

SECTION 43 11 33

ROTARY LOBE BLOWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged rotary lobe blowers with sound-attenuating enclosures and appurtenances.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 22 15 00 - General Service Compressed-Air Systems
2. Section 26 29 23 - Variable Frequency Drives - Low Voltage.

1.2 REFERENCES

A. Abbreviations:

1. "ACFM" means "actual cubic feet per minute," referring to volumetric flow rate of air or gas measured at actual, local conditions of temperature, absolute pressure, and relative humidity.
2. "ICFM" means "inlet cubic feet per minute," referring to ACFM entering blower equipment, measured at blower's inlet flange (or similar connection).
3. "PSIA" means "pounds (force) per square inch absolute," referring to measured pressure of air or gas, expressed as atmospheric pressure at local conditions plus locally-measured gauge pressure (i.e., above atmospheric pressure).
4. "PSIG" means "pounds (force) per square inch gauge," referring to pressure measured above local atmospheric pressure.
5. "SCFM" means "standard cubic feet per minute," referring to volumetric flow rate of air or gas at 68 degrees F, 14.70 psia (i.e., ambient, atmospheric air pressure at sea level), and 36 percent relative humidity.

B. Reference Standards:

1. Acoustical Society of America (ASA):
 - a. ANSI/ASA S2.19, Standard Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications.
2. American Bearing Manufacturers Association (ABMA):
 - a. ABMA/ANSI 9, Load Ratings and Fatigue Life for Ball Bearings.
 - b. ABMA/ANSI 11, Load Ratings and Fatigue Life for Roller Bearings.
3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE):
 - a. ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size,
4. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code (BPVC), Section VIII, Construction of Pressure Vessels (Division 1).
 - b. ASME/ANSI B16, Standards for Pipes and Fittings:
 - 1) B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
5. ASTM International (ASTM):
 - a. ASTM SAE AISI 1045, Carbon Steel Heat Treatment Chemical Composition Properties.
6. International Organization for Standardization (ISO):
 - a. 1217, Displacement Compressors – Acceptance Tests.

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7. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
8. Underwriters Laboratories (UL):
 - a. 508, Industrial Control Panels.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer of Rotary Lobe Blower Equipment:
 - a. Manufacturer shall be corporation regularly engaged in the business of manufacturing rotary lobe blower equipment of the type required for the Work.
 - b. Manufacturer shall have furnished blowers for not less than three separate facilities in the United States of America each operating satisfactorily for not less than one year. Document not less than six rotary lobe blowers (total) operating at the facilities. To qualify under this provision, each such rotary lobe blower shall have air flow capacity and motor horsepower equal to or greater than that required for the rotary lobe blowers required for the Work.
 - c. In addition, equipment manufacturer shall be able to submit satisfactory documentation of not less than 20 installations and 50 operating rotary lobe blowers, regardless of installation location.
 - d. Manufacturer shall have an established base of operation in North America that employing experienced, factory-trained technical personnel, resources, and services. Personnel available from such service base facility shall perform checkout, startup, and troubleshooting of installed rotary lobe blower equipment.
 - e. Manufacturer shall have service network in North America responding to technical inquiries within 24 hours and able to furnish replacement parts replacement within 48 HRS of Supplier's receipt of order from Contractor, Owner, or facility manager.
 - f. Upon Engineer's request, Submit to Engineer documentation of compliance with qualifications requirements.
 - g. **Blowers, motors, and all primary components shall be manufactured in the United States with replacements and parts available from multiple sources within the United States.**

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule (table) of proposed blower equipment, indicating proposed performance, manufacturer and model, and similar information.
 - b. Schedule (table) of electric motors, indicating manufacturer, model, enclosure type, motor size, and similar information.
 - c. Bill of materials for all equipment, components, and appurtenances.
 - d. Equipment fabrication drawings indicating arrangement, materials, dimensions, weight, and similar matters, showing plan, section, and cutaway views of blower units, enclosures, and blower system package.
 - e. System process and instrumentation (P&ID) drawings for the rotary lobe blower Work.
 - f. Control panel layout drawings and wiring diagrams.
2. Product Data:
 - a. Component manufacturer's published product data, including brochures, specifications, and blower data.
 - b. Factory-certified performance curves from previous tests of identical blower units, indicating speed, capacity, horsepower, and efficiency over the range of operation.
 - c. Catalog information showing the details of blower, motor, belt drives, valves, and other accessory construction.

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- d. Blower weight and weights of each separate item of equipment, as well as total package weight, including enclosure and control panel.
 - e. Blower enclosure and associated enclosure accessories data.
 - f. Flexible connection data.
 - g. Control valves and actuators furnished by blower equipment manufacturer.
 - h. Silencers technical data.
 - i. Product data for control panel and associated components, including microprocessors, indicators, transmitters, relays, human-machine interfaces, cabling, and similar items.
 - j. Product data for blower system instrumentation provided by blower equipment manufacturer, including: vibration monitoring and control; ammeter; switches; pressure and temperature sensors and transmitters; temperature protection devices; limit switches; and similar items.
 - k. VFDs: Furnish Submittals under, and in accordance with, Section 26 29 23 – Variable Frequency Drives – Low Voltage.
3. Samples:
- a. Color Samples of finish coat of blower and enclosure, from Manufacturer's standard finish coat colors.
4. Testing Plans:
- a. Plan for performing required source quality control activities (including shop testing). Indicate limitations of testing facility. Include copies of most-recent certification of calibration for test instruments.
 - b. Plan for performing required field quality control activities.
- B. Informational Submittals: Submit the following:
- 1. Certifications:
 - a. Manufacturer's written statement of installation, checkout, and startup, in accordance with Section 01 75 00 - Checkout and Startup Procedures.
 - 2. Manufacturer's Instructions:
 - a. Instructions and recommendations for handling, storing, protecting, and installing the equipment.
 - 3. Source Quality Control Results:
 - a. Written results of required source quality control activities.
 - 1) Results of blower equipment manufacturer's standard factory tests and inspections.
 - 2) Results of motor manufacturer's standard factory tests and inspections.
 - 3) Report of dynamic balancing and maximum vibration amplitude.
 - 4. Field Quality Control Results:
 - a. Written results of required field quality control activities, including:
 - 1) Field performance testing.
 - 2) Vibration testing.
 - 3) Sound test.
 - b. Written results of motor tests at the Site.
 - 5. Supplier Reports:
 - a. Submit written report of results of each visit to the Site by Supplier's service personnel, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
 - 6. Qualifications Statements:
 - a. Manufacturer, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
- 1. Operation and Maintenance Data:

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- a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.
 - b. Indicate serial number and Project equipment designation (or tag number).
 - c. For each protective relay, PLC, or microprocessor with programmable requirements, provide the final as-constructed settings for all devices.
- D. Maintenance Materials Submittals: Furnish the following items and submit documentation of delivery to and acceptance by the Owner or facility manager (as applicable):
1. Spare Parts and Extra Materials:
 - a. One complete set of bearings, seals, and O-rings for one blower-and-motor unit.
 - b. Multiple V-belts and sheaves for each type and size of blower furnished.
 - c. One complete set of inlet filters for each type and size of blower furnished.
 - d. One complete set of gaskets for one blower-and-motor unit.
 - e. Lubricants, recommended by blower equipment manufacturer, sufficient for first year of operation.
 - f. One quart of touch-up coating of finish coat of blower and enclosure.
 2. Tools:
 - a. Two sets of special tools, if any, required for normal maintenance.

PART 2 - PRODUCTS

2.1 EQUIPMENT MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Hardy Pro-Air.
 2. Atlas Copco.
 3. Gulf States Engineering.
 4. **Universal Blower Pac.**
 5. Other approved equal by HDR and IES EOR.

2.2 PERFORMANCE AND DESIGN CRITERIA

- A. Description:
1. Contractor shall provide labor, materials, equipment, tools, and services to furnish and install rotary lobe blowers, motors, enclosures, instrumentation and controls, and appurtenances as shown, indicated, and necessary for a complete, operational system.
 2. Provide all rotary lobe blowers and accessories from one manufacturer, which has sole responsibility for compatibility of all materials and components necessary for a complete, operating, efficient system as required by the contract Documents.
 3. Comply with Section 01 61 03 - Equipment - Basic Requirements.
 4. Provide each blower and its associated motor and inlet and discharge silencers, frame-mounted in sound-attenuating enclosure.
 5. Factory-assemble each blower package with associated, factory-installed wiring.
- B. Required Blower Performance:
1. **Blower:**
 - a. **Quantity: 2**
 - b. **Blower model (BOD): Gardner Denver Heliflow 817**
 - c. **Motor HP (ea.): 100**
 - d. **Motor RPM (ea.): 1,800**
 2. Indicate blower **condition (performance indicated is for EACH blower):**
 - a. Service Application: **Positive displacement blower** for process air for water filtration media beds.

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- b. Blower Elevation: 300 feet above mean sea level
- c. **Inlet Air Temperature: 108°F, db**
- d. Inlet Relative Humidity: 60%
- e. Approximate design values (may differ slightly depending on manufacturer):
 - 1) Blower RPM: 1,929
 - 2) Brake Horsepower (BHP): 85.8
 - 3) Power at Relief: 97.5
 - 4) Free Field Noise (Max) dB(A), without enclosure: 93
- f. Design Point 1: 2,000 SCFM at 7 PSIG blower discharge pressure
 - 1) **Total design requirement will be accomplished by running (2) parallel blowers (no redundancy), each at 2,000 SCFM for a total of 4,000 SCFM. See also WARNING in Section 2.3.F.1.a.2.**
- g. Maximum Acceptable Inlet Pressure Loss: 0.20 PSI.
- h. Blower Inlet Air Connection Size: 8 inches diameter.
- i. Blower Discharge Air Connection Size: 8 inches diameter.
- j. Provide piping reducers and increasers, when necessary, to connect blowers to inlet and discharge piping.
- k. Capability to reduce air flow a minimum of 50% of by blower motor speed reduction via VFD, without motor overload.

2.3 ASSEMBLY AND MATERIALS

A. General:

- 1. Blower connections to process air piping, silencers, control valves furnished by blower equipment manufacturer, and similar items, shall have flanged connections in accordance with ASME/ANSI B16.1.

B. Inlet Filter/Silencer:

- 1. Provide blower inlet filter/silencer for each blower, to attenuate pulsation noise.
- 2. Provide unit that minimizes pressure loss.
- 3. Heavy-duty units of all-welded metal construction.
- 4. Material: Heavy gage steel, suitable for outdoor installation
- 5. Provide with replaceable dry filter elements.
 - a. Washable.
 - b. Filter particle size as deemed appropriate by blower manufacturer.
- 6. Average efficiency in accordance with ANSI/ASHRAE 52.2: MERV 7 (50-70% @3-10 microns).
- 7. Inlet Size: As indicated above in this Section's "Performance and Design Criteria" Article.
- 8. On blower enclosure wall, provide maintenance indicator to indicate when inlet filter is to be replaced or cleaned.

C. Blower:

- 1. Type: Positive displacement blowers shall be of rotary, 2-lobe/3-lobe, involute design with electric motor designed for direct drive operation, suitable for continuous operation 24-hours per day. All blowers shall be based upon data previously established by tests in accordance with ANSI/ASME Performance Test Code 9 or ISO 1217.
- 2. Blower Housing:
 - a. Material: Close-grained iron, ribbed.
 - b. Fabrication: One-piece construction to ensure accurate operating clearances
 - c. Dowel bearing carriers to housing for proper alignment.
- 3. Rotors: Symmetrical, straight, three-lobe design.

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4. Rotors and Shafts:
 - a. Solid, one-piece, drop-forged.
 - b. Material: ASTM SAE AISI 1045 (medium tensile steel)
 - c. All surfaces precision machined to final dimensions.
 - d. Dynamically balanced in accordance with ANSI/ASA S2.19 G6.3.
 5. First critical speed shall be greater than 1.2 times maximum rotating speed.
 6. Timing Gears:
 - a. Material: Alloy steel, single helical type
 - b. AGMA Class 12 or equivalent quality
 - 1) Service Factor: 1.7 at equipment's maximum operating point.
 - c. Provide precise rotor synchronization, so that operating clearances are satisfactorily maintained.
 - d. Secure gears with interference fit on ground, tapered shaft ends.
 - e. Provide constant oil bath for gears and gear end bearings.
 - f. To minimize backlash, slippage, and loss of timing, taper fit spur gears shall not be allowed.
 7. Bearings:
 - a. Provide bearings to achieve mean of five years or more between overhauls, with normal maintenance. Comply with AGMA 9 and AGMA 11, as applicable.
 - b. Proper axial and radial rotor positioning, maintaining required clearances under rated loads.
 - c. Heavy and ground, combined with ground spacers to set axial clearances, and ensure uniform bearing loading.
 - d. Size drive shaft bearing for overhung V-belt drive under equipment's maximum continuous operating loads.
 - e. Minimum B-10 bearing life of 100,000 hours.
 - f. Provide with an oil seal on each bearing preventing lubricant from leaking into the process air stream and minimizing process air leakage.
 8. Shaft Connection to Head Plate:
 - a. Provide four rotary piston ring shaft seals, oil deflector ring, grooved multiple labyrinth bushing, and O-ring between the shaft and ring retainer at point where shaft passes through head plate.
 - b. Vent labyrinth to atmosphere to eliminate possible carry-over of lubricant into process air stream.
 9. Lip Seal:
 - a. Provide at drive shaft only.
 - b. Seal Design: Radial lip seal riding on replaceable shaft sleeve.
 10. Drives:
 - a. Belt-driven from electric motor mounted on a common motor slide base.
 - b. Provide motor mounts to tension automatically without adjustment.
 11. Belts:
 - a. Provide multiple V-belts with sheaves
 - b. Matched cogged type V-belts or equivalent quality.
 - c. Rated for 160% of motor horsepower.
 - d. Provide OSHA compliant belt guard.
 12. Dynamically balanced sheaves for linear tip speeds > 6500 feet/MIN.
 13. Ensure that the rotation of blower is in proper direction.
- D. Motor:

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1. Provide high-efficiency, 480V, three-phase, 60 Hz, electric motor appropriate for the associated blower equipment.
 2. Maximum Speed: 3600 RPM.
 3. Enclosure Type: Totally-enclosed fan cooled (TEFC).
 4. Rated for constant speed, continuous operation.
 5. Service Factor: 1.15.
 6. Maximum Motor Size: 100 HP.
 7. Comply with Section 01 61 03 - Equipment - Basic Requirements, regarding motor requirements.
- E. Equipment Base:
1. Base shall support and be appropriate for blower, motor, belt drive, inlet filter/silencer, and discharge silencer.
 2. Material: Fabricated steel.
 3. Provide vibration isolating mounting feet with a minimum efficiency of 80%.
- F. Discharge Air Assembly:
1. Provide at process air discharge from each blower a multi-chamber silencer.
 - a. Provided to reduce noise emitted from blower's discharge process air piping to **93 dBA (w/o package enclosure)** or less
 - 1) Based on carbon steel, Schedule 40 piping of a diameter equal to the blower package's discharge air nominal connection size.
 - 2) **WARNING: Contractor to provide signage on all building facades where blower fans are visible. Signage shall warn personnel of the need for hearing protection when within the vicinity of the fan pairs. The National Institute for Occupational Safety and Health (NIOSH) (Section 1910.95) has recommended that all worker exposures to noise should be controlled below a level equivalent to 85 dBA for eight hours to minimize occupational noise induced hearing loss (i.e. this is a time-weighted requirement). IES, despite the weighted requirement, strongly recommends hearing protection, regardless. IES strongly recommends the employer provide policies (if not already in place) that ensure employees wear their hearing protection, provide training in the use and care of all hearing protection provided to employees, supervise the correct use of all hearing protection, and ensure that employees are informed of instructions on the use and care of hearing protection.**
 - b. Materials: Either cast iron or pressure vessel steel. Fibrous materials or any absorption materials, which could deteriorate over time, are unacceptable.
 - c. Fabrication: Single shell with continuous welds.
 - d. Internal diffusers are unacceptable for silencers.
 - e. Provide fully-closable port sufficient for inspecting and cleaning.
 - f. Account for silencer pressure loss in blower power calculation.
 2. Discharge Air Check Valve:
 - a. Each package shall be supplied with one check valve that shall be installed on the discharge line to prevent back-flow through the blower.
 - b. The check valve shall be of the full-bore low pressure-drop, flapper type design with a steel body, and steel flap embedded in EPDM with full-contact seal for sizes 6" and greater. Spring-loaded non-return valves shall be allowed for sizes 4" and smaller.
 - c. The valve shall be removable without disturbing the piping. Pressure losses produced by the check valve shall be included in the blower performance calculation.
 3. Pressure Relief Valve:
 - a. A weighted or spring-loaded discharge pressure relief valve (PRV) shall be installed in the piping system immediately downstream of the discharge silencer and upstream of the check valve.

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- b. The relief set point of the valve is to be 1.0 psig above the blower design operating pressure to protect the blower from exceeding its maximum pressure rating, and shall be sized to pass 100% of the design flow.
4. Flexible Connector:
- a. Provide elastomer material sleeve with industrial quality clamps for blower package's discharge air connection.
 - b. Provide suitable for continuous exposure to temperatures up to 300 degrees F and process air discharge pressure up to 15 PSIG.
 - c. Provide sufficient distance between blower package and connecting discharge process air piping for sufficient thermal expansion without touching.
5. Discharge Butterfly Valve:
- a. Provide wafer type, resilient seated, lever operated, tight closing butterfly valve for positively isolating the blower from the manifold system.
 - b. Furnish valve with body and disc of nodular iron; Stainless steel stem and disk; EPDM seat; and position indicator.
- G. Lubrication:
- 1. Provide oil fill level sight glass on each oil sump, visible without opening or removing panels.
 - 2. Provide one, easy access oil drain.
 - 3. Provide lubricants recommended by equipment manufacturer, in quantity sufficient for checkout, startup, field quality control, and first year of operation.
- H. Sound-Attenuating Enclosures (Mallory and McCord projects only):
- 1. Provide freestanding, rigid, noise-reducing, acoustical, factory-mounted enclosure for each blower package housing the following:
 - a. Each package shall be supplied with a sound enclosure covering the entire blower package. The enclosure shall be designed to be able to install them side-by-side with all maintenance done from the front or back of the package.
 - b. A sound enclosure shall be provided which fully covers the blower, motor, drive assembly, inlet silencer, blower base frame with integrated discharge silencer, and be shipped fully assembled.
 - c. The sound enclosure shall be the product of the blower manufacturer to insure proper integration of blower package components.
 - d. If located outdoors, the enclosure shall have a sealed, beveled roof to allow for rainwater runoff and provide suitable protection for outdoor installation under the specified site conditions (wind load and snow load).
 - e. The sound enclosure shall meet the sound level specified and the acoustic material shall comply to FMVSS 302 with a burning rate B or lower than 100 mm/min.
 - f. The sound enclosure assembly shall have a metal powder coat (Hardy Blue **basis of design**) with lift off panels on all sides of the enclosure.
 - g. The sound enclosure ventilation cooling air circuit shall be separate from the process air circuit. Mixing of the two air circuits within the enclosure shall not be allowed.
 - h. The sound enclosure ventilation air exhaust and the ventilation fan shall be located on top of the sound enclosure.
 - 1) The ventilation fan shall be sized to provide adequate cooling of the blower package at all blower speeds.
 - 2) The ventilation fan shall be powered by a 120V circuit and controlled by a thermostat.
 - i. The sound enclosure shall have customer-defined, predrilled holes with grommets for easy pass-thru of electrical wiring.
 - j. Electrical components, instrumentation and instrument connections shall not be mounted on, or interface with, moving panels of the sound enclosure.

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- k. The blower oil sumps may be piped to individual fills and drains, and located at the front of the package for easy maintenance. All oil lines to be constructed with hydraulic hose and fittings. No plastic tubing with compression fittings is allowed.
 - l. Enclosure LED light kit may be added to simplify maintenance tasks in dark conditions. Kit is driven by a separate 120V circuit.
2. Enclosure Panel Material:
 - a. Material: Galvanized (“galvaneal”) steel sheet.
 - b. Thickness: 16 gauge.
 - c. Finish: Painted exterior, in accordance with this Section’s “Factory Finishes” provision, below.
 3. Fabrication and Assembly:
 - a. Provide enclosure so that belt tensioning, oil level checks, and oil changes are performed without removing enclosure or any part thereof. Provide in enclosure panels latched and hinged access doors and lintels, on each side, for such purposes.
 - b. Weight Limit: Removable panels shall weigh less than 50 pounds each.
 - c. Enclosure shall be suitable for blower’s permanent installation outdoors, exposed to sunlight and weather elements, without adverse effect on equipment’s service life. Enclosure shall be rated NEMA 4X, in accordance with NEMA 250, or greater.
 - d. Install gauges at enclosure’s exterior to allow convenient reading by personnel standing adjacent to enclosure.
 - e. Provide enclosure with flame-retardant acoustic lining.
 - f. Maximum allowable noise, when blower is operating at maximum speed, shall not exceed 85 dBA measured three feet from any part of blower enclosure.
 4. Enclosure Cooling and Ventilation:
 - a. Provide electric-driven cooling fan, properly sized for appropriate cooling and ventilating of blower enclosure.
- I. Finishes:
 1. Provide equipment manufacturer’s standard factory finish for blowers, motors, enclosures, silencers, valves, and appurtenances.
 2. Color: When more than one standard color is available for finish coat of blower and enclosure, submit color Samples. When only one standard color is available, provide standard color.
 3. Materials:
 - a. Finishes shall be appropriate for the substrate to which they are applied and the equipment’s service environment at its installed location.
 - b. Where equipment will be installed outdoors, factory finish shall be suitable for prolonged exposure to sunlight and weather elements without deterioration or fading.
 4. Furnish touch-up paint for repair of scratches and blemishes following installation.

2.4 BLOWER DIGITAL CONTROL PACKAGE AND VARIABLE FREQUENCY DRIVE (VFD)

- A. Instrumentation:
 1. Comply with Section 40 61 13 - Process Control System General Requirements.
 2. Provide inlet filter/silencer differential pressure gauge suitable for the intended service, environment, and operating conditions.
 3. Provide discharge process air temperature gauge with integral shutdown switch that will cause blower system controls provided by blower equipment manufacturer to automatically shut down the blower upon detection of over-temperature condition.
 4. Provide discharge process air pressure gauge suitable for blower service, environment, and operation conditions.
 5. Provide filter vacuum gauge.

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6. Provide discharge process air pressure switch.
 7. Provide appropriate vibration switches.
 8. Provide appropriate RTDs.
- B. Factory Wiring:
1. Provide appropriate junction boxes, with terminal boards, at blower motor and blower equipment to serve as termination points for the wiring to associated blower VFD.
 2. Provide factory-installed wiring for all motor and blower equipment control and instrumentation devices to the terminal boards in blower manufacturer-provided junction boxes, for Contractor's connection of external cabling for electrical power and controls.
 3. Properly identify each wiring unit when disassembly required for shipping to the Site.
 4. Provide separate junction boxes for AC and DC control signals.
- C. Control Panels (NEMA 4X):
1. Control panels shall be in accordance with, and labeled as complying with, UL 508.
 2. Provide in accordance with Section 40 67 00 - Control System Equipment Panels and Racks, and Section 40 78 00 - Panel Mounted Instruments.
 3. Provide control panels sufficient for controlling each individual blower packaged and blower system.
- D. Controls:
1. Provide blower equipment manufacturer's standard controls for proper control of the blowers in manual and automatic modes.

2.5 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
1. Test Plan:
 - a. Prior to performing factory testing, prepare and submit to Engineer plan describing proposed source quality control activities, testing facility limitations relative to the equipment being furnished, and criteria for acceptance.
 2. Inspections:
 - a. For all items furnished, perform manufacturer's normal inspections and source quality control activities.
 - b. Submit to Engineer documentation that such inspections and source quality control activities were completed successfully.
 3. Factory Performance Testing:
 - a. Except as required below, test at blower manufacturer's production facility one blower of each type and size furnished, in accordance with ISO 1217 and blower factory test plan approved by Engineer.
 - b. Measure power consumption with wattmeter (with current, valid calibration) on the electrical power feed to a calibrated test motor identical to that required for the blowers furnished.
 - c. Measure volumetric process air flow rate by a rotary meter (with valid, current calibration) installed on the blower's process air inlet.
 - d. Measure and record vibration and temperature measurements to determine its mechanical integrity.
 - e. Measure and record temperature of bearing housing near end of test run.
 - f. Criteria for Acceptance: In accordance with factory test method indicated in this provision.
 - g. Performance Test Results:
 - 1) Submit to Engineer written report of blower's factory performance testing, including blower's as-tested performance curves.

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- 2) Factory test report shall be certified as complete and accurate by person (who may be manufacturer's employee) possessing a current, valid, license and registration as a professional engineer (not necessarily in the same jurisdiction as the Site), whose seal and signature shall appear on all factory test reports.
 - 3) Test report shall also indicate: serial number(s) of tested equipment, test method used, deviations (if any) from test method and approved test plan, explicit indication whether testing had acceptable results, and relevant comments.
4. Controls Factory Test:
- a. Factory-test at control panel manufacturer's shop all microprocessors with programming specific to the Project. There is no contractual requirement to factory-test blower equipment manufacturer's standard controls not modified for the Project.
 - b. Perform test in accordance with Section 40 61 21 - Process Control System Testing.
 - c. Owner and Engineer reserve the right to attend and witness factory test. Advise Engineer in writing of scheduled dates for controls factory test not less than 30 days prior to start of the test. If Owner or Engineer attend the test, Engineer will so advise Contractor not less than 10 days prior to the start of the test and Contractor will not be responsible for any of Owner's or Engineer's time or expenses to attend the test, unless initial test does not produce acceptable results and Owner or Engineer must return for a retest. In the latter event, Contractor shall be responsible for costs of Owner's and Engineer's time and travel expenses for the retest, including travel, and such amounts may be deducted (as one or more set-offs) from payment due Contractor.
 - d. Submit to Engineer written results of successful factory testing of controls.
5. Obtain Engineer's acceptance of source quality control results before shipping equipment to the Site.
- B. Defective Work:
1. If required source quality control activities indicate unacceptable results or defects, remedy the defects at the factory and retest.
 2. If acceptable results are not obtained after a total of three tests and two cycles of remedial work, submit to Engineer indication of whether further remedies and retesting are expected to achieve the required performance. If required performance cannot be achieved, submit to Engineer a Change Proposal for a suitable reduction in the Contract Price.
 3. Owner and Engineer may require either that equipment complying with the Contract Documents be furnished, or further remedial work followed by retesting, request a revised Change Proposal to accept the defective Work, or accept the Change Proposal for defective Work. Owner is under no obligation to accept defective Work.
 4. Contractor is responsible for delays resulting from retesting, remedying defective Work, and for negotiating an acceptable Change Proposal for the Owner to accept defective Work.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation – General:
1. Install equipment in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Obtain Engineer's written interpretation or clarification in event of conflict between such requirements.
 2. Do not modify structures to install equipment, without Engineer's written approval.
 3. Comply with:
 - a. Section 01 61 03 - Equipment - Basic Requirements.
 - b. Section 01 75 00 - Checkout and Startup Requirements.
- B. Field-Applied Finishes:
1. Apply field touch-up paint, furnished by blower equipment manufacturer, to scratches and blemishes in equipment's factory-applied coatings.

2. Apply in accordance with coating manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Field Testing and Inspections:

1. General:
 - a. After equipment installation is complete, Contractor and qualified, factory-trained field service representative of blower equipment manufacturer shall perform tests and inspections required in this Article, in accordance with field testing plan approved by Engineer.
 - b. Perform required field tests in Engineer's presence.
2. Inspect the installed Work and remedy defects as necessary.
3. Operating Tests:
 - a. Field-test each blower together with its controls and appurtenances. Tests shall demonstrate to Engineer that each part and all parts together function in accordance with the Contract Documents. Provide necessary testing equipment, labor, and appurtenances. Motor testing shall comply with Section 01 61 03 - Equipment - Basic Requirements.
 - b. Verify: (1) equipment operates at design point as intended; (2) vibration limits are not excessive and beyond manufacturer's recommendations; and (3) blower operates smoothly without excessive noise, temperature rise, or other defects, across entire range of operating curve. Verify all controls operate as intended in all operating modes. Successfully test-operate each blower in accordance with Section 01 61 03 - Equipment - Basic Requirements, and Section 01 75 00 - Checkout and Startup Requirements.
 - c. If equipment does not comply with the Contract Documents and does not pass the tests, Contractor shall adjust, modify, and retest the equipment as often as necessary until tests are successfully passed.
4. Vibration Testing:
 - a. Perform field vibration testing of equipment when required by Section 01 61 03 - Equipment - Basic Requirements.
 - b. Vibration testing shall comply with Section 01 61 03 - Equipment - Basic Requirements.
5. Sound Tests:
 - a. Perform sound pressure level test on one blower of each type and size provided. Engineer will select the blower to be so tested following field operating tests.
 - b. Present test results in decibels.
 - c. Obtain overall sound pressure level at points evenly spaced around blower tested and motor assembly and at three feet from nearest part of blower enclosure. Sound level shall not exceed 85 dBA at distance of three feet from blower enclosure (Mallory and McCord). Max. requirement remaining sites without blower enclosures is 93 dBA based on the same distance from the nearest point of the skidded blower assembly.
6. Manufacturer shall submit, through Contractor, written statement regarding the blowers' compliance with the Contract Documents and equipment manufacturer's recommendations, regarding whether remedial measures are required, and if so, what remedial measures he proposes.

B. Manufacturer's Services:

1. Provide services of qualified, factory-trained service person to perform the following:
 - a. Instruct Contractor's workers in handling, storing, and installing equipment.
 - b. Be present to supervise delivery, unloading, handling, and storage of equipment, and assist Contractor with inspecting condition of equipment and verifying that all required items, including required spare parts and extra materials, were furnished and are appropriate for the equipment,
 - c. After installation, inspect and adjust equipment, verify proper operation, and assist with required field testing and inspections.

REVISED

- d. Instruct facility operations and maintenance personnel in accordance with Section 01 79 23 - Instruction of Operation and Maintenance Personnel. Extent of required instruction is indicated in Section 01 79 23 - Instruction of Operation and Maintenance Personnel.
2. Submit, through Contractor, written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner or facility manager (as applicable).
3. Manufacturer's factory-trained service representative shall revisit the Site as often as necessary until installed equipment is acceptable, and as necessary during the correction period.
4. All costs, including travel, lodging, sustenance, and incidentals, for visits to the Site are included in the Contract Price.

END OF SECTION

SECTION 46 61 13
FILTER MEDIA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements for furnishing and installation of filter media:
 - a. Silica Sand.
 - b. Anthracite.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 46 61 19 – Wash Water Troughs.
 - 2. Section 46 61 23 – Gravity Filter Underdrains.
- C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Water Works Association (AWWA):
 - a. B100, Standard for Granular Filter Material.
 - b. C653, Disinfection of Water Treatment Plants.
 - 2. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.
 - b. C123, Standard Test Method for Lightweight Particles in Aggregate.
 - c. C128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
 - d. D409, Standard Test Method for Grindability of Coal by the Hardgrove-Machine Method.
 - e. D3174, Standard Test Method for Ash in the Analysis Sample of Coal and Coke from Coal.
 - f. D3175, Standard Test Method for Volatile Matter in the Analysis Sample of Coal and Coke.
 - g. E11, Specification for Wire-Cloth Sieves for Testing Purposes.
 - 3. NSF International (NSF):
 - a. 61, Drinking Water System Components – Health Effects.
- B. Perform certified material testing of new filter media by an Owner approved independent testing laboratory employed by the Contractor.
- C. Certified test results shall cover all physical, gradation, size, and chemical characteristics specified in this Section.
 - 1. All tests shall be made in accordance with test procedures as described in AWWA B100.
 - 2. At a minimum, testing shall include Effective Size, Uniformity coefficient and Percent size passing at 10%, 30%, 60% and 90%. Said testing shall occur on the media that is being provided for the project. Separate samples shall be taken and tested in accordance with AWWA B100.
 - ~~3. Uniformity of sample results may serve as a basis for rejection of the materials. **Effective Size shall not deviate more than 0.2 mm across the samples.**~~

1.3 DEFINITIONS

- A. Percent size: Size of the theoretical opening of a sieve through which that percentage of the filter media, by weight, will pass. (For example, if the size distribution of the filter media particles is such that 20% of the sample is finer than 0.70 millimeters, the filter media shall be said to have a 20% size of 0.70 millimeters.)

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1. Sieve dimensions: Per ASTM E11 and Table B.1 of the Appendix to AWWA B100.
- B. Effective size (ES): 10% size (d_{10}), i.e. 10% of the sample is finer than the effective size.
- C. Uniformity coefficient (UC): Ratio of media 60% size (d_{60}) to media 10% size (d_{10})
- D. Flat Particles: Particles in which a circumscribing rectangular prism exceeds five times the shortest axis.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Shop Drawings will provide the expected media gradations, Uniformity Coefficient, Effective Size, Acid Solubility percentages as well as other material information identified herein. Approval of the Shop Drawings is not acceptance of the material identified. Final acceptance of the material is based upon the sampling of the material to be delivered to the project site as noted in Article 1.2 and in AWWA B100.
- B. Product Data:
 1. Acknowledgement that products submitted meet requirements of standards referenced.
 2. Manufacturer's installation instructions including media initial washing procedures.
 3. Test reports.
- C. Samples:
 1. Media Sample Number and Sizes: Per AWWA B100 Section 5.2.
 2. Test Laboratory:
 - a. Submit name of independent testing laboratory along with statement of experience and qualifications to perform the specified tests.
 - 1) Engineer must approve independent laboratory.
 - 2) Engineer's rejection of any testing laboratory proposed by Contractor shall not serve as basis for extra costs to Owner.
 - 3) Laboratory shall not be associated with supplier in any way.
 3. Laboratory Test Results:
 - a. Per AWWA B100 Section 5.3.
 - b. Show Drawing submittal shall include test reports with expected media characteristics included.
 - c. Project media shall be sampled and tested prior to delivery to site. The results will determine final approval of the media material for installation. Submit analyses from test laboratory:
 - 1) Effective Size, Uniformity Coefficient, Acid Solubility and percent gradations at 10%, 30%, 60% and 90% shall be based upon 3 samples.
 - 2) Consistency of samples for ES and UC shall be **0.052** mm or less.
- D. Certificates.
 1. Documentation of NSF 61 certification for all filter media to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 1. Shall be done in accordance with AWWA B100 Section 6.
 2. **Do not ship media materials** until final media samples have been analyzed and approved by the Engineer.
 3. Package and deliver filter media in a manner to exclude all dust, dirt, or deleterious material and to protect particles from physical damage and unsuitable environments.
 4. Package filter media in ultraviolet resistant polyethylene super sacks with bottom pour spout on pallets.
 5. Clearly mark each bag of material with the following information:
 - a. Effective size.
 - b. Uniformity coefficient.
 - c. Source.

REVISED

- d. Date of bagging.
 - e. Lot or stockpile identification.
- B. Storage:
- 1. Store filter media in a clean area protected from unsuitable environments and accessible at all times.
 - 2. Take care to maintain filter media and storage area for cleanliness and neat appearance.
 - a. Contaminated or dirty media, as judged by the Engineer, will be rejected.
 - 3. Provide temporary protection of media after installation as required until acceptance.

1.6 SEQUENCING AND SCHEDULING

- A. Schedule delivery of media so that it is placed in the filters within 30 days of arrival at the jobsite.

PART 2 - PRODUCTS

2.1 SUPPLIERS

- A. Subject to compliance with the Contract Documents, the following suppliers are acceptable:
- 1. Northern Filter Media, 2509 Pettibone Avenue, Muscatine, IA 52761, 1-800-962-7190
 - 2. Red Flint Sand and Gravel LLC, 717 Short Street, Eau Claire, WI 54701, 1-800-238-9139
 - 3. Unifilt, P.O.Box 614, Ellwood City, PA 16117 1-800-223-2882
 - 4. Xylem Leopold, 227 South Division St, Zelenople PA 16063 1-724-452-6300
 - 5. Or Approved Equal

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Filter Media System
- 1. Filter media shall be provided as a compatible system. The media provided by the manufacturer will meet the individual requirements identified in this specification as well as the following media system requirements.
 - a. Dual media – For dual media filters, the manufacturer shall confirm prior to shipment that the following criteria is met.
 - 1) Anthracite d90 size/Sand ES ratio of 3.25 (+/- 0.25) ~~2.8—3.2~~
 - 2) L/d ratio > 1,000
- B. Number of filters: As shown on the Drawings.
- C. Filter Description: As shown on the Drawings.

2.3 MATERIALS

- A. General:
- 1. Material to conform to AWWA B100 as modified herein.
 - 2. Screen all material through standard sieves conforming to ASTM E11.
- B. Silica Sand Media:
- 1. Material Properties:
 - a. Conform to AWWA B100 as modified herein.
 - b. Composed of hard, durable, uncoated silica grains, containing not more than 1% of flat or elongated particles free of clay, loam, silt, and organic matter.
 - c. Maximum acid solubility: 5% in accordance with AWWA B100
 - d. Maximum permissible percentage loss on ignition: 2%.
 - e. Specific gravity: 2.65 (+/- 0.05).
 - 2. Gradation:
 - a. Effective size (d_{10}) (mm): 0.45-0.55 ~~0.50 to 0.54~~.
 - b. Uniformity coefficient (UC): < 1.40.
 - c. Porosity (max): 0.45.
 - 3. Filter Sand Layer:

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- a. Thickness: as shown on drawings after all required washing and scraping.
 - 1) Thickness tolerance: -0 and +1/2 inches tolerance after installation and washing.
- C. Anthracite Media:
 - 1. Material Properties:
 - a. Conform to AWWA B100 as modified herein.
 - b. Composed of hard and durable grains substantially free of iron sulfides, clay, shale, or extraneous dirt.
 - c. Acid solubility: <2% when tested in accordance with AWWA B100.
 - d. Caustic solubility: <5% solubility by weight in one% hot (190 degrees F) sodium hydroxide solution when tested in accordance with AWWA B100.
 - e. Minimum hardness: ~~2.7 3-0~~ on the MOH scale.
 - f. Specific gravity: 1.65 (+/- 0.0~~53~~).
 - g. Dry processed.
 - h. Hardgrove grindability index: less than or equal to 38 as determined by ASTM D409.
 - 2. Gradation:
 - a. Effective size (d₁₀) (mm): 0.95 to ~~1.05 0.99~~.
 - b. Uniformity coefficient (UC): <1.40.
 - c. Maximum Particle Diameter: 2.00 MM.
 - d. Minimum particle Diameter: 0.65 MM.
 - 3. Filter Anthracite Layer:
 - a. Thickness: As shown on drawings after all required washing and scraping.
 - 1) Layer thickness tolerance: zero-minus and one-half IN plus tolerance after installation and washing.

2.4 SOURCE QUALITY CONTROL

- A. Laboratory Testing:
 - 1. Test and submit analyses from test laboratory with the following information:
 - a. Silica sand:
 - 1) Gradation, including effective size, uniformity coefficient and shape factor.
 - 2) Average apparent specific gravity.
 - 3) Acid and caustic solubility.
 - 4) Loss on ignition.
 - b. Anthracite:
 - 1) Gradation, including effective size, uniformity coefficient and shape factor.
 - 2) Average apparent specific gravity.
 - 3) Acid solubility.
 - 4) Solubility in hot, one% sodium hydroxide.
 - 5) MOH hardness.
 - 2. Supplier to pay all costs for media testing prior to shipment of the media.

2.5 MAINTENANCE MATERIALS

- A. Extra Materials:
 - 1. Supply, as necessary, ~~at least 15% of~~ additional each type of filter media of each type ~~by volume~~ to account for variations in filter box dimensions and media loss due to washing and scraping in order to produce a level, full depth media (as shown herein) profile after all initial cleaning and backwashing activities are complete.
 - 2. All excess media to become property of Owner.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Media Removal:
 - 1. Remove existing media from the filters.

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- a. Methods used shall not damage the existing underdrains, backwash water troughs, surface wash piping, handrails, access ladders, level probes, nor any other structural, electrical, instrumentation, architectural, and mechanical appurtenances of the filters.
 2. Media removed from filters shall be legally disposed of offsite by contractor.
 3. Exercise caution when support gravel begins to appear in excavation.
 4. Wash down basin walls and surfaces as media is removed.
 5. **No more than one filter may be removed from service at a pumping station for filter work with a maximum of two filters out of service across Owner's production system.**
 6. A filter must be complete and put back into service prior to removing the next filter from service, unless approved otherwise by the Owner.
- B. Before placing media, ensure all structural repairs are complete and fully cured.
- C. Thoroughly clean filter box prior to placement of filter materials in accordance with AWWA C653, Section 4.1 and AWWA B100.
- D. Do not place media until backwashing system is fully installed and tested.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. General
1. Place filter materials in accordance with AWWA B100 as modified herein.
 2. Ensure against damage to filter underdrains and backwash mechanisms during installation.
 - a. Repair or replacement of these systems if damaged by Contractor's operations will be at no additional cost to Owner.
 3. Maintain clean environment throughout installation.
 4. Level lines shall be placed on all sides of the filter basin designating the top elevation of each media layer.
 5. Install in a manner which prevents contamination from any source.
 6. Prevent disturbance of previously installed layers.
 7. Do not stand or walk directly on media; utilize boards or plywood to distribute weight without disturbing media.
 8. Smooth top of each layer after installation.
 9. Filter media depth shall be measured after the completion of backwashing and skimming.
- C. Filter Sand Placement:
1. Provide for expansion of filter sand media due to segregation of different particle sizes by placing 10 to 15% less media depth than specified prior to inundation.
 2. Place remainder of specified depth after the filter has been thoroughly washed but prior to scraping.
 3. Repeat backwashing to bring excess fine material to the surface prior to scraping.
 4. After placement, wash filter sand at least 3 times with the Engineer present.
 - a. Minimum duration: 10 minutes each.
 - b. Initial wash rate not to exceed 2 gpm/SQFT.
 - c. Gradually increase over a three-minute period to a maximum of 15 GPM/SQFT and maintain for seven minutes. Verify backwash rates with Engineer
 - d. At the conclusion of each wash cycle, reduce flow rate to that which gives 10% bed expansion and maintain for at least 30 seconds to properly re-stratify the media.
 - e. Repeat until sand is clean and no further discoloration appears.
 5. Scrape off and remove fine-grained materials that accumulate at surface of bed at end of each backwash period.
 - a. Minimum depth of scraping: 1/2 inches, 1/4 inches, and 1/8 inches for successive washes.
 - b. Continue scraping and wasting operations until filter sand remaining in filter contains no more than 10% by weight of sand smaller than the specified effective size (d_{10}).
 - c. Place sufficient excess material to anticipate this requirement.

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6. If necessary, add additional sand to bring the bed up to the required mark
 - a. Slowly refill filter, backwash and re-skim fines.
- D. Anthracite Placement:
1. Do not place anthracite media until filter sand in that cell has been skimmed and the final grain size distribution has been accepted by Engineer.
 2. Place anthracite with the filter partially filled with water in a manner so as not to disturb the top layer of sand.
 3. After anthracite placement, wash filter at least three times, with the Engineer present.
 - a. Minimum duration: 10 minutes each.
 - b. Initial wash rate not to exceed 2 gpm/SQFT.
 - c. Gradually increase over a three-minute period to a maximum of 18 GPM/SQFT and maintain for seven minutes.
 4. Scrape off and remove fine-grained materials that accumulate at surface of bed at end of each backwash period.
 - a. Minimum depth of scraping: 3/4 inches, 1/2 inches, and 1/4 inches for successive washes.
 - b. Continue scraping and wasting operations until filter sand remaining in filter contains no more than 10% by weight of sand smaller than the specified effective size (d_{10}).
 - c. Place sufficient excess material to anticipate this requirement.
 5. If necessary, add additional anthracite to bring the bed up to the required mark.
 - a. Slowly refill filter, backwash and re-skim fines.
- E. Disinfection:
1. Disinfection of each filter will be performed by Owner at the completion of media installation.
 2. The next filter can not be removed from service until the current filter has passed bacteriological testing and the filter has been put back into service.

3.3 FIELD QUALITY CONTROL

- A. Supplier's Field Services:
1. Supplier shall employ and pay for five service days for media supplier representative services.
 2. Supplier's field representative shall:
 - a. Inspect and verify proper installation of filter media as specified and per supplier's recommendations.
 - b. Confirm correct depths of filter media installed by performing core sampling in each filter cell.
 - c. Supervise installation of media in first filter.
 - d. Assist in initial filter start-up.
 - e. Assist in field test of filter media.
 - f. Submit a certification of proper installation.
- B. Field Testing of Media by Owner:
1. Owner **may** conduct independent testing of media (prior to installation) in accordance with AWWA B100 to **assure the shipped material is in compliance with specifications**.
 2. Filter media not meeting the criteria specified herein will be rejected and replaced at no cost to the Owner.

END OF SECTION

SECTION 46 61 19
WASH WATER TROUGHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Wash water troughs (fiberglass reinforced plastic (FRP) and stainless steel), media retention baffles, mounting equipment and appurtenances for a complete installation.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01 33 00 – Submittal Procedures
 - 2. Section 46 61 23 – Filter Underdrain Systems

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Water Work Association (AWWA):
 - a. F101, Contact-Molded, Fiberglass-Reinforced Plastic Wash-Water Troughs and Launders, latest edition.
 - b. F102, Matched-Die Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles and Mounting Brackets, latest edition.
 - 2. National Sanitation Foundation/American National Standards Institute (NSF/ANSI):
 - a. 61, Drinking Water System Components - Health Effects.
 - 3. Tennessee Department of Environment and Conservation (TDEC):
 - a. Community Public Water Systems Design Criteria.
- B. Qualifications:
 - 1. Manufacturer's Qualifications: Manufacturer shall have experience in designing and manufacturing wash water troughs of similar size and configuration to those specified herein. For the manufacturer to be determined acceptable for providing these products on this project, they must show evidence of a minimum of five installations and five years of experience in the design and manufacturer of stainless steel wash water troughs of similar size and type as specified herein.

1.3 SYSTEM DESCRIPTION

- A. Media retention baffles (both to the FRP troughs and as a stainless steel product) shall be offered as an alternative bid. Baffles may be provided by a separate manufacturer under the following conditions:
 - 1. The trough manufacturer and media retention baffle manufacturer must submit documentation showing that the two products are compatible with each other.
 - 2. The combined product is required to provide the same level of warranty as outlined in Section 3.5.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Acknowledgement that products submitted meet requirements of NSF61 and AWWA requirements (if applicable).
 - 2. Certified drawings showing dimensions, project specific layout drawings, construction details and materials used for fabrication.
 - 3. Information and instructions for the storage, handling, installation and inspection of the products.
 - 4. Factory test results.
 - 5. If trough manufacturer does not manufacture media retention baffles, documentation from the baffle manufacturer shall be submitted documenting that media retention baffles are compatible with the submitted wash water troughs.

REVISED

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle the products in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 FRP WASH TROUGHS

- A. Manufacturers
 - 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. Warminster Fiberglass Company.
 - b. NEFCO.
 - c. MFG Water Treatment Products.
 - d. **Xylem-Leopold**
 - e. Or approved equal.
- B. Materials, Performance and Design Requirements
 - 1. Wash Water Troughs:
 - a. Comply with AWWA F101 and F102 except as modified herein.
 - b. Products shall comply with NSF/ANSI 61, Drinking Water System Components – Health Effects and the Safe Drinking Water Act.
 - c. Application (liquid): Potable water.
 - d. Application (process): Gravity filter wash water troughs.
 - e. Operating temperature range when in service: 40 degrees F to 90 degrees F.
 - f. Operating temperature range when out of service: 30 degrees F to 100 degrees F.
 - g. FRP products shall be Type 1 fabrications.
 - h. FRP products shall be aqua in color.
 - i. FRP products shall incorporate ultraviolet stabilizers.
 - j. All cut edges are to be resin sealed, including holes drilled in filed by Contractor.
 - k. Troughs shall be designed to have 2 inches of freeboard during max flow conditions as noted in 2.1.C.
 - l. An integrally molded waterstop shall be provided on the trough when the trough is grouted into or passes through a wall.
 - m. FRP Troughs shall be U-Shaped, ~~Square or V-shaped~~. Trough sizing depths in drawings are for U-Shaped troughs. Any trough submitted shall have the following information submitted:
 - 1) Calculations show water level in trough at max flow rates noted in 2.1.C.
 - 2) Cross section of the troughs shall be similar so that no major modifications to the filter structure are required.
 - 3) Cut sheets indicating that the height of the trough shall still satisfies the requirement of the 50% expanded bed depth shall not come in contact with the bottom of the trough.
 - 4) **Basis of Design shall be Xylem Leopold**
 - n. **For Bid Alternative No. 1 – FRP** Troughs shall be equipped with media retention baffles.
 - 1) Media retention baffles shall be constructed of 304 stainless steel and thickness shall be determined by manufacturer.
 - 2) Baffles shall arrive on site preassembled with the wash water trough.
 - 3) Troughs shall connect to the side of the wash water troughs and not be of an elevation lower than the bottom of the wash water trough
 - 4) **Basis of Design (BOD) shall by Xylem Leopold Trough Guard.**
- C. Requirements specific to Wash Water Troughs:
 - 1. Flow conditions:
 - a. **Backwash and Filtration Design Criteria**
 - b. **Air Scour Rate: 3-4 SCFM/ft2**

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- c. Maximum Water Wash Rate, Water Only: 25 gpm/ft²
 - d. Expected Water Wash Rate, Water Only: 22 gpm/ft²
 - e. Water Wash Rate, Concurrent with Air: 6 gpm/ft²
 - f. Filtration Rate: 4.0 gpm/ft²
 - g. Backwash flow capacity at peak flow conditions:
 - 1) Mallory Pumping Station: 20,000 GPM.
 - 2) Davis Pumping Station: 22,50 GPM.
 - 3) Morton Pumping Station: 24,000 GPM.
 - 4) McCord Pumping Station: 20,000 GPM.
 - 5) Shaw Pumping Station: 24,000 GPM.
 - h. Estimated Trough lengths (Each Cell/Total)
 - 1) Mallory Pumping Station: 4 Each/32 Total/480' Total Trough Length
 - 2) Davis Pumping Station: 6 Each/ 96 Total/1,200' Total Trough Length
 - 3) Morton Pumping Station: 6 Each/48 Total/576' Total Trough Length
 - 4) McCord Pumping Station: 6 Each/48 Total/634' Total Trough Length
 - 5) Shaw Pumping Station: 6 Each/48 Total/634' Total Trough Length
2. Loadings: The troughs shall be designed to support, within stress and deflection limitations the following loadings:
- a. Gravity Load
 - 1) Downward vertical loads shall include the weight of the trough and all attachments, such as weir plates, media retention baffles and spreader bars. Any additional loads related to the troughs shall be considered.
 - b. Buoyant Load
 - 1) The buoyant load shall act vertically upward. Its magnitude equal to the weight of the water displaced (minus the weight of the trough).
 - c. Lateral Load
 - 1) Loads acting against the trough side walls. Specifically, the loads induced by differential water levels on either side of the trough walls.
 - d. Thermal Stresses
 - 1) Troughs shall be designed to accommodate temperature stresses resulting in thermal expansion based off in and out of service conditions listed above.
 - e. Torsional stiffness
 - 1) Trough system and its supports shall be designed to resist torsional movement induced by the flow of water over the trough edges.
 - f. Deflection
 - 1) Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to $L/1000$ where L is defined as the unsupported trough length, in inches. Vertical deflection shall not be greater than 3/16" at the midpoint between two trough supports.
 - 2) Maximum trough sidewall deflection shall not exceed $D/100$, where D is the inside trough depth in inches. This shall not exceed 3/16".
3. Stabilizers and related mounting hardware shall be designed by the trough manufacturer. If media retention baffles are not manufactured by trough manufacturer, the trough manufacturer shall design stabilizer and mounting hardware that are sufficient to support both pieces of equipment as one assembly.

2.2 STAINLESS STEEL TROUGHES

A. Manufacturers

- 1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - a. Leopold, A Xylem Company.
 - b. Orthos Liquid Systems.
 - c. Kurita Water – Tonka Products
 - d. Or Approved Equal.

REVISED

- B. Basis of Design (BOD)
1. Stainless Steel trough BOD is the Orthos Poseidon Ortho-Wash troughs with media baffling troughs.
- C. Wash Water Troughs
1. FRP trough with stainless steel media retention baffles does not meet this specification.
 2. Products shall comply with NSF/ANSI 61, Drinking Water Systems Components – Health Effects and the Safe Drinking Water Act.
 3. Wash Water troughs and connections from a single supplier to ensure complete and operable wash trough systems.
 4. Application (liquid): Potable water.
 5. Application (process): Gravity filter wash water troughs.
 - ~~6. Troughs shall be constructed of 304 stainless steel.~~
 7. Each Wash Water trough shall be provided with media deflector baffles to prevent loss of media during combined air and water backwash. Baffles shall be attached to the wash troughs using stainless steel bolts and supports. The baffles shall be designed to resist oscillations caused by flow of water over the trough edges. Baffle to baffle and trough to baffle stabilizers shall be furnished as required by the manufacturer. The baffle system along with all spreaders, hangers, support rods and appurtenant structural items shall be Type 304/304L stainless steel.
 8. The entire trough along with all spreaders, hangers, support rods, and appurtenant items shall be Type 304/304L stainless steel.
 9. Operating temperature range when in service: 40 degrees F to 90 degrees F.
 10. Operating temperature when out of service: 30 degrees F to 100 degrees F.
 11. Troughs shall be designed to have 2 inches of freeboard during max flow conditions as noted in 2.2.C.
 12. An integrally molded waterstop shall be provided on the trough when the trough is grouted into or passes through a wall.
 13. Troughs shall be equipped with media retention baffles.
 - a. Media retention baffles shall be constructed of 304 stainless steel and thickness shall be determined by manufacturer.
 - b. Baffles shall arrive on site preassembled with the wash water trough.
 - c. Troughs shall be attached to the side of the wash water troughs and not have a bottom elevation lower than the bottom of the wash water trough.
 14. Troughs may be U-shaped, Square or V-shaped. Trough sizing depths in drawings are for U-shaped troughs. Any trough submitted shall have the following information submitted:
 - a. Calculations showing water level in the trough at max flow rates noted in 2.2.C
 - b. Cross section of the troughs shall be similar so that no major modifications to the filter structure are required.
 - c. Cut sheets indicating that the height of the trough shall still satisfy the requirement of 50% expanded bed depth does not come in contact with the bottom of the wash water trough.
- D. Requirements specific to Wash Water Troughs:
1. Flow Conditions
 - a. Backwash and Filtration Design Criteria
 - 1) Air Scour Rate: 3-4 SCFM/ft²
 - 2) Maximum Water Wash Rate, Water Only: 25 gpm/ft²
 - 3) Expected Water Wash Rate, Water Only: 22 gpm/ft²
 - 4) Water Wash Rate, Concurrent with Air: 6 gpm/ft²
 - 5) Filtration Rate: 4.0 gpm/ft²
 - b. Flow capacity at peak flow conditions:
 - 1) Mallory Pumping Station: 1,550 GPM.
 - 2) Davis Pumping Station: 2,550 GPM.
 - 3) Morton Pumping Station: 1,750 GPM.
 - 4) McCord Pumping Station: 1,500 GPM.

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- 5) Shaw Pumping Station: 2,000 GPM.
2. Loadings: The troughs shall be designed to support, within stress and deflection limitations the following loadings:
 - a. Gravity Load
 - 1) Downward vertical loads shall include the weight of the trough and all attachments, such as weir plates, media retention baffles and spreader bars. Any additional loads related to the troughs shall be considered.
 - b. Buoyant Load
 - 1) The buoyant load shall act vertically upward. Its magnitude equal to the weight of the water displaced (minus the weight of the trough).
 - c. Lateral Load
 - 1) Loads acting against the trough side walls. Specifically, the loads induced by differential water levels on either side of the trough walls.
 - d. Thermal Stresses
 - 1) Troughs shall be designed to accommodate temperature stresses resulting in thermal expansion based off in and out of service conditions listed above.
 - e. Torsional stiffness
 - 1) Trough system and its supports shall be designed to resist torsional movement induced by the flow of water over the trough edges.
 - f. Deflection
 - 1) Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to $L/1000$ where L is defined as the unsupported trough length, in inches. Vertical deflection shall not be greater than $3/16''$ at the midpoint between two trough supports.
 - 2) Maximum trough sidewall deflection shall not exceed $D/100$, where D is the inside trough depth in inches. This shall not exceed $3/16''$.
3. Stabilizers and related mounting hardware shall be designed by the trough manufacturer. If media retention baffles are not manufactured by trough manufacturer, the trough manufacturer shall design stabilizer and mounting hardware that are sufficient to support both pieces of equipment as one assembly.

2.3 ACCESSORIES

- A. Attachment hardware for any supplied troughs shall be 316 stainless steel and supplied by the manufacturer.

2.4 SOURCE QUALITY CONTROL

- A. Factory Inspection:
 1. Owner or Engineer shall be allowed to inspect the fabrication process and witness the factory testing. Provide a minimum of two weeks' notice to Owner prior to scheduling the factory testing.

PART 3 - EXECUTION

3.1 PREPARATION AND DELIVERY

- A. Troughs shall be packaged and delivered to prevent damage during delivery and while stored on site.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Top installation of troughs shall be at the same elevation as the existing troughs.
- C. Top elevation of troughs shall be installed level with $\pm 1/8''$ per 10 ft. of length.

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3.3 FIELD QUALITY CONTROL

- A. Wash water troughs shall be carefully aligned and leveled to the elevations shown on the Drawings.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Trough manufacturer, if different than the underdrain manufacturer, shall supply a manufacturer's qualified representative for an amount of time equal to the underdrain field services requirements stated in Section 46 61 23 or 46 61 23A, depending on the selected underdrain style.
- B. Representative shall be present at the jobsite to ensure proper installation of media retention troughs.
- C. Representative shall check completed installations and alignment of troughs and baffles.
- D. Representative shall provide a certification of proper installation for each facility.

3.5 WARRANTY

- A. All parts shall be guaranteed for a period of 1 year from the date of final acceptance by the Owner.
- B. Troughs shall be guaranteed that no more than 1" of filter media is lost from the filter bed per year. Initial filter media depths will be recorded upon substantial completion and submitted to the Owner. Filter media depths shall be taken again 120 days after substantial completion of the filter. If the loss rate of media is greater than 1" of media per year, Contractor shall replace the defective components, if any, and replenish missing filter media.

END OF SECTION