TOWN OF WAREHAM

Request for Proposals (RFP)

Two Rotary Positive Displacement Blowers
For the Town of Wareham
Water Pollution Control Facility (WPCF)

LEGAL NOTICE

REQUEST FOR PROPOSALS

The Town of Wareham is seeking and accepting sealed proposals for two rotary positive displacement blowers for the Wareham Water Pollution Control Facility. Proposals will be accepted at the Wareham Water Pollution Control Facility, 6 Tony's Lane, Wareham, MA 02571 until 11:00 a.m., on Thursday, May 23, 2024. Proposals not submitted on original bid forms shall be deemed non-responsive. **Proposal submissions must be made in a sealed envelope clearly marked Two Rotary Positive Displacement Blowers – Wareham Water Pollution Control Facility - 11:00 a.m., Thursday, May 23, 2024.** The Town of Wareham assumes no liability for proposals mistakenly opened due to improperly labeled envelopes and will return same to bidder without notice.

Proposal and specification documents may be obtained from the Wareham Water Pollution Control Facility at the above address and on the Town of Wareham's website, https://www.wareham.ma.us/bids-rfps, after 11:00 a.m., Monday, April 29, 2024. The Water Pollution Control Facility Director, Scott Kraihanzel, will be accepting questions via email at skraihanzel@wareham.ma.us until 4:00 p.m. on Tuesday, May 14, 2024.

The Town of Wareham reserves the right to reject any and all bids, in whole or in part, and to make awards in a manner deemed in the best interest of the Town as provided by M.G.L.

The Town of Wareham is an Equal Opportunity Employer. Bids from Women and Minority Business Enterprises are strongly encouraged.

Derek Sullivan
Town Administrator

Request for Proposals
Two Rotary Positive Displacement Blowers
Contents

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittal procedures.

B. Review of submittals.

C. Schedule of submittals.

D. Construction progress schedules.

E. Proposed products list.

F. Shop drawings.

G. Product data.

H. Samples.

I. Manufacturer's instructions.

J. Manufacturer's certification

K. Online submittal platform

1.02 SUBMITTAL PROCEDURES

A. Transmit each required submittal in hard copy and electronic form using an Engineer accepted form.

B. Number the submittals as follows:

1. First: Specification section number.

2. Submittal number within the Specification section.

3. Review cycle number.

4. Title of submittal.

5. For example:

a. 15073-01-01 – Field lock gaskets for DIP (first review cycle)

b. 15073-01-02 - Field lock gaskets for DIP (second review cycle)

c. 15073-02-01 – Flange pipe and fittings (first review cycle)

d. 15073-02-02 – Flange pipe and fittings (second review cycle)

e. 15073-02-03 – Flange pipe and fittings (third review cycle)

C. Identify Project, Contractor, Subcontractor, and Supplier; pertinent Drawing number and detail number(s), and Specification sections, as appropriate.

D. Apply stamp, signed or initialed providing certification required by General Condition Article 6.17.C.2. At a minimum, stamp shall include the following information:

1. Submittal Number _____

2. Deviations: None_____; As Listed _____

3. Reference Specification Section _____

4. Reference Drawing Number _____

5. Space Requirement: As Designed_____ Different, As Listed _____

6. Representation is made to Owner and Engineer that Contractor has satisfied the requirements of General Conditions Article 6.17.C.1.a through d and that the Contractor hereby approves this submittal. Further, the Contractor certifies that he has developed a plan to meet the AIS "Buy American" requirements for the entire project and that this product will allow the Contractor to satisfy these requirements for the projects; any waivers relied upon by the Contractor to meet these requirements have already been approved.

Contractor _____

Signature _____

Date _____

Date _____

NOTE TO CONTRACTOR: All line numbers must be filled out (those lines with multiple options require only one of the options to be filled out). Failure to complete all the lines or to complete the lines below the certification statement will result in the return of the unreviewed shop drawing submittal.

E. Schedule submittals to expedite the Project, and deliver to parties in the quantities specified in this Section and at the locations identified during the Preconstruction Conference.

F. Identify deviations from Contract Documents in accordance with General Conditions Article 6.17.C.3.

G. Identify product and/or system limitations which may be detrimental to successful performance of the completed Work.

H. Identify space requirements which differ from those designed and/or shown on the Contract Documents.

I. Provide space for Contractor and Engineer review stamps.

J. Revise and resubmit in accordance with General Conditions Article 6.17.E. Identify all changes made since previous submittal in a cover letter or memorandum. Resubmittals shall be

comprehensive, including the previous submittal(s) and additional information in the resubmittal.

K. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

L. Submittals not required will not be recognized or processed.

M. Items shall not be fabricated or delivered without fully approved Shop Drawings.

N. Ensure no associated work begins until associated Shop Drawings are fully approved.

O. Fabrication prior to receiving an "Accepted" or "Accepted as Corrected – No Resubmittal Required" is at Contractor's risk.

P. All products provided by the Contractor or his subcontractors for the project require a shop drawing submittal. This includes any products provided as part of change orders.

Q. The Owner reserves the right to hold the Contractor responsible for the Engineer's costs to review more than two submittals (one resubmittal) on any one product.

1.03 REVIEW OF SUBMITTALS

A. Review of submittals will be in accordance with General Conditions Article 6.17.D.

B. Review Times:

1. No less than 30 days shall be allowed for Engineer's review of submittals and resubmittals unless otherwise specified in the Contract Documents.

2. No less than 45 days shall be allowed for Engineer's review of Division 17 submittals and all other items including PLC based control systems.

C. Review Codes:

1. Accepted.

2. Accepted as Corrected – No Resubmittal Required.

3. Accepted as Corrected – Resubmittal Required.

4. Revise and Resubmit.

5. Not Accepted.

6. Not Reviewed.

7. Informational Purposes Only.

D. Payment for items requiring resubmittals shall not be made in full (100 percent of the line item) until all submittals are coded Accepted or Accepted as Corrected – No Resubmittal Required.

1.04 SCHEDULE OF SUBMITTALS

A. Submit preliminary Schedule of Submittals in accordance with General Conditions Article 2.05.

B. The Schedule of Submittals shall be reviewed by the Engineer. Contractor shall revise and resubmit the schedule, if required, until acceptable to Engineer.

1.05 CONSTRUCTION PROGRESS SCHEDULES

A. Submit detailed baseline progress schedule within 30 days after date indicated in the Notice to Proceed for Engineer review.

B. Submit monthly updates to construction progress schedules with each Application for Payment identifying changes since previous version.

C. Prepare in accordance with the requirements of Section 01310 – Progress Schedule.

1.06 PROPOSED PRODUCT LIST

A. Within 10 days after date indicated in the Notice to Proceed, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product, and appropriate Specification Section Number.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.07 SHOP DRAWINGS

A. Provide information in accordance with General Conditions Article 6.17 as supplemented herein and as required by individual Specification sections.

B. Shop Drawing submittals shall include all descriptive data, performance characteristics, material specifications, spare parts list, drawings, piping diagrams, wiring schematics, and shall be complete and accurate to indicate item-by-item compliance with the Contract Documents. All associated drawings relating to a complete assembly of the various parts necessary for a unit shall be included.

C. Shop Drawings shall be drawn at scales matching those on the Drawings depicting the same items.

D. All catalog cuts, manufacturer's specifications, drawings, and verbal descriptions shall be clearly marked to allow identification of the specific products used.

E. If the submittal deviates from the requirements of the Specifications in any way, it shall be clearly marked in the submittal with the justifying reason stated for evaluation by Engineer.

F. Electrical and control submittals shall include a verbal description of the functions, metering equipment, alarm points, alarm sequences, and any other specific features provided.

G. Electric motor submittals shall be in accordance with Section 15170 - Motors.

H. All electrical equipment submittals shall be in accordance with Division 16, Electrical Specifications.

I. Submit one electronic copy of each submittal and resubmittal. Two hard copies shall be submitted to the Engineer after approval.

1.08 PRODUCT DATA

A. One electronic copy shall be submitted to Engineer of each submittal and resubmittal. Two hard copies shall be submitted to the Engineer after approval.

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

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

1.09 SAMPLES

A. Provide in accordance with General Conditions Article 6.17 as supplemented herein and as required by individual Specification sections.

B. Submit Samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate Sample submittals for interfacing work.

C. Submit Samples of finishes in custom colors selected, textures, and patterns for Engineer's selection.

D. Include identification on each Sample, with full Project information.

E. Submit the number or samples specified in individual Specification sections; one of which will be retained by Engineer.

F. Reviewed samples which may be used in the Work are indicated in individual Specification sections.

1.10 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual Specification sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, startup, adjusting, and finishing, in quantities specified for Shop Drawings.

B. When specified in Section 01640 - Equipment – General submit manufacturer's operation and maintenance instructions for equipment supplied under this Contract in the quantities and locations identified in Section 01640 - Equipment – General.

C. Identify conflicts between manufacturers' instructions and Contract Documents.

1.11 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual Specification sections, submit manufacturers' equipment certification and certification of equipment compliance in accordance with the requirements of Section 01640 – Equipment – General.

PART 2 PRODUCTS

2.01 ONLINE SUBMITTAL SOFTWARE

A. Contractor shall procure, administer, and maintain a third-party on-line platform for electronically exchanging, reviewing, and archiving construction submittals, RFIs, and other construction communications.

B. On-line platform shall be maintained throughout the duration of the Contract up to Final Payment or upon delivery of the archived construction documents, whichever is later.

C. Access to the on-line platform shall be made for select members of the Owner's and Engineer's representatives.

D. On-line platform shall be Submittal Exchange or equal.

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01640

EQUIPMENT-GENERAL

PART 1 GENERAL

1.01. SECTION INCLUDES

A. Submittals.

B. Performance affidavits.

C. Equipment design.

D. Spare parts.

E. Equipment identification.

F. Standardization of grease fittings.

G. Shop tests.

H. Installation of equipment.

I. Services of manufacturer's representative.

J. Operation and maintenance manuals.

K. Guarantees.

L. Panel Orientation and Sun shields.

M. Grease fittings.

1.02. SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01300 - Submittals.

B. Submit performance affidavits prior to or with Shop Drawings.

C. Installation Certificates.

D. Certification of Equipment Compliance.

E. Operations and Maintenance Manuals.

F. Training Plans

1. Submit no less than 30 days prior to proposed date for training in accordance with procedures identified in Section 01300 - Submittals.

2. Training plan must be approved by Engineer prior to scheduling actual date for training.

3. Provide syllabus with sufficient detail to establish content of training, duration of each topic, and demonstrate adequate content to train Owner's staff on proper operation and maintenance of equipment.

G. DVD recordings of training sessions.

H. Written training reports.

1.03. PERFORMANCE AFFIDAVITS

A. Provide performance affidavits for items listed in the Schedule of Manufacturer's Services, included at the end of this section, and as required in the individual Specifications sections.

B. Performance affidavits shall be developed by each manufacturer and shall certify to Contractor and Owner, jointly, that manufacturer has examined the Contract Documents, and that the equipment, apparatus, process, or system will meet the performance requirements set forth in the Contract Documents in every way. Equipment design, manufacturing, and assembly specifications are an integral part of the performance requirements.

C. Shop Drawings will not be reviewed prior to receipt by Engineer of an acceptable performance affidavit.

D. The performance affidavit shall be signed by an officer (vice president or higher) of the basic corporation, partnership or company manufacturing the equipment, and witnessed by a notary public.

E. Performance affidavits shall be in the following format:

Addressed to: (Contractor) and (Owner)

Reference: Contract No. _____

(Project) _____

Text "(manufacturer's name) has examined the Contract Documents and verified that the (product) meets in every way the performance and design requirements set forth in Specification Section(s) _____ of the Contract Documents and related Drawings."

Signature: Corporate officers shall be vice president or higher (unless statement authorizing signature is attached).

Notary: Signature(s) must be notarized.

1.04. EQUIPMENT DESIGN

A. Equipment and appurtenances shall be designed in conformity with ANSI, ASME, IEEE, NEMA and other generally accepted applicable standards.

B. Equipment and appurtenances shall be of rugged construction and of sufficient strength to withstand all stresses which may occur during fabrication, testing, shipping, handling, installation, all conditions of operation, and as required by the Contract Documents.

C. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provisions shall be made for adequate lubrication by readily accessible devices.

D. Details shall be designed for appearance as well as function. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

E. Machinery parts shall conform within allowable tolerances to the dimensions shown on the Shop Drawings. The corresponding parts of identical machines shall be made interchangeable.

F. All machinery and equipment shall be safeguarded in accordance with the safety codes of the ANSI, OSHA, and local Laws and Regulations. All rotating shafts, couplings, and other moving parts of equipment shall be provided with suitable protective guards of sheet metal or wire mesh neatly and rigidly supported. Guards shall be removable to provide access for repairs.

G. Details promoting maintenance, ease of replacing parts, and lubrication shall be a prime consideration in design.

H. Products shall be designed for corrosion resistance and shall not be constructed of materials which may prohibit ease of maintenance due to corrosion. All fasteners on areas requiring access for maintenance and lubrication shall be Type 316 stainless steel unless otherwise specified. Zinc- or cadmium-plated fasteners for these areas shall not be used.

1.05. SPARE PARTS

A. Provide spare parts as required by individual Specification sections.

B. Provide spare parts that are identical and interchangeable with original parts.

C. For each part (or group of small parts), provide a tag indicating the following:

1. Name and associated tag number(s) of equipment.

2. Name of the part.

3. Manufacturer's name and the date of manufacture.

4. Identification number of the part.

1.06. EQUIPMENT IDENTIFICATION

A. Each piece of equipment shall be provided with a substantial brass or stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

1.07. STANDARDIZATION OF GREASE FITTINGS

A. Coordinate grease fittings on all mechanical equipment to be compatible with a single type of grease gun.

B. Grease fittings shall be accessible to an operator. None shall be over five feet above the floor. Provide extensions to allow for accessibility.

C. Contractor shall provide extended grease fittings for all equipment that requires grease.

D. Grease fittings shall be extended to the nearest accessibly walking surface.

1.08. SHOP TESTS

A. Arrange shop tests of the equipment indicated in the Schedule of Manufacturer's Services and the individual Specification sections.

B. Arrange for the Engineer to witness shop tests in the manufacturer's shop, if required by the individual Specification sections.

C. Demonstrate equipment characteristics, including any specified pressure, duty, capacity, rating, efficiency, performance, function, and other special requirements, comply fully with the requirements of the Contract Documents and that the item will operate in the manner specified.

D. Submit certified copies of the manufacturer's test data and interpreted results in accordance with the procedures identified in Section 01300 - Submittals.

1.09. INSTALLATION OF EQUIPMENT

A. Field modifications shall not be made without prior approval from Engineer.

B. Provide all necessary guides, bearing plates, anchors, and attachment bolts, working drawings for installation, templates, and all other appurtenances necessary for the installation of the equipment specified.

C. Anchor bolts shall be of size and strength suitable for purpose intended and shall be in accordance with Section 05500 - Miscellaneous Fabrications, and the individual Specification sections. Bolts shall be 316 SS unless otherwise noted.

D. Pipe sleeves or other means of adjusting anchor bolts shall be provided where indicated and where needed. Equipment shall be leveled by first using sitting nuts on the anchor bolts and then filling the space between the equipment base and concrete pedestal with grout. Where equipment bases (i.e., pumps) are installed with grout holes, those bases shall be totally filled with grout after successful completion of Functional Testing and prior to System Demonstration Testing.

E. Provide equipment and housekeeping pads for equipment in accordance with the Drawings. Equipment and housekeeping pads shall be a minimum of 4-inches in height.

F. Acceptance Tests (Part of the Functional Test)

1. The Contractor shall enter into an agreement with an independent testing firm capable of conducting laser alignment, vibration testing, infrared testing procedures and other tests as indicated below. The firm must be approved by the Engineer and must have a minimum of five documented years of experience in this field. The Contractor shall submit five references complete with contact information showing this experience.

2. For each failure, Contractor shall consult with manufacturer for a remedy. Upon successful completion of the testing of a piece of equipment, manufacturer must approve of the results prior to Contractor sending to Engineer. Contractor is

responsible for any remedy. If modifications are required, Engineer will need to accept the modifications prior to any changes being made.

3. All tests apply to all motor-operated equipment with motors that exceed 1 HP.

4. Testing performed by this firm shall be as follows:

   a. Laser Alignment of Direct Coupled and V-Belt Systems:

      1) Contractor shall arrange for laser alignment of all mechanically driven equipment shafting, drives, and/or couplings prior to operating the units. Contractor shall present Engineer with field alignment calculations and certification that all equipment is properly aligned per specifications and manufacturer's instructions.

      2) All testing shall be in accordance with the procedures provided in Attachment A of this section for direct coupled machines and V-belt systems.

      3) The Contractor shall be responsible for correcting any equipment which fails to comply with the tolerances provided in Attachment A.

      4) Provide Owner with one bound copy of testing reports and findings.

   b. Vibration Testing:

      1) Contractor shall arrange for vibration testing of equipment prior to operating the units.

      2) Written certification from the testing service personnel that all equipment meets the vibration tolerances described herein should be received by the Contractor who shall in turn submit to the Engineer.

      3) Vibration testing requirements for specific equipment items are contained in Attachment A.

      4) The Contractor shall be responsible for correcting all equipment which fails to comply.

      5) Provide Owner with one bound copy of testing reports and findings.

   c. Infrared Testing:

      1) Contractor shall arrange for an instrumental infrared scan test to be performed on all electrical components furnished under this Contract.

      2) Written certification from the testing service personnel that all equipment meets the limits described herein should be received by the Contractor who shall in turn submit to the Engineer.

      3) The standard infrared testing requirements are contained in Attachment A.

4) The Contractor shall be responsible for correcting every problem area. All problem areas will be corrected, and a second thermograph taken and submitted.

5) Provide Owner with one bound copy of testing reports and findings.

d. Motor Circuit Evaluation:

1) Contractor shall arrange for a motor circuit evaluation to be performed prior to operating equipment.

2) Written certification from the testing service personnel that all equipment meets the limits described herein should be received by the Contractor who shall in turn submit to the Engineer.

3) The motor circuit evaluation requirements are contained in Attachment A.

4) The Contractor shall be responsible for correcting every problem area. All problem areas will be corrected, and a second thermograph taken and submitted.

5) Provide Owner with one bound copy of testing reports and findings.

1.10. SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Arrange for the equipment manufacturer to furnish the services of a qualified representative where specified in the Schedule of Manufacturer's Services and/or the individual Specification sections. The manufacturer's representative shall visit the Site as many times as needed to fulfill its obligations required by the Contract Documents.

B. Contractor shall be responsible for any additional time required for the manufacturer's representative to resolve equipment installation and/or operation problems due to a lack of coordination between the supplied equipment and the Contract Documents such as, but not limited to, dimensions, electrical problems or performance.

C. Arrange for the equipment representative to visit the Site on occasions after Startup and during the first year of operation if required by the individual Specification sections. The purpose of these visits shall be to review equipment operation, assist the operators in correcting operational problems and basic inspection of the equipment.

D. Manufacturer's representative shall assist and supervise Contractor during installation, testing, and operation of equipment where specified in the Schedule of Manufacturer's Services and the individual Specification sections.

E. Manufacturer's representative shall provide all certificates specified in the Manufacturer's Services and the individual Specification sections.

1. Manufacturer's Equipment Certification (Attachment B) - Submit one copy to both Owner and Engineer of Manufacturer Equipment Certificate indicating that the manufacturer's representative has witnessed the Functional Test for the equipment provided by their organization, final adjustments to the equipment have been made, the equipment has been tested to their satisfaction, and the equipment meets all performance and testing requirements included in the Contract Documents, excluding testing to be performed either during or after Startup.

F. Testing Reports

1. Functional Test Reports - Submit one copy to both Owner and Engineer of manufacturer representative's written Functional Test reports including performance test results unless otherwise noted.

2. Performance Testing During or After Startup - When the Contract Documents require performance testing to be conducted during or after Startup, submit one copy of performance test results with an updated Certification of Equipment Compliance as previously specified.

G. Training

1. Manufacturer shall provide services of qualified, factory trained, operations and maintenance personnel to instruct Owner personnel in proper care, operation, and maintenance of equipment. At a minimum, training shall include:

   a. Theory of operation.

   b. Actual operation.

   c. Mechanical maintenance.

   d. Electrical maintenance.

   e. Instrumentation and alarms.

   f. Optimization of operation.

   g. Safe operating and working practices and operation of safety devices.

   h. Troubleshooting.

   i. Demonstration of equipment startup procedures, operation, and shutdown procedures using equipment installed under this contract.

2. Training sessions shall be conducted at the Site on weekdays between the hours of 8:00 a.m. and 3:30 p.m. Actual times, locations, and durations of training sessions shall be approved by Owner.

3. Trainer shall provide all materials and training manuals required for training in quantities required by Owner.

4. Contractor shall digitally record and produce video from all training sessions. All videos shall be clear in picture and sound quality and free from shake or vibration. Videos should be edited to include dates of training, subject matter, trainer's name and affiliation, and length of video on the title credits and shall be edited to remove any gaps from the program. Unacceptable training videos should be rerecorded and reproduced. Provide one digital DVD recording of each training session to both Owner and Engineer. DVDs and cases shall be labeled with Project name, equipment description, date of training, trainer's name and affiliation.

5. Trainer shall develop a written report for each training session. At a minimum, reports shall summarize training sessions, indicate any problems that may have been encountered during operation of equipment, and include a sign-in sheet identifying all

attendees (see Attachment C). Contractor shall submit one copy of each training report to both Owner and Engineer.

1.11. OPERATION AND MAINTENANCE MANUALS

A. General:

1. Submit operation and maintenance manuals as required by the Schedule of Manufacturer's Services, and the individual Specification sections in accordance with the procedures identified in Section 01300 - Submittals.

2. Prior to completion of the Work, and at least 30 days prior to the 50 percent payment, submit for Engineer's review three copies of all preliminary draft operation and maintenance manuals. Preliminary draft operations and maintenance manuals may be submitted separately for individual items.

3. Prior to completion of the Work, and at least 60 days prior to the 85 percent payment, submit for Engineer's review three copies of all final draft operation and maintenance manuals. Preliminary draft operations and maintenance manuals may be submitted separately for individual items.

a. All comments generated by Engineer during review of preliminary draft operation and maintenance manuals must be adequately addressed prior to submission of final draft operation and maintenance manuals. Final draft operation and maintenance manuals shall be complete in their entirety except for specific information related to testing and startup. Final draft operations and maintenance manuals must be approved by Engineer prior to the following:

1) Training of associated items.

2) System Demonstration Testing.

4. Prior to final payment, provide one digital and two hard copies of the final operation and maintenance manual. The final operation and maintenance manual shall include all required operations and maintenance information consolidated into one manual with multiple volumes. The final operation and maintenance manual shall include testing and Startup results where applicable.

B. Manual Preparation - Manuals shall include operation and maintenance information on all systems and items of equipment. The data shall consist of catalogs, brochures, bulletins, charts, schedules, approved Shop Drawings corrected to as-built conditions and assembly drawings and wiring diagrams describing location, operation, maintenance, lubrication, operating weight, lubrication charts and schedules showing manufacturer's recommended lubricants for each rotating or reciprocating unit, and other information necessary for Owner to establish effective operating and maintenance programs. The following shall also be included:

1. Title page giving name and location of facility, Drawing number where shown, and Specification section where described.

2. Equipment cover sheet listing the supplied equipment manufacturer's name, brand name, model numbers, serial numbers, equipment installer (provide contact name, address, phone and fax numbers, and e-mail address), equipment Supplier (provide contact name, address, phone and fax numbers, and e-mail address), and equipment

manufacturer (provide contact name, address, phone and fax numbers, e-mail address, and website address).

3. Performance curves for all pumps and equipment.

4. Approved Shop Drawings of each piece of equipment.

5. Manufacturer's cut sheets and dimensional drawings of each piece of equipment, and details of all replacement parts.

6. Manufacturer's erection, operation, and maintenance instructions for all equipment and apparatus, and complete listing of nameplate data.

7. Complete electrical and control schematics with labeled terminations for all individual pieces of equipment and systems including one line diagrams, schematic or elementary diagrams, and interconnection and terminal board identification diagrams.

8. Complete piping and interconnecting drawings.

9. Complete parts list with parts assembly drawings (preferably by exploded view), names and addresses of spare parts suppliers, recommended list of spare parts to be kept "in stock" and sample order forms. Lead time requirements for ordering parts shall be estimated.

10. Instructions with easily understood schematics or diagrams for disassembling and assembling equipment for overhaul and repair.

11. Shop testing results where applicable.

12. Manufacturer's Equipment Certification.

13. Field testing/performance reports where applicable.

14. Manufacturer's equipment warranty.

15. Information not applicable to a specific piece of equipment installed on this Project shall be removed from or crossed out on the submissions.

16. Illegible data due to any cause, including poor copy quality or reduction, will not be accepted. Manuals with illegible data will be rejected and returned for correction.

C. Organization - O&M Manuals shall be organized as follows:

1. All instructions shall be bound into a series of identical three or four inch, heavy-duty, three ring binders, all black covers with transparent exterior leaves for inserting cover pages. Where necessary, more than one binder may be used to assemble the data. When two or more binders are used, each book or volume shall be titled to indicate its particular book or volume number and the total number of volumes per set (e.g., Volume 2 of 12). The Contractor shall plan manual content and shall "break" the data between volumes at reasonable locations so no loss in continuity of data presentation occurs.

2. Information shall be organized by Specification section, each covering an individual equipment item.

3. Sections shall be listed in a Table of Contents at the front of each volume.

4. Shop Drawings 24 inches by 36 inches in size shall be folded to approximately 12 inches by 9 inches with drawing title box exposed along either edge. Shop Drawings descriptive of a single item of equipment shall be grouped together. All Shop Drawings shall be placed in accordion-type folders similar to File Pocket No. 74CG (9-1/2 inches by 14-3/4 inches) as manufactured by the Cooke and Cobb Company, or equal, and fully indexed on the outside of the folders in a neat and uniform manner.

5. All Shop Drawings included in the binders and/or folders shall be those previously submitted for review and approval and shall bear Engineer's stamp of approval and comments as originally noted thereon.

D. Electronic Operations and Maintenance Data

1. In addition to the specified printed operations and maintenance materials, furnish all specified operations and maintenance materials in electronic format with the final draft operations and maintenance manual submittals. Electronic equipment manual files shall be submitted in Adobe Acrobat Reader (.PDF) format.

2. Electronic files shall be submitted on one or more compact disks (650 MB CD). Two sets of compact disks shall be provided, one for Owner and one for Engineer. CDs and covers shall be labeled with the Project name, Supplier, equipment identification, and Specification section. CDs shall be provided in individual hard plastic cases.

1.12. GUARANTEES

A. Manufacturer Warranties During Correction Period

1. Where indicated in the individual Specification sections, provide a one-year manufacturer warranty made out in the name of the Owner, coinciding with the correction period defined in General Conditions Article 13.07.A for the particular piece of equipment.

2. One copy of each manufacturer warranty shall be provided to both Owner and Engineer within 30 days of successful completion of Startup.

3. All requirements of the of the correction period defined in General Conditions Article 13.07 shall apply to the manufacturer's warranty and the equipment Supplier obligations shall be the same as Contractor obligations defined in General Conditions Article 13.07 for the particular piece of equipment covered by the warranty.

B. Special Guarantees - Provide both Owner and Engineer one copy of special guarantees required in individual Specification sections. Special guarantees shall be made out in the Owner's name.

1.13. PANEL ORIENTATION AND SUN SHIELDS

A. Panel orientation with southern exposure should be avoided. Any panel with southern exposure being necessary or desirable shall be reviewed with Owner.

B. Contractor shall provide sun shields for all outdoor control panels.

C. Shields shall protect control panel screens from sunlight and shall allow screens to be read in full sunlight.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

(continued on next page)

SCHEDULE OF EQUIPMENT TESTING AND MANUFACTURER'S SERVICES

EQUIPMENT ITEM	SPEC. SECTION	PERFORMANCE AFFIDAVIT	SHOP TESTS	FIELD TESTS	MANUFACTURER'S EQUIPMENT CERTIFICATE	SERVICES OF MANUFACTURER'S REPRESENTATIVES (1)				OPERATION AND MAINTENANCE INSTRUCTIONS	EXTENDED WARRANTY	ACCEPTANCE TEST	PERFORMANCE TEST (AS DEFINED IN INDIVIDUAL SPECIFICATION SECTION)
						PRELIMINARY FIELD TEST	FUNCTIONAL TEST	SYSTEM DEMONSTRATION TEST	TRAINING				
Weir Plates and Accessories	11287	No	No	Yes	No	--	--	--	--	No	No	No	No
Slide Gates	11291	No	No	Yes	Yes	1	1	1/2	--	Yes	No	No	No
Horizontal Screw Centrifugal Pumps	11302	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	No	No
Submersible Recirculating Chopper Pumps	11309	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	No	No
Sump Pumps	11319	Yes	No	Yes	Yes	1	1	1	1	Yes	No	Yes	Yes
Screening Equipment	11320	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	Yes	Yes
Grit Removal Equipment	11330	Yes	Yes	Yes	Yes	2	2	2	1	Yes	No	Yes	Yes
Septage Receiving Equipment	11332	Yes	Yes	Yes	Yes	1/2	1/2	1/2	1/2	Yes	No	Yes	Yes
Final Clarifier Equipment	11336	Yes	Yes	Yes	Yes	--	2	4	1/2	Yes	No	Yes	Yes
Clarifier Brush Cleaning Equipment	11338	No	No	Yes	Yes	1/2	1/2	1/2	1/2	Yes	Yes	No	No
Chemical Metering Pumps	11345	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	No	No
Chemical Transfer Pumps	11346	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	No	No
Chemical Storage Tank	11350	Yes	Yes	Yes	Yes	1/2	1/2	1/2	1/2	Yes	No	No	No
Odor Control System	11351	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	Yes	Yes
Coarse Bubble Diffusers	11373	No	No	No	No	1	1/2	1/2	--	Yes	No	No	No

EQUIPMENT ITEM	SPEC. SECTION	PERFORMANCE AFFIDAVIT	SHOP TESTS	FIELD TESTS	MANUFACTURER'S EQUIPMENT CERTIFICATE	SERVICES OF MANUFACTURER'S REPRESENTATIVES (1)				OPERATION AND MAINTENANCE INSTRUCTIONS	EXTENDED WARRANTY	ACCEPTANCE TEST	PERFORMANCE TEST (AS DEFINED IN INDIVIDUAL SPECIFICATION SECTION)
						PRELIMINARY FIELD TEST	FUNCTIONAL TEST	SYSTEM DEMONSTRATION TEST	TRAINING				
Positive Displacement Blowers	11802	Yes	Yes	Yes	Yes	1	1	1	1	Yes	No	Yes	Yes
OEM Control Panels	11990									Yes	No		
Hoists, Cranes, Fall Protection	14602	Yes	No	Yes	Yes	--	1	--	--	Yes	No	No	Yes
Aboveground Process Valves	15100	No	No	Yes	No	--	--	--	--	Yes	No	No	Yes
Axial Fans	15865	No	No	Yes	No	1/2	--	1/2	--	Yes	No	No	No
Power Ventilators	15870	No	No	Yes	No	1/2	--	1/2	--	Yes	No	No	No
HVAC Controls and Sequence	15985	No	No	Yes	No	--	--	2	1	Yes	No	No	Yes
Variable Frequency Drives	16480	No	No	Yes	Yes	5	5	4	1	Yes	No	No	Yes
Radar Level Sensors	17310	No	No	Yes	Yes	1	1	1	1	Yes	No	Yes	Yes

(1) All times are actual, on-site times (days) and represent minimum requirements.

END OF SECTION

ATTACHMENT A

ACCEPTANCE TESTS, TOLERANCES, AND PROCEDURES

1. INFRARED THERMOGRAPHY

Motor Windings:

For analysis of infrared data on motor windings the insulation rating should be known (see chart below). The following is the design formula used to measure the life of the electrical insulation in motors.

$L = (1/2^N) \times 100{,}000$ hrs. L= life of the motor's insulation
N= factor related to service temperature

Using the formula, it can be shown that motor insulation life is cut in half when subjected to temperatures that are only 10° C above the rated temperature. Also, it is important to note is that electrical insulation must be kept free of moisture, dirt, dust, or any other conductive contaminants that will cause deterioration of the insulating quality.

- Conversion formulas for converting temperatures in Celsius to Fahrenheit and vice versa:

  Temp. ° C = 5/9 * (Temp. °F - 32)
  Temp. ° F = (9/5 * Temp. °C) + 32

Motor Insulation Class	Absolute Temperature Limits
Class A	105°C 221°F
Class B	130°C 266°F
Class F	155°C 311°F
Class H	180°C 356°F

To determine the internal winding temperature of a motor, add 10°C or 18°F respectively to the outer surface measurement.

Most manufactures design their equipment to be operated under conditions where the ambient air temperature does not exceed 40°C or 104°F NEMA Standard 11-20. Exceeding this ambient air temperature can often affect the ratings of various electrical components.

ANSI/IEEE C37.20.1 Table 4 calls for the limits of Buses and Connections as used in Switchgear Assemblies for Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear to be the following.

Type of Bus or Connection	Limit of Hottest-Spot Temp. Rise	Limit of Hottest-Spot Total Temp.
Buses and connections with unplated copper to copper connecting joints	30°C 86°F	70°C 158°F
Buses and connections silver surfaced, tin surfaced, or equivalent connecting joints	65°C 149°F	105°C 221°F
Connection to insulated cables unplated copper to copper	30°C 86°F	70°C 158°F
Connections to insulated cables silver surfaced, tin surfaced or equivalent	45°C 113°F	85°C 185°F

From NEMA STANDARDS for Molded Case Breakers and Molded Case Switches come the Temperature-Rise Limits For Various Materials and Parts Table 4-10

Description of Parts	Temperature Rise Limit
Copper	45°C 113°F
Metal Parts	35°C 95°F
Insulating Material	60°C 140°F
External Connections	50°C 122°F

Typical Wiring Insulation	Maximum Temperature
SIS, TA, TBS, THHN, RHH	90°C 194°F

In addition to overall temperature limits, a 5 degree C difference in temperature from like components will be reported as moderate problems, a 10 degree C difference will be reported as a caution, and greater than 10 degree C differential will be reported as severe. All reported problems whether moderate or severe should be investigated and corrected. A follow-up thermographic survey will be required to insure the problems are successfully corrected.

2. MOTOR CIRCUIT EVALUATION - ELECTRICAL TEST TOLERANCES

All motors shall be baseline tested using a PdMA MCEmax 3000 motor circuit evaluation tester. The following tests will be performed and documented. The de-energized tests will be performed on all new motors at the motor junction box before final connection and then from the MCC from the load side of the starter or drive whichever is applicable after the final connections have been made. Existing motors or new motors if already connected, shall first be tested from the MCC and then at the motor if required to isolate a poor test result. New or rebuilt motors shall be tested at the motor prior to installation and then from the MCC.

TESTS:	LOOKS AT:	IDENTIFIES:
Resistance to Ground (RTG)	Insulation System Integrity.	Ground condition of insulation
Polarization Index (PI) & Dielectric Absorption (DA)	Insulation System Integrity.	Deterioration of insulation.
Circuit Resistance (Phase to Phase)	Power Circuit & Stator Windings	High resistance connections which cause overheating and voltage imbalance.
Capacitance to Ground (CTG)	Insulation System Isolation	Cleanliness of stator winding - conductive material buildup.
Inductance (Phase to Phase)	Stator & Rotor	Turn to turn or phase to phase shorting. Broken rotor bars, eccentricity, broken end rings.
Rotor Influence Check (RIC)	Rotor Condition (isolates between rotor and stator)	Broken or cracked rotor bars and end rings, eccentricity and voids.
Motor In-Rush	Stator & Rotor	Correct design & startup characteristics
3 Phase Voltage & Current	Stator & Rotor	Power quality, efficiency and rotor problems
Motor Current Signature Analysis	Rotor Condition	Broken or cracked rotor bars and end rings, eccentricity and voids.

MOTOR TEST TOLERANCES – Using a PdMA MCEmax Motor Tester

RESISTANCE TO GROUND (RTG) - For existing motors under 600 VAC, anything >500 megohms shall be considered acceptable. Any new motor or motor returning from overhaul (complete rewind, or a dip and bake) shall have resistance to ground readings >3500 megohms. If a motor fails to meet the >3500 megohm tolerance but is at a level considered safe to start, the motor should be run long enough to warm up to a stable temperature, shutdown and retested.

CAPACITANCE TO GROUND (CTG) - Capacitance is reflective of moisture and dirt in vicinity of motor circuit components. Analysis is performed by trending and relative comparison: take initial readings; compare readings for similar motor circuits; compare follow-up readings, look for upward trends; and schedule inspection when differences are significant. A baseline CTG is required on all motors.

PHASE RESISTANCE - In AC motors any phase-to-phase resistive imbalance ≤ 3% is acceptable for motor voltages <600V and ≤ 2% for motors > 600V.

PHASE INDUCTANCE - For new or rebuilt AC motors, an inductive imbalance <10% is considered acceptable. For existing motors, an inductive imbalance of < 15% with a steady average inductance trend is considered acceptable.

POLARIZATION INDEX (PI) AND DIELECTRIC ABSORPTION (DA) - A PI ratio of 2 or higher with a continuing upward graph shall be considered acceptable. A DA > 1.5 shall be considered acceptable. Any PI or DA that reaches 3500 megohm and whose graph doesn't break down will be considered acceptable as long as the RTG reading is >100 mohms.

STEP VOLTAGE TEST - A step voltage test should only be performed after a PI has been performed and only if the PI Ratio was >1. A linear graph of the step voltage test results indicate a GOOD condition, a non-linear slightly increasing sloped graph indicates that the electric circuits insulation system has marginal dielectric strength.

ROTOR INFLUENCE CHECK (RIC) - A RIC test shall be performed on all electric motors that have more than a 10% inductive imbalance or when the vibration tests indicate that electrically induced mechanical vibration is present. If MCE testing is an on-going PDM technology, a baseline RIC shall be performed regardless of the balance of inductance.

INRUSH – STARTUP (NON VFD AC MOTORS) – Using an Emax tester, the motors peak inrush current as well as the start-up time will be obtained graphically for baseline purposes on new motors. Although there are no warning levels associated with in-rush start-up testing on new motors, future tests and trends can identify early indications of rotor or stator degradation.

CURRENT ECCENTRICITY ANALYSIS - Using current FFT spectrum analysis, evaluate for peaks that are generally related to rotor to stator static or dynamic eccentricity problems. Correlate as needed with vibration, laser alignment/softfoot checks and infrared thermography. Motors with eccentricity current spectrum graphs that exhibit 4 peaks, 2 on each side of the eccentricity frequency with 2 times line frequency separation, are non-synchronous to line frequency and are 20 dB higher than the average noise level will be considered non-acceptable.

CURRENT ROTOR BAR ANALYSIS – Using High\Low Resolution current FFT spectrum analysis, evaluate for peaks that are generally related to rotor bar or stator slot problems. Correlate as needed with vibration and infrared thermography. Motors with pole pass frequency sideband peaks in the current spectrum under 55 dB of the line frequency dB amplitude will be considered non-acceptable as long as there are also pole pass frequency sidebands present around the 5th line frequency harmonic.

CURRENT AND POWER ANALYSIS CAUTION AND ALARM LIMITS FOR AC MOTORS

Any motor test outside the following IEEE or NEMA caution levels will be considered non-acceptable. Some of the following tests may not be applicable to motors with VFD's unless there is a bypass installed for running across the line. Many of the energized tests must be performed when the motor is at 70% of load or higher. Motors above 500 volts are tested using the secondary side of the current transformers or potential transformers as available.

TEST DESCRIPTION	UNACCEPTABLE	ALARM LEVEL
ENERGIZED TESTS		
Voltage Line to Line	Above/Below 5%	Above/Below 10%
Voltage Imbalance Line to Line	Above 1%	Above 3%
Voltage Imbalance Line to Neutral	Above 1%	Above 3%
Voltage Crest Factor Line to Line	Above 2	Above 3
Voltage Crest Factor Line to Neutral	Above 2	Above 3
Voltage THD Line to Line	Above 3	Above 5
Harmonic Voltage Factor	Above 0.8	Above 1
Current RMS (Amps)	Above FLA	5% Above FLA
Current Imbalance	Above 6%	Above 10%
Current Crest Factor	Above 6	Above 10
Current Total Harmonic Distortion (THD)	Above 5	Above 7
Impedance Imbalance	Above 7%	Above 12%
Line Frequency (Change from Baseline)	+/- 1 Hz	Above/Below 3.33%

3. VIBRATION ANALYSIS

A vibration analysis database will be developed consisting of the equipment to be tested. The database will be built using state of the art vibration condition monitoring and analysis software such as a CSI 2120 Dual Channel Analyzer and associated RBMware analysis and trending software. The equipment will be configured as individual machines with vibration measurements per the following example:

Vibration readings will be taken on each bearing in 2 radial directions 90 degrees apart and 1-2 axial directions per coupled shaft. The preferred axial reading, if accessible, would be at the bearing adjacent to the coupling or v-belt drive. For example, a motor pump combination mounted in a horizontal orientation would require a minimum of 10 vibration measurements on the four bearings. The measurements would be taken as follows:

Motor outboard bearing horizontal direction	M1H or AH
Motor outboard bearing vertical direction	M1V or AV
Motor inboard bearing horizontal direction	M2H or BH
Motor inboard bearing vertical direction	M2V or BV
Motor inboard bearing axial direction	M2A or BA
Pump inboard bearing horizontal direction	P1H or CH
Pump inboard bearing vertical direction	P1V or CV
Pump inboard bearing axial direction	P1A or CA
Pump outboard bearing horizontal direction	P2H or DH
Pump outboard bearing vertical direction	P2V or DV

For new equipment, additional measurement points will be established for obtaining impact resonance tests on the equipment and the equipment housing and support structures. The test points will be marked accordingly on equipment and on associated vibration diagrams for ease of cross-referencing to waveform and frequency data plots. Structural or component resonance frequencies must not coincide, i.e. be within +/-10% of 1 x RPM of machine(s) shaft running speeds, +/- 5% of 2 x RPM, or +/- 5% of 1 and 2 times electrical line frequency.

On variable speed equipment, vibration must be checked on the drive and driven equipment bearings at rated nameplate or maximum design RPM. Additionally, vibration at each bearing must be checked by ramping up the speed from the lowest possible running speed to the highest possible running speed in 1 Hz increments to determine if harmful resonant vibration exists. In certain instances depending on operational requirements, harmful resonant frequencies can be locked out (avoided) via the drive setup. Otherwise, vibration levels exceeding the allowable tolerances will have to be reduced by correction methods that would allow the equipment to run at such speeds.

Measurement Point Setup - Each measurement point will be setup to acquire vibration spectral data with an associated Fmax that encompasses the higher of: 1) the second harmonic of the ball pass inner race frequency, 2) the first harmonic of any gearmesh frequency, 3) the motor rotor bar pass frequency, 4) or the motor slot pass frequency. Each spectrum will have a resolution of at least 800 lines with the capability to acquire vibration spectrums with resolutions of 1600 lines, 3200 lines, and 6400 lines as required to ensure that all component vibration frequencies can be accurately determined. Each 0-Fmax broad band will be sub banded into bands corresponding to harmonics of the running speed, i.e. 0-0.75xRPM for sleeve or journal bearing machines or 0-1.5xRPM for anti-friction type bearings, .75-1.5xRPM for sleeve bearing machines, 1.5-2.5xRPM, 2.5-3.5x RPM, 3.5 – 10.5xRPM, 10.5 – 20.5xRPM. In addition, an overall acceleration reading from a high frequency detection band from Fmax – 1,200,000 CPM will be obtained. If there are any abnormal acceleration amplitudes found, a waveform and amplitude versus frequency plot will be obtained for evaluation. Each band will have an associated alert and alarm level as set forth in the "Tolerances" guidelines table(s). Any band that exceeds the alert or alarm level will require a spectrum and waveform evaluation to determine if a problem or defect exists.

As available, all potential fault frequencies, e.g., motor and fan bearing frequencies (ball spin, cage, ball pass inner race and ball pass outer race frequencies), blade or vane passing, motor rotor bar or electrical frequencies shall be pre-established and over-laid on the amplitude versus frequency graphs for verification that there are no related defects.

It is recommended that initial vibration readings be taken at original start-up and again after 100 hours of operation to allow for component wear in time. This also establishes the vibration baseline.

A full hard copy report shall be generated and will include: 1) a diagram of the equipment assembly illustrating where all measurements were taken, 2) an overall profile bar graph plot of all the bearing measurement points versus frequency zone and comparison to the pre-established alert levels for each frequency band, 3) vibration plots of all the velocity and as needed waveform data in a bottom to top strip type comparison format. This is very good for comparing vibration data from one test time to another or from when a process load changes, 4) recommendations for fixing any problems that may exist.

IN-SITU ALARM LEVELS FOR TYPICAL MACHINERY

Typical Frequency bands and Alarm levels are shown below. Most machinery should meet these standards if it is running well. When product quality is affected by machine vibration these limits may need to be significantly lower. This is the case with machine tools. Higher limits are acceptable for known rough running equipment, (i.e. as coal pulverizers, diesel engines, reciprocating compressors, and shaker motors) and the limits adjusted as necessary and agreed upon by the project design engineer in conjunction with the vibration testing firm.

The following tolerances will be used to determine the condition and acceptability of new and existing machines unless the manufacturer supplies tolerances of acceptable vibration velocity and acceleration levels across similar frequency bands that are lower than the levels listed below. In this case, the lower levels will be used as acceptability criteria.

Tolerances for **New** or **Rebuilt** machines with shaft speeds up to 3600 RPM

ips = inches per second and g's = acceleration units in "g" forces

Frequency Band	Good	Acceptable	Not Acceptable
0 to FMax (Overall)	< 0.15 ips	>.15 ips < .25 ips	> .25 ips
Sub & 1XRPM	< 0.13 ips	>.13 ips < .20 ips	> .20 ips
1. 2XRPM	< 0.10 ips	>.10 ips < .15 ips	> .15 ips
3-5XRPM	< 0.10 ips	>.10 ips < .15 ips	> .15 ips
5-10XRPM	< 0.05 ips	>.05 ips < .10 ips	> .10 ips
10-20XRPM	< 0.05 ips	>.05 ips < .08 ips	> .08 ips
20XRPM-1,200KCPM	< 1.0 g's	2. >1.0 g's < 2.0 g's	> 2 g's

Tolerances for **EXISTING** machines with shaft speeds up to 3600 RPM

ips = inches per second and g's = acceleration units in "g" forces

Frequency Band	Good	Acceptable	Not Acceptable
0 to Max (Overall)	< 0.25 ips	>.25 ips < .35 ips	> .35 ips
Sub & 1XRPM	< 0.20 ips	>.20 ips < .30 ips	> .30 ips
2XRPM	< 0.15 ips	>.15 ips < .20 ips	> .20 ips
3-5XRPM	< 0.12 ips	>.12 ips < .18 ips	> .18 ips
5-10XRPM	< 0.10 ips	>.10 ips < .12 ips	> .12 ips
10-20XRPM	< 0.08 ips	>.08 ips < .10 ips	> .10 ips
20XRPM-1,200KCPM	< 1.5 g's	>1.5 g's < 3.0 g's	> 3 g's

ADDITIONAL IN-SITU VIBRATION ANALYSIS CRITERIA – The presence of discernible vibration amplitude peaks in the vibration spectra at motor bearing inner race, outer race, fundamental cage, or ball spin frequencies or harmonics of these frequencies shall be cause for rejection of the motor.

The following vibration results will also be cause for rejection: 1) Stator problems that generate high vibration spectral peaks at 2 times electrical line frequency, 2) Rotor problems that generate high 2 times line frequency vibration peaks surrounded by pole pass frequency (Fp) sidebands (Fp = Slip freq x # poles). There could also be Fp sidebands around 1 times shaft RPM, 3) Other rotor problems that generate high vibration peaks at the rotor bar frequency or harmonics of rotor bar frequency with 2 times line frequency sidebands, or 4) vibration peaks in the motor that cause high 2 times line frequency vibration peaks with sidebands spaced at 1/3-line frequency.

Tolerances for **NEW** and **REBUILT ELECTRIC MOTORS –** Run un-coupled in- place or at the OEM or motor shop

ips = inches per second

Frequency Band	Acceptable
0 to Max (Overall)	< 0.10 ips
Sub & 1XRPM	< 0.075 ips
2XRPM	< 0.04 ips
3-5XRPM	< 0.03 ips
5-10XRPM	< 0.03 ips
10-20XRPM	< 0.03 ips
20XRPM-1,200KCPM	< 0.5 g's

AC motors will be tested at rated voltage, frequency, and no load. DC motors will be tested at their highest rated speed. All balancing as well as vibration readings will be obtained using a ½ key in the key seat.

METHOD OF MOTOR ISOLATION FOR MEASURING VIBRATION – When motors are tested at the factory or at a rebuild shop, place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as 25 % of the test speed of the motor. To accomplish this, it is required that the elastic mounting be deflected downwards (due to the motors weight) at least by the amounts shown in the following table. When a flexible pad is used, the compression shall in no case be more than 50 % of the original thickness of the flexible pad; otherwise, the support pad may be too stiff.

Motor Synchronous Speed RPM	**Isolation Pad Compression INCHES**
900	1
1200	9/16
1800	¼
3600	1/16
7200	1/64
The required deflection is inversely proportional to the speed squared	

Refer to Item No. 6 below for rotating equipment balance tolerance.

4. LASER SHAFT ALIGNMENT TOLERANCES FOR DIRECT COUPLED MACHINES

For coupled machinery, angular and parallel misalignment specifications are directly related to the size of the coupling and the speed of the machinery. The following chart is an acceptability guideline for industry standard alignment tolerances.

1 mil = .001"

RPM of Shafts	**Parallel Offset - mils**	**Angularity - mils/in of Coupling Diameter**	**Spacer Shaft with 2 Flex Planes – mils/in of spacer length**
< 600	5.0	1.0	1.8
600 to 900	3.0	0.7	1.2
900 to 1200	2.5	0.5	0.9
1200 to 1800	2.0	0.3	0.6
1800 to 3600	1.0	0.2	0.3
> 3600	0.5	0.1	0.15

Maximum Softfoot Reading for all speeds of 2.5 mils as read at the coupling centers,

Maximum Coupling Hub Runout of 2.5 mils up to 1800 RPM and 2.0 mils for shaft speeds > 1800 RPM,

Maximum Shaft Runout of 1.5 mils up to 1800 RPM and 1.0 mil for shaft speeds > 1800 RPM,

Face Runouts (if available) shall not exceed 0.5 mils per inch of coupling face diameter up to a maximum of 5 mils for speeds up to 900 RPM, a maximum of 2.0 mils for speeds > 900 to 1800 RPM, a maximum of 1.5 mils for speeds > 1800 RPM to 3600, and 1.0 mils for speeds > 3600 RPM.

Thermal Growth consideration shall be given on equipment that may grow "out of alignment" under actual operating conditions. OEM manuals are to be reviewed for thermal growth data. Final "Hot Alignment" checks shall be made to verify and correct alignment as necessary.

****All Runouts are TIR**

Softfoot - refers to the effect that uneven base plates, angled or non-planer machine feet, or induced distortion of machine frames from pipe misalignment, etc. have on the rotating machinery shaft centerlines. Excessive softfoot conditions distort rotating shaft centerlines which then produces unwanted forces on rotating machinery bearings causing premature equipment failure.

Pipe flange alignment and pipe supports – all piping shall be independently supported and all pipe fittings where they bolt up to rotating machinery shall be left with the bolts loose for inspection of proper pipe alignment and supporting prior to final tightening. Laser alignment checks including the softfoot check will be made after final tightening of pipe and after motor conduit connections are completed.

Motor conduit connections – it is highly recommended that the last 2-3 feet of conduit be of the flexible conduit type for connecting to the motor conduit boxes. This will allow the motor to be moved for obtaining final laser shaft alignment of the equipment.

Factory or pre-installation quality control checks – all rotating equipment that consists of coupled shafts should have been checked for softfoot and laser aligned at the factory prior to shipping. This will ensure that the machinery can actually be realigned after final installation, e.g., insure that there is sufficient room in the bolt holes for performing precision shaft alignment moves, that there is sufficient precision vertical alignment shims under the motors to allow for final vertical shim adjustments, and that softfoot conditions from non-planer base plates and uneven machinery feet have been corrected.

If the OEM's can't provide factory laser alignment, it is required that the equipment be laser aligned on their base plates and any softfoot conditions corrected prior to setting the equipment in place or at the very least prior to attaching any piping. Re-drilling or modifying base plates or over sizing motor bolt holes to allow for horizontal alignment moves can be done much easier in a shop than in the field. Final alignment is still required after final installation.

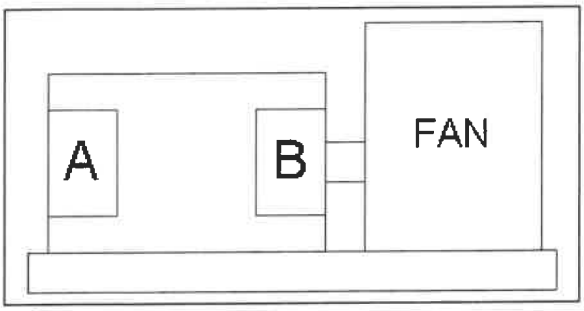
5. V-BELT SYSTEMS

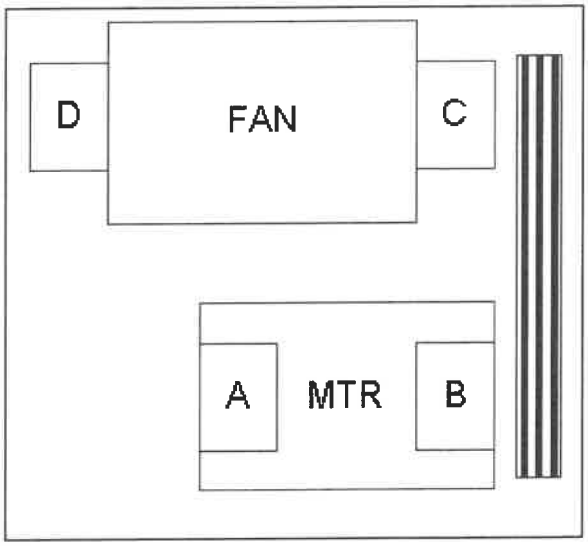
Dial indicators with 0.001" graduations shall be used to check face and rim runouts. Sheave runouts should not exceed 0.001 inch per inch of sheave diameter. Sheave cross sections must match each other as well as match for the proper belt cross section. After the runouts are verified, a level shall be used to check that both sheaves are vertically level to one another. Precut 304 or better stainless steel shims must be used under the motor feet to correct any vertical angular misalignment as well as to eliminate any softfoot which might be present due to uneven base supports. Lawton shims are preferred due to their consistent manufacturing process and higher design quality. After the vertical angles have been verified and/or corrected, a "Dotline" V-belt laser alignment system along with v-belt tension gages shall be used to evaluate, align, or re-align the v-belt drives. Alignment on belt systems with the smaller sheave up to 10 inches should be within 1/16", sheaves 10 inches through 20" should be within 3/32" and sheaves greater than 20" may have misalignment up to 1/8" (Again, the tolerance on the system is based on the smallest sheave diameter). Belt tensions shall conform to the v-belt manufacture's specifications as available from the v-belt manufacturer or other generic charts that are applicable for the belt type, cross-section, sheave speed, and belt span length. Recommended practice is to align and tension, run for 8-24 hours and retension and re-align as necessary.

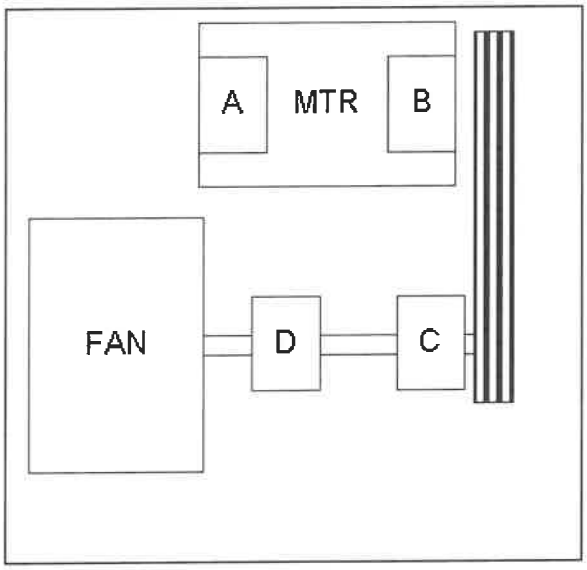
6. ROTATING EQUIPMENT BALANCE TOLERANCE

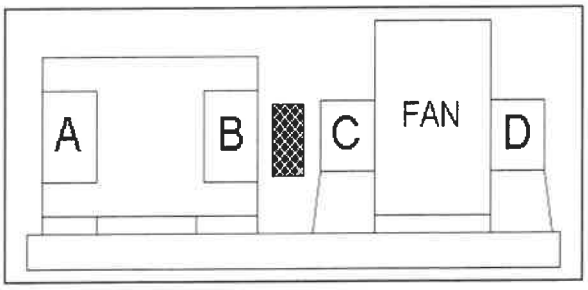
Unless the equipment manufacturer specifies a tighter tolerance, vibration force levels due to machine rotor unbalance for general plant rotating machinery such as motors, pumps, fans, blowers, rolls, drive shafts, sheaves, etc., shall not exceed a velocity vibration amplitude reading of 0.10 inches per second peak (ips) at the corresponding 1 times RPM frequency on the rotating machines bearings in both horizontal and vertical directions. 0.1 ips peak equates to 2.0 mils peak to peak at 900 RPM, 1.6 mils pk-pk at 1200 RPM, 1.0 mils pk-pk at 1800 RPM, and 0.5 mils pk-pk at 3600 RPM. New and rebuilt motors shall conform to the tolerances as stated in section 3.

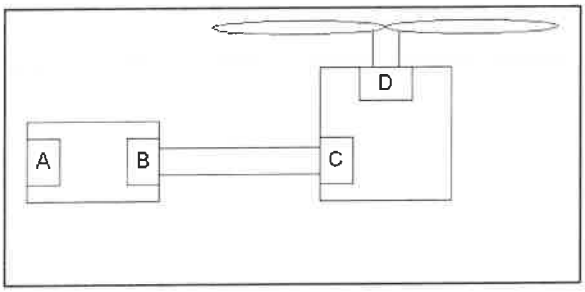
7. TYPICAL EQUIPMENT MEASUREMENT POINT DIAGRAMS

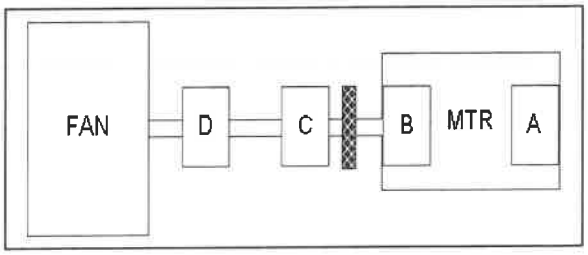


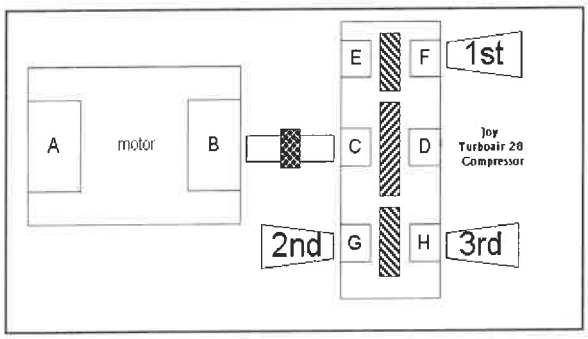


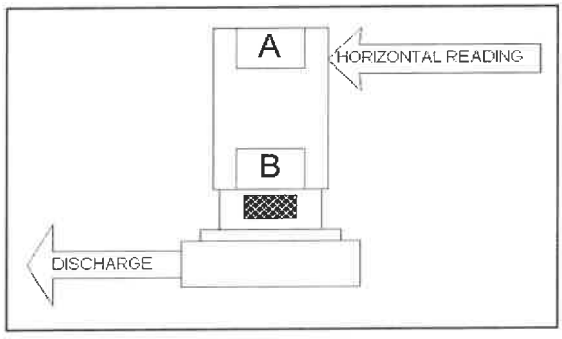


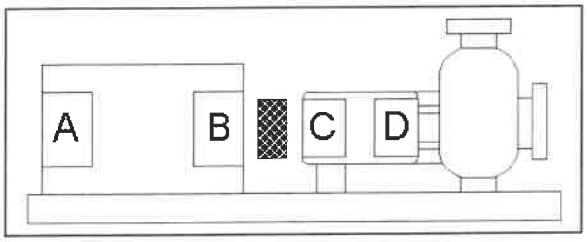








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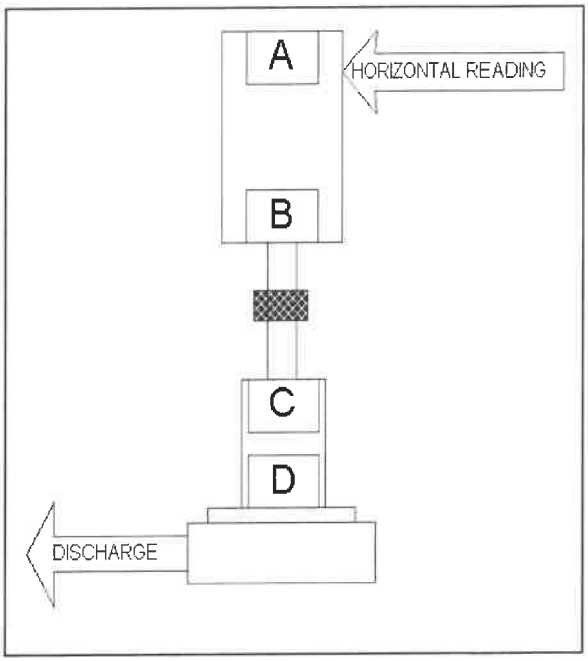
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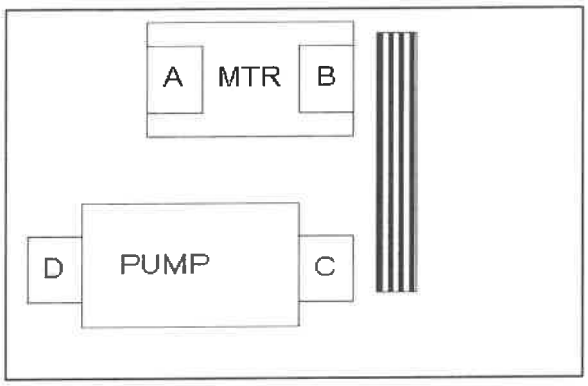
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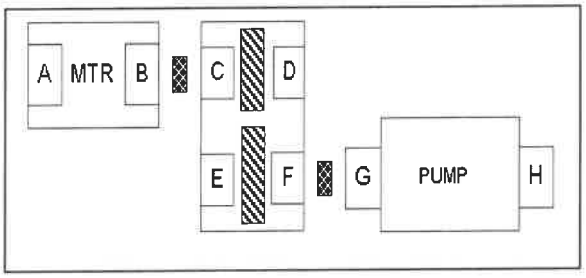
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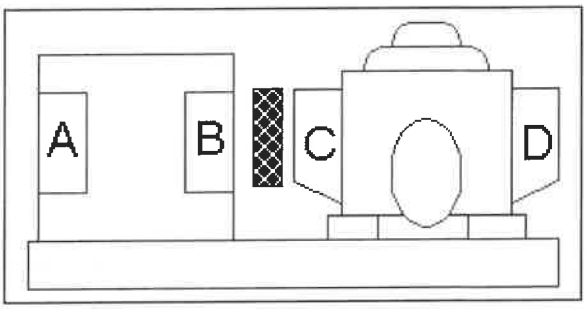
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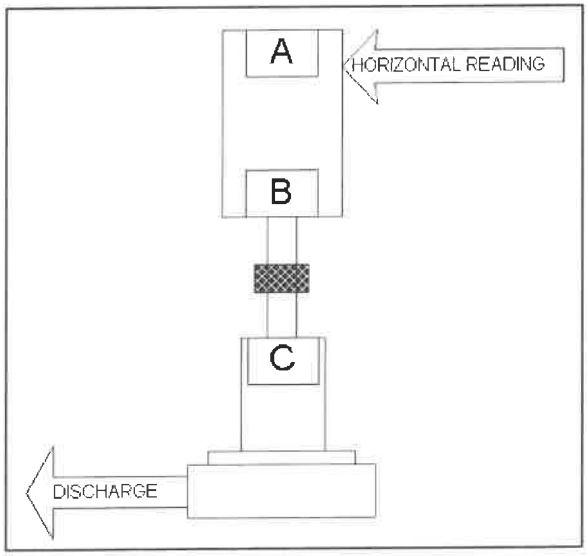
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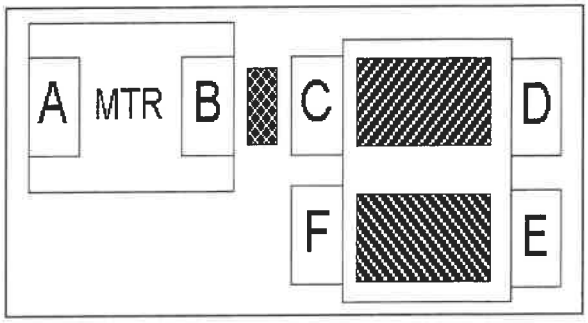
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ATTACHMENT B

MANUFACTURER'S EQUIPMENT CERTIFICATION

MANUFACTURER'S EQUIPMENT CERTIFICATION

PROJECT:	WPCF Improvements – Phase 2	**REPORT NO.:**	
COMPANY:		**DATE:**	
NAME OF EQUIPMENT:		**PROJECT NO.:**	12609515
EQUIPMENT TAG:		**CONTRACT NO:**	2021-WW-01
SPEC SECTION:		**MODEL NO.:**	
SHOW DRAWING ITEM NO.:		**SERIAL NO.:**	

_____, as the authorized Manufacturer's Representative for the above-referenced equipment, hereby certifies that we have completely inspected, aligned, operated, and adjusted said equipment on this date.

Equipment Evaluation Checklist	**Completed and Acceptable**	**Deficient Explanation Below**
Verify there is no visible corrosion or mechanical damage to the equipment.		
Verify the nameplates are correct.		
Verify that all mountings are secure, all piping is attached, all belts and drives are installed and tensioned correctly, and all safety features are in place.		
Verify that prerequisites and preliminary tests for low voltage motor control centers, adjustable frequency drives, and all other electrified equipment, have been completed. Verify all control and power circuits to the equipment are energized.		
Verify that factory test reports have been received and approved.		
For systems tests, verify that all applicable prerequisites and preliminary tests for subsystems and auxiliary equipment have been completed.		
Bump motors to verify correct rotation.		
Verify operation of seal water system.		
Verify operation of valves and verify proper open or shut positions.		
Check all feed and drain lines.		
Verify the equipment has been checked against the approved shop drawing and complies with all details, including comments by the Engineer.		
Verify that all equipment has been properly lubricated in accordance with manufacturer's requirements.		
Manufacturer's Testing Form(s) attached. (Yes/No)		

Deficiencies

_____

_____

_____

_____

_____

MANUFACTURER'S EQUIPMENT CERTIFICATION

PROJECT:	WPCF Improvements – Phase 2	**REPORT NO.:**	
COMPANY:		**DATE:**	
NAME OF EQUIPMENT:		**PROJECT NO.:**	12609515
EQUIPMENT TAG:		**CONTRACT NO:**	2021-WW-01
SPEC SECTION:		**MODEL NO.:**	
SHOW DRAWING ITEM NO.:		**SERIAL NO.:**	

Corrections

Special Instructions

Training (Check One)

	_____ hours of training on equipment operation and maintenance was given on _____ (see attached attendance sheet):
	No training was provided; it will be scheduled for a later date.
	No training is required.

MANUFACTURER'S EQUIPMENT CERTIFICATION

PROJECT:	WPCF Improvements – Phase 2	**REPORT NO.:**	
COMPANY:		**DATE:**	
NAME OF EQUIPMENT:		**PROJECT NO.:**	12609515
EQUIPMENT TAG:		**CONTRACT NO:**	2021-WW-01
SPEC SECTION:		**MODEL NO.:**	
SHOW DRAWING ITEM NO.:		**SERIAL NO.:**	

Manufacturer's Certification Statement

The equipment is complete, conforms to the requirements of the Contract and is ready for permanent operation. There is nothing in the installation that will render the Manufacturer's warranty null and void.

Authorized Signature _____

Title _____ Date _____

The equipment is ready for permanent operation and nothing in the installation will render the Manufacturer's warranty null and void. The deficiencies noted are minor and will not adversely affect the equipment operation. The deficiencies will be corrected at a later date.

Authorized Signature _____

Title _____ Date _____

The equipment certification cannot be completed at this time.

Authorized Signature _____

Title _____ Date _____

Witnessed by Contractor

Authorized Signature _____

Title _____ Date _____

Witnessed by Engineer

Authorized Signature _____

Title _____ Date _____

ATTACHMENT C

TRAINING OF SYSTEMS

Attachment C

TRAINING OF SYSTEMS

PROJECT:	WPCF Improvements - Phase 2	**PROJECT NO.:**	12609515
SPECIFICATION SECTION:		**CONTRACT NO.:**	2021-WW-01
EQUIPMENT:		**LOCATION:**	
TRAINER:		**DATE INSTALLED:**	
MANUFACTURER:		**DATE OF TRAINING:**	

WITNESSED (have all attendees sign):		
Affiliation	**Name**	**Signature**

Certificate Received (if applicable)? ☐ Yes ☐ No

Manufacturer's Representative _____ **Print Name** _____

Contractor's Representative _____ **Print Name** _____

Engineer's Representative _____ **Print Name** _____

Notes: _____

SECTION 01660

TESTING AND STARTUP

PART 1 GENERAL

1.01. SECTION INCLUDES

A. Definitions.

B. Submittals.

C. General.

D. Preliminary Field Testing.

E. Functional Testing.

F. SCADA Programming Phase.

G. System Demonstration Testing.

H. Startup.

I. Meetings.

1.02. DEFINITIONS

A. System - The combination of Subsystems that will collectively undergo sequential System Demonstration Testing, Startup, and delivery to the Owner. Each System includes all components necessary for that System to function as intended, including structural/architectural components, HVAC, plumbing, process equipment, piping, power, automated controls, life safety, etc.

B. Subsystem - The multiple components of a System. Subsystems are generally defined as unit processes and support systems, including structural/architectural components, HVAC, plumbing, process equipment, piping, power, automated controls, life safety, etc.

C. SCADA – Supervisory Control and Data Acquisition.

D. System Delivery Plan - Contractor's schedule for delivering Systems to the Owner.

E. Preliminary Field Test - Field test to demonstrate that equipment is properly installed and ready for operation.

F. Functional Test - Field test to demonstrate successful operation and performance of equipment in all intended modes of operation, including operation from remote devices with the exception of the SCADA system, for at least one hour.

G. SCADA Programming Phase - Period of time for SCADA programmer to load, test, and debug SCADA application software.

H. System Demonstration Testing - Continuous successful operation of a System in its entirety utilizing a testing fluid prescribed by the Owner for seven consecutive days prior to Startup of

that System. If there are any interruptions during the test, the test shall be repeated until the equipment or System operates trouble free for the specified time period.

I. Startup - Continuous successful online operation of a System in its entirety utilizing actual process fluid and at actual service conditions for fourteen consecutive days prior to delivery of that System to the Owner. If there are any interruptions during the test, the test shall be repeated until the equipment or System operates trouble free for the specified time period.

1.03. SUBMITTALS

A. Functional Testing Plans

1. Submit at least 30 days prior to proposed Functional Testing date in accordance with procedures identified in Section 01300 - Submittals.

2. Submit individual plans for each piece of equipment requiring a Functional Test.

3. Coordinate with Owner to determine testing fluid sources and include in Functional Testing Plans.

B. System Delivery Plan

1. Submit within 60 days of Notice to Proceed in accordance with procedures identified in Section 01300 - Submittals.

2. Define each System to be independently delivered to the Owner after Startup. At a minimum, the System Delivery Plan shall include the following Systems:

a. Final Clarifiers 1 and 2

b. Return Sludge Pump Station

c. Secondary Scum Pump Station

d. Influent Screen

e. Grit Removal Equipment

f. Septage Receiving Equipment

g. Sludge Holding Tanks 1, 2 and 3

h. Odor Control System

i. Alkalinity System

j. Electrical Service and Electrical System

k. HVAC

l. SCADA

3. Include proposed start and finish dates for all System Demonstration Tests and Startup.

4. Incorporate into Progress Schedule.

5. Resubmit proposed changes in accordance with accordance with procedures identified in Section 01300 - Submittals.

C. System Demonstration Testing and Startup Plans:

1. Submit a minimum of thirty (30) days prior to proposed System Demonstration Test date in accordance with procedures identified in Section 01300 - Submittals.

2. Identify all testing media sources and disposal locations including testing fluid, sludge, utility water, chemicals, process air, instrument air, etc. for both System Demonstration Testing, and Startup.

3. Identify all instrumentation and recording devices required to complete testing.

4. Identify all required laboratory testing.

5. Identify days during which the manufacturer's representatives will be on Site.

1.04. GENERAL

A. Provide a minimum of 14 days' notice to the Owner and Engineer prior to all testing. The Owner and Engineer reserve the right to witness all testing.

B. Materials, Supplies, and Utilities:

1. Owner Furnished

a. Testing Fluids (water and wastewater)

b. Sludge

c. Septage

2. Contractor Furnished

a. All required tools, materials, and spare parts.

b. All required instrumentation and monitoring devices, including temporary devices required for testing (e.g., flowmeters, pressure gauges, level sensors, etc.)

c. All required fuel, lubricants, energy, equipment, and instruments.

d. All required utilities not furnished by the Owner.

e. Chemicals

1) Contractor shall arrange with the Owner for the filling of one chemical storage tank for each chemical feed system provided on the project. Chemicals shall be provided by the Owner after performing the Functional Testing and prior to the system startup. Should any system fail the system demonstration testing and/or startup phase, the Contractor shall arrange with the Owner for refilling the chemical

storage tank for the affected system. The cost for refilling the tank shall be the responsibility of the Contractor.

2) Chemicals to be provided include:

a) 25% Sodium Hydroxide (10,000 gallons)

f. Provide means to convey designated testing fluid to testing location and to disposal location unless otherwise indicated, including all temporary facilities required (e.g., pumps, piping, etc.).

C. Connection to Existing Equipment and Facilities: Test all equipment and facilities to ensure that they are in operating condition before the final tie-ins are made which connect new equipment and facilities to existing equipment and facilities.

D. Contractor Operating Personnel

1. System Demonstration Testing

a. Provide 24 hour per day onsite personnel that are thoroughly familiar with all the equipment and construction. At a minimum, 24 hours per day staff shall include the following:

b. Contractor's Superintendent or personnel capable of operating the pumping system, including instrumentation. Provide the following on-call personnel that are capable of arriving at the Site within two hours after request by Contractor furnished and monitored alarms:

i. Subcontractor's representative.

2. Startup

a. Provide Owner support as specified subsequently in this section during normal working hours.

b. Provide the following on call personnel that are capable of arriving at the Site within two hours after request outside of normal working hours:

c. Contractor's Superintendent or personnel capable of operating the system, including instrumentation.

d. Subcontractor's representative.

E. Tagging System

1. A tagging system will be provided by the Contractor and used by Engineer to document testing and Startup progress as follows:

a. Yellow Tag - Preliminary Field Testing complete.

b. Red Tag - Functional Testing Complete.

1) Mass DEP Clear Water Test (see Section 01010 – Summary of Work) must be completed prior to startup. Completion of test is entirely defined by approval by Mass DEP representative.

c. Blue Tag - Successful completion of Startup.

2. Tags will be signed and dated by Engineer upon acceptance and shall remain attached to the item until ordered removed by Engineer.

1.05. PRELIMINARY FIELD TESTING

A. Demonstrate the following:

1. Equipment is permanently installed in the correct location and orientation.

2. Equipment is properly adjusted, aligned, and lubricated.

3. Equipment is prepared for operation in strict accordance with the Contract Documents and with manufacturer's recommendations.

B. Make all changes, adjustments and replacements required to comply with the requirements of the Contract Documents.

C. Preliminary field testing shall be witnessed by the manufacturer's representative where required by individual Specification sections.

D. Prerequisites

1. Accepted System Delivery Plan.

2. Permanent power has been connected and unit is ready for operation.

1.06. FUNCTIONAL TESTING

A. At a minimum, Functional Tests shall include the following:

1. Verification that equipment meets the specified performance requirements in every detail and performs its intended function without any unusual vibration, noise or other signs of possible malfunction. Unless specifically identified otherwise in individual Specification sections, all performance testing shall be conducted during Functional Testing.

2. Conduct acceptance tests in accordance with Section 01640 – Equipment - General Article 1.09 and Attachment A.

3. Demonstration of successful operation in all control modes including from remote devices and SCADA.

B. Prerequisites

1. Accepted Functional Testing plan.

2. Preliminary Field Testing.

3. Manufacturer's Installation Certificate (see Section 01640 – Equipment - General).

4. Final Draft Operations and Maintenance Manual.

5. Testing fluid shall be non-potable water or treated plant effluent unless otherwise required by Owner or unless otherwise noted.

6. Testing fluid for the septage receiving system is septage.

1.07. SCADA PROGRAMMING PHASE

A. General Contractor and Subcontractors shall provide assistance to programmer as required by Engineer.

B. SCADA Programming Phase work shall be performed on a System-by-System basis.

C. SCADA programming will be performed by Engineer. Contractor shall allocate 14 days in the Progress Schedule for the SCADA Programming Phase and provide Engineer 14 days' notice.

1.08. SYSTEM DEMONSTRATION TESTING

A. Operate System in simulated fashion as described in the accepted System Demonstration Testing and Startup Plan demonstrating all modes of operation. This shall include, when practical, simulation of extreme conditions so as to check the response of instrumentation and control devices, bypass functions, pumping cycles, etc. Contractor shall be responsible for the complete operation of the System, including the positioning of valves, gates, switches, proper equipment devices, controls and associated components furnished and/or installed under this Contract. Owner will provide operation of all existing treatment plant components unless otherwise specified.

B. If any component of the System fails to operate in accordance with the Contract Documents during System Demonstration Testing, provide all necessary repairs, maintenance, replacement of parts, corrections, adjustments, and other actions necessary to restore proper operation of the System. Required adjustments to equipment shall be made by a qualified manufacturer's representative. After the System is restored to proper operating conditions, restart the test. No credit will be given for operating time prior to System failures when calculating test durations.

C. Equipment shall be powered from the permanent power source prior to System Demonstration Testing.

D. Prerequisites

1. Accepted System Demonstration Testing and Startup Plan.

2. Functional Testing of all System components.

3. Manufacturer's Certification of Equipment Compliance for all associated equipment.

4. Associated System Demonstration Testing and Startup meeting.

5. Required training for all System components not specifically identified in individual Specifications sections as post-Startup training.

6. Leakage testing of associated piping and tanks.

7. Permanent safety and protection devices installed and operational. Safety devices shall include, but not be limited to, fall protection, hand railing, grating and floor plates, leak detection, equipment protective guards, motor thermal and overload protection,

emergency power generation, equipment lockouts, floatation devices, fire alarms and systems, ventilation systems, and lighting in operational areas in or directly related to the System being tested. All open excavations in or adjacent to the operational areas shall be covered.

8. Verification that all required lubrication equipment and materials are readily available to Contractor at the Site.

9. System piping, valves, instruments, control panels, and electrical equipment properly labeled in accordance with the Contract Documents.

10. Completion of SCADA Programming Phase.

E. Testing fluid shall be non-potable water or treated plant effluent unless otherwise required by Owner and unless otherwise noted.

1.09. STARTUP

A. Operate System under Owner's direction demonstrating all modes of operations. This shall include, when practical, simulation of extreme conditions so as to check the response of instrumentation and control devices, bypass functions, pumping cycles, etc. Contractor shall be responsible for the complete operation of the System, including the positioning of valves, gates, switches, proper equipment devices, controls and associated components furnished and/or installed under this Contract. Owner will provide operation of all existing treatment plant components and provide all required sampling and laboratory testing required for operation of System during Startup unless otherwise specified.

B. During Startup, Owner will operate the System under actual operating conditions and test for successful operation in the various operating modes required by the Contract Documents under the direction and responsibility of the Contractor. Owner will provide all required sampling and laboratory testing required for operation of System during Startup unless otherwise noted.

1. Provide the following support to Owner:

a. Routine maintenance of new equipment and devices.

b. Non-routine operations and maintenance, such as cleaning clogged pumps, etc.

c. Notify Owner prior to performing actions related to Startup or shutdown of Systems including, but not limited to, valve and gate operation, electrical shutdown, change in process flow configuration, etc.

C. If any component of the System fails to operate in accordance with the Contract Documents during Startup, provide all necessary repairs, maintenance, replacement of parts, corrections, adjustments, and other actions necessary to restore proper operation of the System. Required adjustments to equipment shall be made by a qualified manufacturer's representative. After the System is restored to proper operating conditions, restart the test. No credit will be given for operating time prior to System failures when calculating test durations. Examples of System failures include, but are not limited to the following:

1. Tank overflows.

2. Equipment failures and/or malfunctions.

3. Instrumentation failures and/or malfunctions.

4. Tank or piping failures and/or leakage.

5. Loss of power to equipment and/or devices.

6. Controls malfunctions.

D. Upon successful completion of Startup, the System shall be delivered to the Owner for partial utilization.

E. Periods for Startup shall begin at least 28 days prior to issuance of the Certificate of Substantial Completion as follows:

1. Minimum 14 days of uninterrupted operation by Contractor. Operational failure of any equipment will require a restarting of the 14-day period for the process/equipment that is being demonstrated.

2. Minimum 14 days of uninterrupted operation by Owner. Operational failure of any equipment will require a restarting of the 14-day period for the process/equipment that is being demonstrated.

F. Prerequisites:

1. Completion of System Demonstration Testing.

2. Provide Owner with up-to-date record Drawings showing all components as they are installed. The record Drawings shall cover all major components of the System including power feed, control and alarm annunciation, and piping.

3. Provide complete set of Operation and Maintenance Manuals.

4. Turn over spare parts.

5. Seven days written notice prior to proposed actual beginning of Startup date. Startup cannot begin without Owner and Engineer acceptance of proposed Startup commencement date.

6. The Contractor shall supply the chemicals for all the chemical feed systems per Paragraph1.04.B.

7. All electric, natural gas, gasoline, propane, diesel, and other utilities required during the Startup, until the issuance of the Certificate of Substantial Completion shall be provided by the Owner.

1.10. SYSTEM DEMONSTRATION TESTING AND STARTUP MEETINGS

A. At least 14 days prior to the proposed start date for each System Demonstration Test, conduct a meeting with Owner and Engineer to review testing plans, finalize testing procedures, verify status of associated equipment and prerequisites, and coordinate all aspects of System Demonstration Testing and Startup. Representatives of the Owner, Engineer, and Contractor shall attend the conference.

B. Prerequisites:

1. Accepted System Demonstration Testing and Startup Plan.

2. Completion of all associated Functional Testing.

1.11. SUBSTANTIAL COMPLETION

A. Utilize the EJCDC Certificate of Substantial Completion (Form C-625, 2007), attached to the end of Section 01019 - Contract Considerations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01700

RECORD DOCUMENTS

PART 1 GENERAL

1.01. SECTION INCLUDES

A. Closeout procedures.

B. Record documents.

1.02. CLOSEOUT PROCEDURES

A. Contract closeout procedures shall be in accordance with GC-15.0.

1.03. RECORD DOCUMENTS

A. The following supplements the requirements of GC-7.12:

1. Record, keep, and monitor up to date record documents of work constructed in the field. Legibly mark in red ink or red pencil to show all changes in, or directly associated with, the Work of this Contract. Keep entire set or record documents current on a daily basis. Record documents shall be kept on hand in the Contractor's field office and shall be available for periodic examination by Engineer upon request.

2. Examples of annotations that could occur are as follows:

a. Change in location or elevation of structures.

b. Change in dimensions of structures.

c. Elimination of structures.

d. Unforeseen modifications to existing structures.

e. Relocation of equipment.

f. Additions to or expansion of structures.

g. Changes in mechanical trades components; (electrical, heating, ventilating, plumbing).

h. Measured location of internal utilities or mechanical trade items, which are to be concealed from view, referenced to visible and accessible features of the structure.

i. Change in location or elevations of Underground Facilities installed under this Contract.

j. Change in materials, such as pipe materials.

k. Relocation of existing Underground Facilities.

l. Change in topographical contours of finished earth and paved surfaces.

m. Change in elevations of finished surfaces along route of installed Underground Facilities.

3. Show measurement of pipeline location from edge of pavement, at a minimum of 100-foot intervals.

4. Record Documents shall include the Certified Survey provided by the Contractor's Licensed Professional Land Surveyor in accordance with Section 01039 – Coordination - 1.03.

B. At Substantial Completion, affix Contractor's red identification stamp to front cover of each set of record documents and label them as "Record Documents". One hard copy and one electronic set of record documents shall be given to Engineer no later than 14 days after the date of Substantial Completion. Engineer will either approve record documents or return them to Contractor with comments. Contractor shall resubmit record documents until Engineer has no further comments. Affix Contractor's identification stamp, together with the label "Record Documents," as follows:

1. On each Drawing, just above the Engineer's title block.

2. On each Shop Drawing, just above the preparer's title block.

3. On the front cover or front page of all other documents.

C. Final payment to Contractor will not be considered until acceptable record documents have been turned over to Owner.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 11370

POSITIVE DISPLACEMENT BLOWERS

PART 1 GENERAL

1.01. DESCRIPTION OF WORK

A. Furnish, install, and test the following positive displacement blowers complete with sound attenuating enclosures, motors, drives, and all necessary accessories and appurtenances and in compliance with these specifications and as shown on the Drawings.

1. Two (2) Rotary Positive Displacement Blowers (B-431, B-432). The blowers shall operate in a lead / lag / standby configuration.

1.02. RELATED SECTIONS

A. Section 01300 – Submittals.

B. Section 01640 – Equipment – General.

C. Section 01660 – Testing and Startup.

D. Section 01700 – Record Documents.

E. Section 15170 – Motors

F. Section 16480 – Variable Frequency Drives

1.03. REFERENCES

A. American Society of Testing and Materials (ASTM).

B. American Gear Manufacturers Association (AGMA).

C. International Organization for Standardization (ISO).

D. National Electric Code (NEC).

1.04. PERFORMANCE REQUIREMENTS

A. The positive displacement blowers shall meet the following conditions. All elevations are relative to the NAVD88 datum:

Parameters	**B-431, B-432**
Maximum air demand	2,700 scfm per machine
Required discharge pressure at blower discharge flange	7.6 psig
Minimum air flow achievable with VFD	454 scfm per machine
Operating elevation	45 feet above sea level
Location	Indoor
Design Inlet Temperature	100 degrees F
Relative humidity	80%

Parameters	B-431, B-432
Design Inlet Pressure	14.68 psia
Brake Horsepower (Max)	127.9 bHp
Motor Size (Max)	150 Hp

B. Maximum noise level with sound attenuating enclosure shall not exceed 77 db(A) within 1 meter of the blower package.

C. Blowers shall be capable of continuous operation 24 hours per day.

D. Pressure losses through the accessories specified herein shall be accounted for in the blower performance calculation and motor horsepower selection of the blower package.

E. Each blower must have a discharge piping layout as shown on Contract Drawings and must maintain clearances shown.

F. Blowers and accessories shall be provided as a packaged system by a single manufacturer.

1.05. SUBMITTALS

A. Provide in accordance with Sections 01300 - Submittals and 01640 - Equipment-General; and as supplemented herein. Submittals shall include, but not be limited to, the following:

1. Shop drawings shall include the following:

   a. Descriptive data.

   b. Layout drawings of all equipment.

   c. Performance characteristics.

   d. Certified performance curves.

   e. VFD curves for each blower (must show a minimum of eight operating speeds).

   f. Shop test results.

   g. Material specifications.

   h. Accessories.

   i. Spare parts.

2. Manufacturer's installation instructions.

3. Performance affidavit.

4. Manufacturer's Installation Certificate.

5. Certification of Equipment Compliance.

6. Training Plans.

7. Recordings of training.

8. Training Reports.

B. Provide operation and maintenance manuals and data in accordance with Section 01640 - Equipment-General.

C. Submit Shop Drawing within 14 days of award of contract. See Section 1.08 for blower delivery requirements.

1.06. SPARE PARTS

A. Furnish the following spare parts for each blower application, as listed in Article 1.01, provided in accordance with Section 01640 - Equipment-General, in clearly identified dust-proof containers:

1. Three sets of V-belts.

2. One-year supply of oil lubricant for gears and bearings.

3. Three sets of integral inlet silencer filter elements.

4. One tube of motor grease (sludge holding tank blower application only)

1.07. EQUIPMENT WARRANTIES AND SPECIAL GUARANTEES

A. The Supplier shall provide the following warranties and special guarantees in accordance with Section 01640 - Equipment - General.

B. The equipment manufacturer shall guarantee for a period of two years starting at the time of equipment delivery to the job site, or one year starting at the time of Substantial Completion (whichever is later), that the equipment supplied is free from defects in materials or workmanship and will meet the specified performance requirements when operated in accordance with the manufacturers' recommendations. The manufacturer shall correct any breach in this warranty at their expense.

1.08. SPECIAL REQUIREMENTS

A. Selected blower manufacturer shall have blower rental units available and can be supplied onsite within 48 hours of being needed. Rental units shall include all necessary enclosures, piping and controls for a complete blower system. Rental unit, should it be needed will be addressed under separate cover to this contract.

B. At least one (1) blower shall be provided and delivered to the WPCF within 45 days of shop drawing approval. See Section 1.05.C. for submittal requirements after award of contract.

PART 2 PRODUCTS

2.01. MANUFACTURERS

A. Aerzen, Model GM90S

B. Atlas Copco, Model ZS5VSD

C. Kaeser, Model HB 1300 PI

D. Approved or equal.

2.02. OR EQUALS AND SUBSTITUTIONS

A. Current design is based on Aerzen blower model gm90s. should blowers be submitted other than the Aerzen GM90s, the contractor shall be responsible for all necessary modifications to make the submitted package fit and perform as required. In the case of an "or equal" or a substitution, demonstrate in writing, to the satisfaction of owner that the manufacturer has produced the specified type and size of equipment for sanitary wastewater service that has been in successful operation for a minimum period of five years prior to the bid date.

2.03. EQUIPMENT DESIGN

A. The blower shall be a rotary tri-lobe design, positive displacement pulsation cancellation, with a V-belt driven inverter-rated motor, corrosion resistant, and capable continuous operation 24 hours per day. Blowers shall be provided complete with all appurtenances necessary to make the equipment complete and operable in compliance with the specifications herein and as shown on the Contract Drawings.

B. Inlet configurations shall be piped. Inlet and outlet connections shall be flanged. Threaded connections shall not be acceptable.

C. Casing:

1. Blower basing shall be of one-piece construction with separate headplates that are bolted and pinned to the housing. Split casings shall not be acceptable.

2. Blower casing shall be of high strength, close-grained cast iron conforming to ASTM A48. The casing shall provide reinforcement ribs to prevent distortion and be designed to facilitate cooling of the motor and be the vertical style.

3. Casing shall be able to withstand a minimum of 15 psig.

4. The casing shall be precision machined to allow for minimum clearances.

5. The design of the housing shall allow for vertical or horizontal blower installation with minimal modification.

D. Rotors:

1. Two three-lobe rotors of one-piece construction fabricated from ductile iron shall convey air from the inlet side to the discharge side of the blower. The two rotors shall intermesh but neither rub nor require lubrication. Stub shafts or two-piece impellers shall not be allowed.

2. Hollow rotors are capped, dust-tight. Open rotors are not acceptable.

3. Blower rotors are to be statically and dynamically balanced according to ISO 1940 Class Q2.5. Modifications to the face of the rotors for balancing purposes are not acceptable.

E. Timing Gears - The rotation of each rotor shall be controlled with a precision ground timing gear consisting of either helical or spur teeth which are accurately machined and constructed of heat-treated hardened alloy steel. The timing gear material shall meet AGMA Grade 12 quality with a minimum service factor of 1.7 at maximum operating point.

F. Shafts, Bearings and Lubricants:

1. The rotor and shaft assemblies shall be supported by heavy-duty anti-friction bearings with thrust control rated for a minimum L-10 life of 160,000 hours.

2. Shafts shall be one-piece, machined from a solid billet or a solid forging of ductile iron or from ductile iron castings.

3. The drive end and gear end bearings shall be oil splashed lubricated. Grease-lubricated bearings are not acceptable.

4. The timing gears and gear end bearings shall be splash oil lubricated. Grease lubrication bearings are not acceptable.

5. All bearings shall be high standard cylindrical or spherical roller bearings.

6. All other bearings shall have an L-10 life of at least 40,000 hours at maximum speed and maximum pressure differential.

G. Rotor Shaft Seal Assembly:

1. Each blower shall be provided with four piston ring-type labyrinth seals at each end of each rotor to minimize leakage and maintenance costs. Seals shall be designed to prevent lubricant from leaking into the air stream as well as to prevent oil from leaking out of the machine.

2. The seals at both ends of each shaft shall be non-rubbing, vented labyrinth type seals. Each assembly shall consist of four hardened steel piston ring seals, an oil deflector, a grooved labyrinth sleeve, and casing wear ring.

3. A vent cavity shall be provided between the air side and oil side rotor shaft seals on all four sets of piston ring-type labyrinth seals. The two vent holes located on the bottom side of the blower shall be left open. The vent holes at other locations shall be closed off with threaded metal plugs.

4. The input drive shaft seal shall be a high temperature radial lip-type seal with Viton elastomers. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft.

H. Input Shaft Seal Assembly (if applicable):

1. The input drive shaft seal shall be a high temperature radial lip-type seal made from Viton elastomer. The seal shall prevent oil leakage from where the input shaft goes through the drive end cover.

2. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft. The sleeve exterior shall be tungsten carbine coated to reduce friction and wear.

3. The input shaft seal design must allow for the lip seal and the shaft sleeve to be replaced without removing the drive end cover plate.

I. Baseplate:

1. Blower, drive, and motor shall be mounted on a common fabricated steel baseplate.

2. The base shall be an elevated, rigid, fabricated steel design with a solid subbase. The blower shall be mounted horizontally for a compact frame. The discharge silencer shall be integral to the frame in order to minimize space requirements.

3. To prevent transmission of vibration and noise, as well as secure the package to the foundation, the base shall include vibration isolators made of rubber in a steel footing equipped with mounting holes for anchoring purposes.

2.04. ACCESSORIES

A. Combination Inlet Silencer and Filters:

1. Each blower shall be provided with an integral inlet silencer and filter contained within the blower enclosure.

2. Inlet silencer shall be of carbon steel construction and absorptive type. Inlet silencer shall be directly connected to the inlet port of the blower. Inlet silencer shall have flanged connections.

3. The silencer portion shall be located upstream of the inlet filter.

4. Each blower shall have an inlet filter that is integral to the inlet silencer and conforms to the following:

a. The filter media shall have an efficiency that meets ASHRAE 52.2 MERV 7 at 3 to 10 microns corresponding to EN779G4. Filter element shall be removable without disconnecting the inlet duct and shall be washable by maintenance personnel as a preventative maintenance procedure.

b. Filter and silencer performance losses shall be included by the blower vendor in the blower performance calculation.

c. Filter shall include a washable and reusable polyester element for minimal pressure drop.

d. The filter silencer shall be designed for a maximum clean pressure drop of 0.3 psi at the design flow.

e. Minimum acceptable noise attenuation shall be between 5 and 10 decibels across the octave band center frequency of 63 to 8,000 hertz.

B. Combination Base Frame and Discharge Silencer:

1. Each blower package will be supplied with one combination base frame and integrated discharge silencer. Combination base and discharge silencer shall be designed for the frequency range of the blower provided.

2. Blower base frame shall be of carbon or cast-iron construction.

3. Discharge silencer shall be an integral part of the frame support and shall be located underneath of the motor slide base. The silencer shall incorporate a combination of adsorption, reaction, reflection, and diffusion techniques to minimize noise and prevent pipe resonance. The silencer shall be a chamber reactive type, free of absorption materials.

4. The combination base and discharge silencer shall be provided with connection ports for the pressure relief valve, discharge pressure gauge, and discharge temperature gauge specified herein and drain port. Unused ports shall be capped or plugged.

C. Frame Support:

1. The frame support shall be provided with a swing-type belt tensioning system. The belt tensioning shall be fully automatic and not require the adjustment of spring tensioners. Motor slide bases shall not be accepted.

2. Inlet filter and inlet silencer shall all be mounted on top of a heavy-duty, unitized base or on top of the blower, with a machined flange connection to the blower inlet.

3. Blower, motor, and all other accessories shall be factory mounted to the support frame and shipped as one unit.

D. Flexible Discharge Connector:

1. Each blower shall include an elastomeric ANSI/DIN flanged arch-type expansion joint at the inlet and discharge connections to prevent transmission of forces and movements from the piping to the blower casing and reduce structure-borne noise.

   a. Discharge connections 4 inches and smaller shall be provided with a web reinforced silicone rubber sleeve with corrosion resistant clamps and flexible hose connection.

   b. Discharge connections 6 inches and larger shall be provided with an ANSI/DIN flanged arch-type expansion joint.

2. The flexible connector capacity shall exceed the blower package's maximum discharge pressure and temperature.

3. Blowers with a discharge of 4 inches or less shall include a flexible hose connection.

4. The expansion joint shall be made from reinforced rubber rated for a minimum working temperature of 300 degrees F.

5. The connector on the discharge must be restrained in the axial direction.

E. Sound Attenuating Enclosure:

1. Each blower shall be provided with a sound attenuating enclosure which fully covers the blower, motor, drive assembly, inlet silencer, and filter combination base from with integrated discharge silencer, and shall be shipped fully assembled. Sound attenuating enclosures shall be the product of the blower manufacturer.

2. The sound enclosures shall have acoustic foam insulation and shall provide sufficient sound attenuation to achieve the maximum sound level specified herein. Acoustic material shall comply with UL-94-HF-1 for fire-retardant, self-extinguishing, non-dripping materials.

3. Enclosure shall limit maximum noise to the level specified herein when measured at 1 meter from the blower package under free fluid conditions with piping isolated, in accordance with DIN EN ISO 2151.

4. Enclosure Cooling Fan:

   a. A high efficiency blower shaft driven ventilation fan shall provide ventilation and cooling integral to the sound enclosure.

   b. Cooling fan shall be sized for sufficient heat removal from the sound enclosure, even when the blower is operated with a VFD at minimum blower RPM.

   c. Enclosures supplied with motor driven enclosure fans (versus blower-driven) shall be the responsibility of the GC to add all necessary wiring to complete installation.

5. Frame – Frames shall be provided for bottom caps, doorjambs, bi-part seams, top caps, and all openings.

6. Panel - Enclosure shall be fabricated with a powder-coated steel exterior skin.

7. Doors - Access must be provided for maintenance and service on the front side of the enclosure of the blower unit. Quick release panels, each less than 50 lbs (as mandated by MSHA) must provide easy and quick access for routine maintenance of the blower package components. Should the panels be heavier than 50 lbs, hinged doors must be supplied, with the appropriate frame, reinforcements and supporting elements.

8. Enclosure shall have inlet and outlet pipe openings that are covered with a two-piece, bolt-on seal plate with a minimum of 0.06-inch thick steel with 2.5 lbs. per square foot of mass.

F. Vibration Isolators:

1. Vibration isolators shall be provided between the base frame with integrated discharge silencer and the sound attenuating enclosure to prevent transmission of vibration to the foundation.

2. A ground wire shall be installed between the blower base and the sound enclosure base to allow for grounding of the complete blower package.

G. Oil drains from the blower drive-end and gear-end lubricating oil sumps shall be piped to the front of the base for ease of maintenance, if not easily accessible at the edge of the blower package already. The drain valves shall be a stainless steel or brass ball valve and Teflon elastomers with a fully retained and gasketed threaded cap. Each blower must come equipped with a sight glass to monitor fluid levels.

H. Pressure Relief Valve:

1. A spring loaded, factory set, pressure relief valve shall be provided with each blower within the enclosure. Pressure relief valve shall be mounted downstream of the discharge silencer and upstream of the check valve.

2. Relief valve shall be set to protect the blower from over-pressurization based on specified conditions of service and shall be sized to pass the full design capacity of the blower.

3. The relief valve exhaust shall be piped out of the enclosure.

4. The relief valve shall be capable of being adjusted in the field.

I. Check Valve:

1. A check valve on the discharge of each blower shall be provided internal to the blower package.

2. Check valve shall be of the full-bore low pressure-drop, swing-type or wafer-type. The blower manufacturer shall include the pressure losses produced by the check valve in the required discharge pressure for the blower. The check valve shall be factory installed and tested with the blower.

   a. Wafer-type check valve shall be aluminum with high temperature silicone elastomer sealing material.

   b. Swing-type check valve shall be of steel body and steel flap embedded in EPDM with full-contact seal and shall be designed so that, in the event of failure, the valve element is retained in the body.

   c. Butterfly or center-hinge designs are not acceptable.

3. The check valve capacity shall exceed the blower package's maximum discharge pressure and temperature.

4. Seals shall be rated for at least 300 degrees F.

J. External Inlet Silencer:

1. Each package shall include an external inlet silencer shipped loose for installation by the contractor on the building exterior.

2. The unit shall be finished with baked-on enamel and shall be equipped with an epoxy coated wire mesh element for the purpose of preventing large debris and wildlife from entering the inlet pipe connection. Final filtration of the process air will be accomplished local to the blower package.

3. The silencer shall be Endustra P09 or equal, with a standard ANSI flange discharge connection.

2.05. MOTORS AND DRIVES

A. Provide in accordance with Section 15170 - Motors, unless otherwise specified herein.

B. Motors and drives for the blowers shall be provided by the equipment manufacturer designed for specific use with the process equipment being served and rated for continuous operation. Motors shall be provided with operating characteristics as specified herein and be of premium efficiency per NEMA MG-1 standards.

C. Motor shall be capable of supplying the maximum rated horsepower and rpm at the conditions and within the ranges required per the equipment manufacturer. Motor shall be capable of withstanding all forces which may be imposed during the course of normal operation.

D. Motor Parameters:

Motor Parameters	Process Blowers
Maximum allowable motor horsepower	150 HP
Motor Selection Manufacturer	WEG
Maximum motor speed (nominal)	1,800 rpm
Minimum allowable motor efficiency at full speed	Premium efficiency per NEMA MG-1
NEMA design	B
Duty	Severe (Dust Tight Enclosures)
Insulation	Class F
Voltage, phase, Hertz	460V, 3 phase, 60 Hertz
Service factor	1.15
Motor enclosure	TEFC
Protection	Integral motor winding thermostats or thermistors (minimum 1 per phase winding)

E. Motor shall be of cast iron (ASTM A48, Class 30) or aluminum, fully guarded, self-ventilated with approved number of adequate size openings to provide ventilation throughout. Motors shall be provided with removable access covers, oil reservoirs, seals, lifting eyes, hollow steel machined and polished shaft, oversized motor terminal box, auxiliary control connection boxes and engraved stainless steel nameplates.

F. Thrust bearings shall be grease or oil lubricated, spherical, anti-friction type. The thrust bearing shall be adequate for all thrust loads. Radial guide bearing shall also be oil lubricated ball bearing type. Shaft stray current insulation shall be provided at the thrust and radial bearings to prevent current flow through the bearing surfaces. All bearings shall be designed to have a minimum of B-10 life of 50,000 hours under rated load and speed.

G. Blower shall not require any external cooling devices such as cooling fans or external water cooling.

1. Motors shall have built-in air-cooling system. Motor enclosures shall be TEFC NEMA frame. IEC motors shall not be allowed.

H. The electric drive motor shall be mounted on a swing-type motor base of heavy-duty cast iron or fabricated steel construction. The motor base shall be adjustable to allow field adjustment of belt tension without disturbing the belt guard or belt alignment.

I. Motor shall be supplied with oversized terminal box and power distribution block if required per the manufacturer's design.

J. Motor shall be furnished with motor winding thermal protection in the motor windings to detect excessive temperature within the motor windings. The control panel supplier shall include the necessary provisions to utilize the thermostats or thermistors.

K. Belt Drive:

1. Each package shall be supplied with a V-belt drive that shall be of the high-capacity type, oil and heat resistant. Drive shall be designed for a minimum service factor of 1.4 times operating power (bHp), or 1.1 times the motor nameplate Hp, whichever is larger to allow a minimum of 1.4-service factor based on the maximum blower bHp.

2. Belt tensioning shall be automatic without the use of any devices or interaction on the part of the operator. Neither slide rails nor load-adjusting springs shall be used.

3. Sheaves shall be dynamically balanced regardless of the operating speed.

L. Variable Frequency Drives – Motors shall operate with VFDs that meet all requirements of Section 16480.

2.06. CONTROLS

A. Local Control Panel:

1. Each blower package shall be provided with an electronic microprocessor local control panel which:

a. Warns the operator in case of an abnormal operating condition

b. Protects the blower

c. Monitors components subject to service

d. Interfaces with the VFD and plant SCADA system

2. Each Local control panel shall provide the following control functions and features:

a. Intuitive TFT color touch screen display

b. Display, monitoring, alarm, and shutdown of inlet pressure, discharge pressure, discharge temperature, enclosure cooling fan thermal overload, main drive motor thermal overload, oil temperature and oil pressure.

c. Display run hours

d. Log errors and first out indication

e. Track and log maintenance

f. E-Stop button mounted on front of blower enclosure

g. Ability to transfer measured values, fault and status messages, as well as remaining times of the service intervals to the plant SCADA system via Modbus RTU or Ethernet IP.

h. Permissive start and stop signals to the VFDs

3. The local control panel shall be provided with the following digital outputs:

a. Common alarm

b. Common fault

c. Ready to run

d. Transfer of external start/stop command

e. Status remote

f. Maintenance required

4. The local control panel shall be provided with the following digital inputs:

a. Remote start/stop

b. Motor controller fault

c. Remote emergency stop

5. Control Enclosure

a. IP65 suitable for indoor/outdoor installation

b. Factory installed, integral to sound enclosure

6. Control Supply Power

a. 460 VAC, 10 Amp feed with 24 VDC transformer

B. Monitoring Sensors: Provide each blower package with the following sensors, premounted and wired to the local control panel:

1. Inlet Pressure Transducer

2. Discharge Pressure Transducer

3. Platinum 1,000 ohm Discharge Temperature RTD

4. Platinum 1,000 ohm Oil Temperature RTD

5. Oil Pressure Transducer

2.07. FABRICATION REQUIREMENTS

A. Shop coat per manufacturer's standard finish system and color.

B. All bolts, nuts, washers, and other fasteners included as part of the manufacturer's package shall be material as recommended by the manufacturer. All hardware external to the packaging shall be Type 316 stainless steel unless otherwise noted.

C. Welds shall be continuous unless noted otherwise.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Furnish nameplates for each piece of equipment:

1. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins.

2. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the equipment performance ratings.

2.08. SHOP TESTING

A. The equipment specified in this section shall be tested in the manufacturer's shop in accordance with the requirements of Section 01640 - Equipment-General, and as specified herein.

B. Shop testing shall be conducted for each blower prior to shipment to demonstrate that the blower can deliver the specified flow rates and pressure using ISO-1217.

1. At minimum, testing shall include:

a. Design point.

b. Secondary design point (if applicable).

c. Design point with motor speed reduction at specified percentage (if applicable).

2. Deviation of actual data from specified performance criteria shall not exceed ±5 percent.

3. Development of at least five blower curves at different speeds for units to be operated with a VFD.

C. Results of factory testing shall be made available to Engineer for review prior to shipment of units.

D. Include results of factory testing in the O&M manual.

PART 3 EXECUTION

3.01. EQUIPMENT INSTALLATION

A. The Manufacturer shall conduct a coordination conference call with the Contractor and Design Engineer to review the integration and installation requirements of the equipment after the Submittal documentation has been approved and prior to installation of the equipment.

B. The Contractor shall install the blowers in accordance with the Manufacturer's written instructions.

C. The Contractor shall make all electrical and process connections to the blower package prior to the arrival of the manufacturer's representative.

D. The Contractor shall complete and return the Manufacturer's installation check list prior to having a Manufacturer's representative come onsite.

E. Representatives of the blower manufacturer shall verify and adjust blower and motor alignment.

3.02. FIELD TESTING

A. After installation of all equipment has been completed and as soon as conditions permit, the manufacturer shall provide one (1) trip for a total of two (2) 8-hour days to verify the installation and conduct an acceptance test under actual operating conditions.

1. The Manufacturer shall perform a physical check of the blower installation, perform safety checks, power up the equipment and perform functional testing.

2. The functional test shall consist of 4 hours of operation of each blower with vibration, temperature, and pressure readings as well as motor amp readings taken and recorded at 60-minute intervals.

3. Installed noise measurements shall be taken to compare the installed noise values with the factory free field ISO 2151 measurements.

4. The Manufacturer shall provide operations and maintenance training to the plant personnel. The training shall consist of 1 hour of classroom training using the Operation and Maintenance Manual for reference and 2 hours of hands-on training at the blower package.

B. If required, Contractor shall make any changes, at his own expense, to the installation that may be necessary to assure satisfactory operation. Contractor shall be held liable for changes needed in the installation.

C. Manufacturer shall provide a written field test / start up report after completion of testing.

3.03. SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Provide services of the equipment manufacturer or their approval representative in accordance with Section 01640 - Equipment-General and as specified herein.

B. Provide the following additional services:

1. Manufacturer's representative shall provide supervision of equipment installation.

C. The training shall include but is not limited to the following topics:

1. Design/theory of operation.

2. Controls and modes of operation.

3. Proper operation and maintenance.

4. Basic inspection, operational troubleshooting, and problem identification.

5. Safety precautions/practices.

6. Equipment manual review.

7. Warranty/repair service information.

END OF SECTION

SECTION 16480

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01. SECTION INCLUDES

A. This section covers the requirements for variable frequency drives (VFDs) for process equipment. VFDs provided by process equipment manufacturers (OEMs) are subject to this specification, but may not be individually listed herein. See the applicable process specification. The provider of the VFDs shall also provide all harmonic reduction equipment and other appurtenances required by this specification.

B. Provide the hereinafter specified equipment as part of the systems called for in the Specifications and the Contract Drawings.

1.02. RELATED SECTIONS

A. General Conditions.

B. Division 1 Specifications.

C. Division 11 Specifications.

D. All Division 16 Specifications.

1.03. REFERENCES

A. The latest revisions of the following standards and specifications are incorporated herein by reference and form a part of this specification to the extent that sections or portions of section are applicable hereto.

1. National Electric Code (NEC).

2. Underwriter's Laboratories, Inc. (UL) - UL 508.

B. National Electrical Manufacturers Association (NEMA).

1. NEMA - 1C – 1.

2. NEMA ICS 3.1.

3. NEMA 250.

C. American National Standards Institute (ANSI).

D. Standards for Industrial Control (J.I.C.).

E. Institute for Electronic and Electrical Engineering (IEEE) - IEEE 519.

1.04. SYSTEM DESCRIPTION

A. Performance Requirements:

1. Manufacturer/VFD supplier shall provide performance affidavits for each drive or system of drives in accordance with Section 01640 - Equipment-General.

2. VFDs for this project are part of equipment provided by equipment manufacturers.

3. Controls - Controls shall be in accordance with the applicable equipment specification and this section.

B. Harmonic Filters:

1. For all drives, provide either 3 or 5 percent input line reactors as recommended by the VFD manufacturer.

2. All drives 7.5 HP and larger shall be of the ultra-low harmonic type.

3. Provide low harmonic filters, or other harmonic mitigation equipment, for all drives 20 HP and larger not meeting IEEE Standard 519.

4. For all motors controlled by VFDs which will be installed at a location farther than 100 feet away from the VFD (and otherwise if an output line reactor is shown on the Electrical Drawings), provide output line reactors.

5. Submit design calculations with the VFD shop drawing submittal proving compliance with IEEE Std. 519 for drives 20 HP and larger.

1.05. SUBMITTALS

A. Submittals shall be made in accordance with Sections 01300 - Submittals and 16050 - Electrical General.

B. Submit performance affidavit per Section 01640 - Equipment-General.

C. Submit harmonic analysis (calculations).

D. Submit written description of sequence of operation for each set of VFDs.

E. Submit dimensional data for each VFD. Include as a minimum: height, width, depth, distance from bottom of enclosure to center line of disconnect handle, conduit openings, size and location of cooling vents.

F. Submit drawings showing interior enclosure layout and panel door layout.

G. Submit elementary diagrams and block diagrams for each VFD system. Indicate how/where remote equipment is wired to each VFD system.

H. Submit manufacturer's literature containing information needed to prove conformance with these specifications.

1.06. QUALIFICATIONS

A. Manufacturer - Company specializing in manufacturing the products specified in this section with minimum three years' experience.

B. The VFD manufacturer/supplier shall have service facilities within 200 miles of the site.

1.07. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle equipment to site under provisions of Section 01600 - Materials and Equipment.

B. Deliver in 40-inch maximum width shipping splits, individually wrapped for protection and mounted on shipping skids.

C. Store in a clean dry space. Maintain factory wrapping or provide a heavy canvas or heavy plastic to protect units from dirt, water, debris, and traffic. The Electrical Contractor shall replace any equipment damaged during shipping, handling, or storage.

1.08. SPARE PARTS

A. The following spare parts shall be furnished for each size VFD provided.

Either:

1. Two of each type of control fuse used.

2. Three of each type of power fuse used.

3. One spare of each type of PC card.

4. One complete power semiconductor assembly for each supplied.

5. All other spare parts normally recommended.

1.09. WARRANTY

A. The VFD and all equipment provided by the VFD supplier shall be provided with a manufacturer's two-year warranty. The warranty period shall begin upon delivery to the site. The warranty shall cover all parts and labor necessary to repair equipment which is inoperable due to defects in material or workmanship.

1.10. SPECIAL SIGNAGE

A. At each remote disconnect switch for all systems operated via VFD, a sign shall be posted to read "Do Not Open With Equipment Operating - Will Cause Damage to VFD." Sign shall have red letters on a white background.

PART 2 PRODUCTS

2.01. MANUFACTURERS

A. Whenever possible, all VFDs provided shall be by the same manufacturer.

1. Allen-Bradley - 1336 (PLUS) Series.

2. Schnider Electric, Square D.

3. ABB - ACS Series

4. Or Equal

B. All materials and equipment furnished shall be current products of manufacturers regularly engaged in the manufacturer of VFD and for which replacement parts are available.

2.02. PULSE-WIDTH MODULATED VARIABLE FREQUENCY DRIVE

A. General

1. The Electrical Contractor shall furnish and install the complete VFD system(s) described in this specification and as shown on the Contract Drawings.

2. Drives shall be microprocessor controlled with digital display and programming/status keypad.

3. The VFDs shall be rated for the full horsepower and full load amperes and rpm of the equipment as indicated. Motor service factors shall be minimum 1.0, unless otherwise specified in respective equipment Sections. VFDs shall be specifically designed to provide continuous speed adjustment of three phase, inverted duty, NEMA design 'B' squirrel cage motors.

4. Complete configured VFD system shall be UL listed per UL 508.

5. Minimum efficiency shall be 95 percent at motor full load. Unit service factor shall be minimum 1.0.

B. Construction

1. The VFDs shall be housed in NEMA enclosures, as noted above. Provide replaceable, cleanable filters in enclosure cooling fan/vent openings. Each VFD enclosure shall also house other components, such as control power transformers, relays, circuit breakers, bypass contactors, thermal overloads, and other devices when such are necessary to achieve conformance to the specified system.

2. An input circuit breaker or fusible disconnect switch shall be supplied for the VFD. The circuit breaker or fusible disconnect switch shall have an external operator. Interlocking provisions shall prevent unauthorized opening of the enclosure door while the handle is in the On position. A defeater shall be provided.When a bypass contactor is used, provide separate disconnecting means for both the VFD and the bypass contactors.

3. The VFD shall be capable of converting 480 volt, 3 phase, 60 Hertz power to a fixed potential DC bus level. The DC voltage shall be inverted to an adjustable frequency pulse width modulated (PWM) sine coded output waveform. The drive shall utilize solid-state full wave diodes and IGBT power transistors.

4. The VFD shall be insensitive to the phase rotation of the AC line and shall not cause displacement power factor of less than 0.95 lagging under any speed or load condition.

5. The VFD shall have the following ratings:

   a. Minimum efficiency of 95 percent at rated load.

   b. Overload Rating:

      1) Constant Torque - 150 percent rated current for 1 minute.

      2) Variable Torque - 110 percent rated current for 1 minute.

   c. Ambient operating temperature of 0 degrees C to 40 degrees C continuously, without derating.

   d. Operating humidity of 5 to 90 percent, non-condensing.

6. The following basic control features shall be provided standard on each VFD:

   a. Manual-Off-Auto Switch - When this switch is in the Manual position, the VFD shall start and stop using pushbuttons located on the VFD enclosure. When this switch is in the Off position, the VFD shall be off. When this switch is in the Auto position, the VFD shall start and stop via remote contacts. VFDs shall be capable of both three- and four-wire control for remote starting and stopping.

   b. Local-Remote Switch - When this switch is in the Local position, the speed of the VFD shall be controlled by a potentiometer on the VFD. When this switch is in the Remote position, the speed of the VFD shall be capable of being controlled by either a remote potentiometer or remote 4-20mA signal.

   c. Unidirectional operation, programmable acceleration and deceleration, restart into spinning loads. Implementation of the programmable acceleration and deceleration ramping shall be achieved without the programming of devices external to the VFD. The Electrical Contractor shall provide acceleration and deceleration ramp programming as requested by the Engineer/Owner during system startup.

   d. Full time torque limit, adjustable. Reduces speed to shed load when over current conditions exists.

   e. Programmable torque performance from 4 to 60 Hertz. Electrical Contractor shall coordinate with manufacturer of each motor controlled by a VFD. Program minimum VFD speed per motor manufacturer's recommendations to avoid overheating the motor.

   f. Integral or remote AC power line reactors or isolation transformers. See paragraph 1.04.B.

   g. Frequency stability of 0.5 percent for 24 hours with voltage regulation of ±2 percent of maximum rated output voltage.

   h. Status indication for the following:

      1) Power On.

      2) Run.

3) Motor Direction.

4) Overcurrent.

5) Overtemperature.

6) High and Low Phase Loss.

7) Current Limit.

8) Ground Fault.

i. Control power transformer (CPT) for 120 volt AC power for operator devices.

j. Motor slip dependent speed regulation.

k. Minimum one cycle logic power carryover during loss of power.

l. Programmable automatic restart upon the return of power following a power outage.

m. Automatic restart after fault, minimum three attempts and shutdown with manual reset.

n. Critical frequency rejection or lockout.

o. Programmable preset speeds, minimum of three.

p. Local speed potentiometer and speed indication, configurable in either rpm, percent of full speed, or hertz.

q. Fault log for minimum of last three faults.

r. Isolated process instrument follower input signal of 4-20mA DC, grounded or ungrounded.

s. 4-20mA DC output proportional to 0 to 100 percent speed.

t. Provide auxiliary run output contacts for remote run indication. Run output contacts shall be wired to an interposing relay. The interposing relay shall be provided with a minimum of two normally open and two normally closed contacts, rated for 10 amps at 120 volts.

u. All wiring connections to the VFD shall be made on labeled terminal strips in accordance with Section 16161 - Control Panels and Enclosures.

v. Common local and remote start/stop contacts and protective automatic shutdown contacts/switches shall be used by the control circuits of both the VFD and the bypass contactor.

w. Bypass contactors shall be housed in the same enclosure as the VFD, or in an adjacent enclosure where installed in an MCC or bank of enclosures. The VFD supplier shall provide interconnecting wiring between VFD and bypass contactors when installed in separate enclosures.

7. The following protective features shall be provided standard on each VFD:

   a. AC input line current limiting fuses for short circuit fault protection of AC to DC converter sections.

   b. Electronic over current trip for instantaneous or timed overload protection

   c. Undervoltage and phase loss protection.

   d. Overfrequency protection.

   e. Overtemperature protection.

   f. Surge protection from AC line transients.

   g. Electrical isolation between power and logic circuits.

   h. Ground fault protection.

   i. VFD enable terminals. Normally closed, field mounted protective devices, (such as auxiliary contacts on disconnect switches, emergency stop pushbuttons, high discharge pressure switch, low suction pressure switch, high motor temperature switches - see Contract Drawings and system specifications) shall be wired in series across the enable terminals.

   j. Provide a minimum of three sets of programmable output contacts for remote alarm indication. Programmable VFD output contacts shall be wired to interposing relays. The interposing relays shall be provided with a minimum of two normally open and two normally closed contacts, rated for 10 amps at 120 volts.

   k. LCD or LED diagnostic display.

   l. Password protection for VFD programming.

8. The following VFD operating parameters shall be capable of being independently adjusted on the VFD:

   a. Minimum Speed - 4 to 40 Hertz (see paragraph 2.02.B.6.e.).

   b. Maximum Speed - 40 to 90 Hertz.

   c. Acceleration Time - 2 to 300 seconds.

   d. Deceleration Time - 2 to 300 seconds.

   e. Low Frequency Boost - Up to 46 volts.

   f. Volts per hertz.

   g. Current limits up to 110 percent for variable torque VFDs, up to 150 percent for constant torque VFDs.

   h. Starting torque up to 150 percent.

i. Programmable Constant Torque - Variable torque switching. Drives which require physical modifications to accomplish this are not acceptable.

9. The following, manufacturer installed options shall be furnished with the VFDs as specified:

a. AC output contactors.

b. Motor overcurrent relay on VFD and on bypass contactors.

c. Bypass contactors when specified.

2.03. SYSTEM-SPECIFIC CONTROLS AND ALARMS

A. General - Field-mounted equipment (remote from the VFD enclosure) such as start/stop pushbuttons, potentiometers, auxiliary contacts on disconnect switches, etc., are shown on the Contract Drawings.

B. The VFDs shall accept a remote start/stop and speed control inputs as shown on the Contract Drawings.

C. Provide run, failure, and speed outputs for connection to the remote equipment as shown on the Contract Drawings.

D. All VFDs shall communicate directly to the plant SCADA system via Ethernet and shall communicate all alarms and indications as shown on the Contract Drawings.

PART 3 EXECUTION

3.01. GENERAL

A. Supply the VFD(s) with the controls specified herein and shown on the Contract Drawings.

B. The Contractor shall arrange for the VFD manufacturer/supplier to furnish the services of a qualified representative to check and supervise the installation and the preliminary testing for not less than one day per drive, to supervise final testing for not less than two days per drive, and to instruct the Owner's operator(s) in proper operation at the time of final acceptance for not less than one day per system. The representative shall also provide an additional one dayof training during the Contractor's warranty period at a date requested by the Owner. A day is defined as eight hours. All days are actual on-site time. Travel and subsistence is the responsibility of the manufacturer's/supplier's representative. Any additional visits beyond those specified above which are necessary to provide a functioning system in accordance with the Contract Documents shall be provided at the Contractor's cost. Refer to Section 01640 – Equipment-General for additional requirements.

C. The Owner's training shall be videotaped with a copy left for the Owner. A full complete session may be made for one system that is typical for all systems. Any specifics which may vary for individual systems shall be covered separately on the video.

D. Three copies of a complete operations and maintenance manual shall be submitted to the engineer per Section 01640, Equipment-General.

E. Field wiring shall be per manufacturers' recommendations.

3.02. FIELD TESTING

A. Field testing shall be in accordance with Section 01640 - Equipment-General, and as specified herein.

B. The Electrical Contractor shall coordinate VFD testing such that both the Owner and the Engineer are available to witness the testing. The Electrical Contractor shall contact both the Engineer and the Owner two weeks prior to the proposed test date. The representative of the equipment run by the VFD (pumps, fans) shall be present during VFD testing.

C. Shop drawing shall be available during testing.

D. A copy of the operations and maintenance manual shall be available during testing.

E. The Electrical Contractor shall verify that all systems have been electrically connected and that equipment is ready for operation.

F. Testing/Verification/Documentation:

1. General explanation of each system shall be made.

2. Electrical Contractor/manufacturer/supplier shall have a written tabulation of all adjustable/settable parameters as set from the factory. In a separate column, all of the actual field adjusted/set values shall be shown.

3. Demonstrate the following and show how each is set/changed.

a. Manual operation both local/remote.

b. Minimum or default speed to be set for specific equipment operation.

c. Maximum set speed.

d. Adjust acceleration/deceleration times for proper equipment operation.

e. Restart after power outage.

f. Demonstrate starting into rotating motor (shut off circuit breaker and turn right back on).

g. Overcurrent/overvoltage (simulate with test equipment).

h. Overtemperature/low voltage (simulate with test equipment).

i. Phase Loss - Remove on fuse on supply voltage.

j. Auto operation (from input current or voltage signal).

k. Output contacts for alarm/run/status, etc., operate as required, simulate with test lights.

G. Unit(s) shall operate without unusual or undue noises or vibrations.

END OF SECTION