requirements common to process piping systems.
   2. Section 400531 – Thermoplastic Process Pipe: PVC and polyethylene pipe and fitting materials as required for piping system.
   3. Section 400523 - Common Work Results for Process Valves: Components, appurtenances, and administrative requirements common to process valves.
   4. Section 400563 - Ball Valves: Execution requirements for ball valves as specified by this Section.

1.2 REFERENCE STANDARDS

A. The Chlorine Institute, Inc.: Requirements for vacuum regulator mounting assembly.

B. Mining Safety and Health Administration: Requirements for self-contained breathing apparatus.

C. National Electrical Manufacturers Association:

   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. National Institute for Occupational Safety and Health: Requirements for self-contained breathing apparatus.

1.3 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with plant operations.

1.4 SITE MOBILIZATION MEETING

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SCHEDULING

A. Section 013000 - Administrative Requirements: Requirements for scheduling.

B. Schedule Work of this Section after finishing concrete work for support pad and prior to connecting piping work.

1.6 SEQUENCING

A. Section 011000 - Summary: Requirements for sequencing.

B. Sequence Work to prevent interference with plant operations.

1.7 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit complete information concerning materials of construction, fabrication, and protective coatings.

C. Shop Drawings:

1. Indicate materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
2. Submit schematic diagram of each system, including tag marks for each item of equipment cross-referenced to chlorine system equipment list.

D. Manufacturer's Instructions:

1. Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.
2. Submit installation, selection, and hookup configuration, with pipe and accessory elevations.
3. Submit hanging and support requirements and recommendations.

E. Manufacturer Reports: Indicate that equipment has been installed according to manufacturer's instructions.

1.8 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for closeout procedures.

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

C. Operation and Maintenance Data: Submit maintenance instructions for equipment and accessories.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

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

a. One flow rate indicator for each vacuum regulator.
b. One spare remote gas flowmeter with rate valve.
c. Three gaskets to fit joints and unions.
d. One set of hose clamps to suit hose connection.
e. Fifty cylinder valve gaskets.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver materials in manufacturer's packaging; include installation instructions.

C. Inspection: Accept equipment on-Site in manufacturer's original packaging. Inspect for damage.

D. Store products in areas protected from weather, moisture, or possible damage.

E. Protect systems from entry of foreign materials by using temporary covers and by isolating parts of completed system.

1.12 WARRANTY

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

B. Furnish one-year manufacturer's warranty for all equipment from the start-up.

PART 2 - PRODUCTS

2.1 CHLORINE FEED SYSTEM

A. Manufacturers:

1. CAPITAL CONTROLS – SEVERN TRENT SERVICES, HYDRO INSTRUMENTS.
2. Substitutions: Section 016000 - Product Requirements.

B. Description:

1. Feed System: Vacuum-operated, solution-feed, manual switchover chlorinator for dispensing chlorine gas from standard 1-ton cylinders.
2. Ejector: Provides operating vacuum for feed system.

C. Performance and Design Criteria:

1. Chlorine Gas Feed Capacity: 250 lb./day.
2. Manually switch gas supply from empty cylinder to full cylinder.

D. Vacuum Regulator:

1. Mounting: On each gas cylinder valve by means of corrosion-resistant, gasketed yoke assembly conforming to standards of The Chlorine Institute, Inc.
2. Vacuum Control: Tantalum inlet valve springs opposing diaphragm that closes tightly upon loss of vacuum.
3. Pressure Relief Valve:
   a. Furnish separate ports for chlorine feed and chlorine vent.
   b. Vent gas away from pressure relief port to atmosphere outside of building; furnish insect screen at end of vent.
4. Furnish inlet filter to remove particulate matter from the gas before it enters inlet safety valve.
5. Furnish flowmeter to indicate gas feed rate and to indicate which cylinder is in use.
   a. Gas Flow Rate Range: Maximum 250 lb./day and minimum of 1/20 of maximum rate.
   b. Solid silver control valve for manual feed rate adjustment.
   c. Mounting: Wall.
6. Furnish loss-of-gas indicator to indicate when cylinder is empty and requires replacement.

E. Automatic Switchover Module:

1. Not used.

F. Ejector Assembly:

1. Type: Water-operated venturi nozzle.
2. Automatic gas flow shutoff upon loss of water supply.
3. Chlorine Feed Rate: 250 lb. per day.
4. Back Pressure: 19 psig.

5. Water Supply Pressure Available: 60 psig.
6. Maximum Water Supply Flow Rate Available: 50 gpm.

G. Check Valve:

1. Spring loaded, normally closed.

H. Mounting: Wall mounted with required piping connections for gas and ejector supply water and discharge.

2.2 MATERIALS

A. Vacuum Regulator:

1. Inlet Adapter: Corrosion-resistant Hastelloy C.
2. Body: PVC.

B. Chlorine Vent and Vacuum Tubing:

1. Polyethylene Tubing and Fittings: As specified in Section 400531 - Thermoplastic Process Pipe.

C. Rigid Chlorine Piping:

1. PVC Piping and Fittings: As specified in Section 400531 - Thermoplastic Process Pipe.

2.3 ACCESSORIES

A. Ball Valves:

1. As specified in Section 400563 - Ball Valves.
2. Working Pressure: 100 psig.
3. End Connections: True-union type.
4. Materials:

a. Body: PVC.
b. O-Ring: Viton.
c. Seat: Self-lubricating PTFE.
d. Removable Handle: Plastic.

B. Cylinder Scale:

1. Manufacturers:

a. CAPITAL CONTROLS – SEVERN TRENT SERVICES, HYDRO INSTRUMENTS.
b. Substitutions: Section 016000 - Product Requirements.

2. Description: Restore two-cylinder scale with individual, circular weighing platforms consisting of PVC base, plastic-coated supporting column, and plastic-coated, adjustable

crossbar with chains to restrain cylinders at each wastewater treatment plant location provided as follows:

a. Isla Blanca WWTP – Replace trunions. One additional scale required.
b. Andy Bowie WWTP – One additional scale required. One existing scale to remain in place.
c. Port Isabel WWTP – One additional scale required. One existing scale to remain in place.
d. Laguna Vista WWTP – Two functioning analog scales to remain in place.

3. Furnish scale head with two indicators and two tare-weight adjusting knobs.
4. Minimum Height of Scale Platform: 1-1/2 inches.
5. Accuracy of Tare Weight Adjustment: 0.5 percent of full scale.
6. Indicator to display net weight of each cylinder.
7. Gross Capacity of Each Scale Platform: 2,500 lb.
8. Tare Capacity Range: Zero to 2,100 lb. with readability to 0.1 lb.
9. Indicators:
   a. Two independent digital displays.
   b. Electrical Characteristics: 120 V, single phase, 60 Hz.
   c. Enclosure: NEMA 250, 4X.
10. Finishes: Scale materials and coatings suitable for use in chlorine atmosphere.

C. Chlorine Leak Detector:

1. Manufacturers:

   a. CAPITAL CONTROLS – SEVERN TRENT SERVICES, HYDRO INSTRUMENTS.
   b. Substitutions: Section 016000 - Product Requirements.

2. Detector:

   a. Specific to chlorine gas and responsive to less than one part per million by volume.
   b. Indications: Warning and alarm with indicating lights.
   c. Operating Temperature Range: Minus 20 to plus 150 degrees F.
   d. Electrical Characteristics: 120 V, single phase, 60 Hz.
   e. Furnish contact closures for separate warning and alarm circuits to activate external safety devices, including external fan and alarm.
   f. One Detector may be used for up to two Sensors.

3. Sensor:

   a. Solid-state material for remote, wall mounting in plastic, chlorine-resistant enclosure.
   b. Chemical-less type.
   c. Furnish 20 feet of No. 4 conductor, shielded cable between sensor and electronics enclosure.

4. Electronics Enclosure:

   a. High-impact plastic construction, wall mounted.
   b. ON-OFF power switch and POWER light.
   c. LOW CHLORINE LEVEL warning light.

d. HIGH CHLORINE LEVEL alarm light.
e. Test switch to verify operation of alarm and warning circuits.
f. Reset switch to manually acknowledge and cancel alarm indication.
g. Three independent, single-pole, double-throw contact closures, rated at 10 A at 120V AC resistive load, for malfunction warning and alarm.
h. Gasketed door with observation window and compression-type latch.
i. Universal mounting brackets for wall or panel mounting.

D. Chlorine Residual Analyzer - not applicable (Operator collects grab sample to analyze for chlorine residual).

E. Existing Self-Contained Breathing Apparatus to remain in place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of equipment, accessories, and piping connections.

3.2 INSTALLATION

A. Install equipment and accessories as recommended by manufacturer and as indicated on Drawings.

B. Install chlorine vent and vacuum tubing in Schedule 80 PVC pipe to location outside of building wall. Install turned-down elbow and terminate with fine mesh insect screen.

3.3 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Preliminary Leakage Testing: Pressurize entire chlorine system with nitrogen to at least 150 psig. With system under pressure, test each joint and connection for leaks by applying soapy water to each joint and connection.

C. Final Leakage Testing: Test automatic chlorinators first to ensure chlorinators are operational. Use chlorinators to evacuate system in event leaks are found. Perform in the following sequence:

1. Check unions and pipe connections in chlorine system for tightness.
2. Open header and auxiliary valves one turn.
3. Soak rag with strong ammonia water (commercial 26-degree Be), and swab each joint and connection.

4. Momentarily open one chlorine cylinder valve to pressurize system to approximately 10 psig, then shut off tight; observe chlorine leaks evident by formation of dense, white smoke.
5. When leaks are found, turn on automatic chlorinators to evacuate system, then repair leaks; retest joints and connections after repairs are made.

D. Performance Testing: Test each piece of chlorination equipment under design conditions for two to four hours to demonstrate proper functioning and automatic regulation of system; test alarms and signal generation; exercise equipment control and manual override where applicable; demonstrate equipment safety features.

E. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified, and rerun tests; make final adjustments to equipment under direction of manufacturer's representative.

F. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on-Site for installation, inspection, field testing, and instructing Owner's personnel in maintenance of equipment.

G. Furnish installation certificate from equipment manufacturer's representative attesting equipment has been properly installed and is ready for startup and testing.

3.4 CLEANING

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

B. Clean portions of chlorine system to remove cutting oil, grease, and other foreign materials; do not use hydrocarbons or alcohols for cleaning residuals from these materials.

C. Before use, dismantle and clean new valves or other equipment received in oily condition. Test valves with clean, dry air at 150 psig for seat tightness before installation.

D. Dry chlorine piping before use using steam and dry air; if steam and dry air are not available, purge completed system with dry cylinder air or nitrogen to remove moisture.

3.5 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 463111

SECTION 463113 - SULFUR DIOXIDE FEED EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Vacuum-regulated, gas-fed, manual switchover, fully automatic-type sulfur dioxide feed controls.

B. Related Requirements:
   1. Section 260503 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this Section.
   2. Section 400523 - Stainless Steel Process Pipe and Tubing: Stainless-steel pipe and tubing materials.
   3. Section 400563 - Ball Valves: Execution requirements for ball valves as specified by this Section.
   4. Section 400567 - Specialized Pressure and Flow-Control Valves: Pressure-regulating valves to prevent over-pressurization and to help prevent liquefaction.
   5. Section 400567.39 - Pressure-Relief Valves: Pressure-regulating valves to prevent over-pressurization and to help prevent liquefaction.

1.2 REFERENCE STANDARDS

A. ASTM International:

   1. ASTM A182/A182M - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

B. National Electrical Manufacturers Association:

   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SITE MOBILIZATION MEETING

A. Section 013000 - Administrative Requirements: Requirements for site mobilization meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information describing materials of construction, fabrication, and protective coatings.

C. Shop Drawings:

1. Indicate materials and equipment, including wiring and control diagrams, performance charts and curves, installation and anchoring requirements, fasteners, and other details.
2. Indicate schematic diagram of each system, including tag marks for each item of equipment cross-referenced to sulfur dioxide feed system equipment list.

D. Manufacturer Instructions:

1. Submit detailed instructions on installation requirements, including storage and handling procedures, anchoring, and layout.
2. Submit installation, selection, and hookup configuration, with pipe and accessory elevations.
3. Submit hanging and support requirements and recommendations.

E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

1.5 CLOSEOUT SUBMITTALS

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

B. Project Record Documents: Record actual locations and final orientation of equipment and accessories.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Spare Parts:

1. Furnish two sets of manufacturer's recommended spare parts, including following:

a. One flow rate indicator for each vacuum regulator.
b. One spare remote gas flowmeter with rate valve.
c. Three gaskets to fit joints and unions.
d. One set of hose clamps to suit hose connection.
e. Fifty cylinder valve gaskets.

C. Tools: Furnish special wrenches and other devices required for Owner to maintain and calibrate equipment.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

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

B. Furnish one-year manufacturer's warranty for sulfur dioxide feed equipment.

PART 2 - PRODUCTS

2.1 SULFUR DIOXIDE FEED EQUIPMENT

A. Manufacturers:

1. Capital Controls – Severn Trent Services, Inc., Hydro Instruments.
2. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:

1. Feed System: Vacuum-operated, gas-feed, manual switchover, sulfur dioxide feed system using standard high-pressure cylinders.
2. Ejector: Provides operating vacuum for feed system.

C. Performance and Design Criteria:

1. Sulfur Dioxide Flow Rate: 250 lb./day.
2. Operating Temperature:

a. Minimum: 43.9 deg. F.
b. Maximum: 110 deg. F.

3. Accuracy: Plus or minus 4 percent of full scale.
4. Repeatability: Plus or minus 1 percent of full scale.
5. Linearity: Plus or minus 0.5 percent of full scale.
6. Manually switch gas supply from empty cylinder to full cylinder.
7. Vacuum Checking: Entire system capable of being checked in place.
8. Available Water Supply Pressure: 60 psig.

D. Vacuum Feed Systems:

1. Description:

a. Mounting: On manifold piping.
b. Furnish loss-of-gas indicator to indicate when cylinder is empty and requires replacement.

2. Vacuum Regulator:

a. Type: Spring-opposed diaphragm.
b. Valve springs close upon loss of vacuum.

3. Inlet Filter: Adequate to remove particulate matter from gas before entering inlet safety valve.
4. Flow Meter: Furnish control valve for manual feed rate adjustment.

E. Operation:

1. Electrical Characteristics:

a. As specified in Section 260503 - Equipment Wiring Connections.
b. Voltage: 120/240 V, single phase, 60 Hz.
c. Maximum Circuit-Breaker Size: 60 A.
d. Minimum Circuit Ampacity: 10 A.

2. Control Panel:

a. Factory mounted.
b. NEMA 250 Type 4X.
c. Single-point power connection and grounding lug.

3. Controller:

a. Turn-Down: 20:1.
b. Accuracy: Plus or minus 2 percent of full scale.
c. Mounting: Wall.
d. Display: 20-character digital display.
e. Inputs:

1) Three analog channels.

2) Four 12- to 24-V dc.

f. Outputs:

1) Two 4- to 20-mA dc signals.
2) Two alarm contacts.
3) Communication Protocol: Modbus RS-485.

4. Disconnect Switch: Factory mounted in control panel.
5. Operation Sequences: Flow pacing.

2.2 MATERIALS

A. Vacuum Regulator:

1. Inlet Adapter: CPVC.
2. Body: CPVC.

B. Vacuum Tubing: CPVC.

C. Pressurized Piping:

1. Material: Type 316 stainless steel.
2. Comply with ASTM A182/A182M.
3. As specified in Section 400523 - Stainless Steel Process Pipe and Tubing.

2.3 ACCESSORIES

A. Flexible Connectors: Type 316 stainless-steel tubing.

B. Elastomers: Viton.

C. Ball Valves:

1. As specified in Section 400563 - Ball Valves.
2. Working Pressure: 100 psig.
3. Materials:

a. Body: CPVC.
b. Internal Components: CPVC.
c. Furnish provision to vent cavity in closed position, on upstream side of valve.

D. Pressure-Reducing Valves:

1. Type: Self-actuating, spring loaded.
2. Type: Pneumatically actuated.
3. As specified in Section 400567 - Specialized Pressure and Flow-Control Valves.
4. Materials: Suitable for sulfur dioxide use.

E. Pressure Relief Valves:

1. As specified in Section 400567.39 - Pressure-Relief Valves.
2. Set Point: 150 psig.
3. Materials: Suitable for sulfur dioxide use.

F. Cylinder Scale:

1. Manufacturers:

   a. CAPITAL CONTROLS – SEVERN TRENT SERVICES, HYDRO INSTRUMENTS.
   b. Substitutions: As specified in Section 016000 - Product Requirements.

2. Description: Restore two-cylinder scale with individual, circular weighing platforms consisting of PVC base, plastic-coated supporting column, and plastic-coated, adjustable crossbar with chains to restrain cylinders at each wastewater treatment plant location provided as follows:
   a. Isla Blanca WWTP – Replace trunions. One additional scale required. Replace existing analog scale with digital display.
   b. Andy Bowie WWTP – Recalibrate one (1) existing digital scale system that will remain in place. One additional scale required.
   c. Port Isabel WWTP – Two new cylinder scales required.
3. Furnish scale head with two indicators and two tare-weight adjusting knobs.
4. Minimum Height of Scale Platform: 1-1/2 inches.
5. Accuracy of Tare-Weight Adjustment: 0.5 percent of full scale.
6. Indicator: Display net weight of each cylinder.
7. Gross Capacity of Each Scale Platform: 2,500 lb.
8. Tare Capacity Range: Zero to 2,100 lb. with readability to 0.1 lb.
9. Indicators:
   a. Two independent digital displays.
   b. Electrical Characteristics: 120 V, single phase, 60 Hz.
   c. Enclosure: NEMA 250 Type 4X.

G. Existing Self-Contained Breathing Apparatus to remain in place.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of equipment, accessories, and piping connections.

3.2 INSTALLATION

A. According to manufacturer instructions and as indicated on Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

B. Leak Testing: As recommended by feed equipment manufacturer.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 2 days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

D. Equipment Acceptance:

1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 CLEANING

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

B. Before use, dismantle and clean new valves or other equipment received in oily condition.

C. Test valves with clean, dry air at 150 psig for seat tightness before installation.

3.5 DEMONSTRATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 463113