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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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AIR AND GAS DIFFUSION SYSTEM

05/21

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AIR AND GAS DIFFUSION SYSTEM
05/21

NOTE: This guide specification covers the requirements for air supply and diffusion equipment for sewage treatment plants.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature

to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 9	(2015) Load Ratings and Fatigue Life for Ball Bearings
ABMA 11	(2014) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 6011	(2014J) Specifications for High Speed Helical Gear Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2012) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.3	(2021) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2022) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX	(2017; Errata 2018) BPVC Section IX-Welding, Brazing and Fusing Qualifications

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110/A21.10	(2021) Ductile-Iron and Gray-Iron Fittings
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115/A21.15	(2020) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm) and Larger
AWWA C207	(2018) Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C208	(2022) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C500	(2019) Metal-Seated Gate Valves for Water Supply Service
AWWA C504	(2015) Standard for Rubber-Seated Butterfly Valves

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A480/A480M	(2023) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A524/A524M	(2021) Standard Specification for Seamless Carbon Steel Pipe for Atmospheric and Lower Temperatures
ASTM A530/A530M	(2012) Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
ASTM A554	(2021) Standard Specification for Welded Stainless Steel Mechanical Tubing
ASTM A774/A774M	(2014; R 2019) Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

ASTM A778/A778M	(2022) Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products
ASTM B98/B98M	(2013) Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B584	(2022) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM D1785	(2015; E 2018) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2310	(2006; R 2012) Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D2992	(2012) Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
ASTM D2996	(2017) Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.13	(2015) Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
IEEE C57.13	(2016) Standard Requirements for Instrument Transformers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-80	(2019) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1	(2022) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 3	(2005; R 2010) Medium-Voltage Controllers Rated 2001 to 7200 V AC
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment
UL 845	(2021) UL Standard for Safety Motor Control Centers

1.2 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes

following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Equipment Installation

Drawings as specified.

SD-03 Product Data

Materials and Equipment

SD-06 Test Reports

Field Testing

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals; G[, [_____]]

1.3 QUALITY CONTROL

1.3.1 Qualifications

Welding procedures and welders are required to be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 MATERIALS SUBMITTALS

Submit a complete list of equipment and materials, including manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, proposed diagrams, installation instructions and other sheets. Spare parts data for each different item of material and equipment specified, after approval of the related submittals, and not later than [_____] months prior to the date of beneficial occupancy. Include a complete list of parts and supplies, with current unit prices and source of supply.

1.4.1 Standard Products

Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of such products and which essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment in required to be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.4.2 Nameplates

Include on each major item of equipment the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

1.4.3 Special Tools

Provide one set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment.

1.4.4 Factory Painting

Unless otherwise specified, clean, prime, and give two coats of machinery enamel to all equipment at the factory. Fiberglass, stainless steel, and galvanized components need not be painted.

1.5 DELIVERY, STORAGE, AND HANDLING

Ensure all equipment delivered and placed in storage is stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

An air and gas diffusion system consists of Air Supply Equipment, the Air Distribution System, the Air Diffusers, and other Miscellaneous Equipment, as specified herein.

2.2 EQUIPMENT

2.2.1 Air-Supply Equipment

The air-supply consists of [multi-stage] [_____] [centrifugal] [and] [or] [positive displacement] air blowers and drive units with filters, controls, and appurtenances as indicated or specified.

2.2.1.1 Centrifugal Blowers

****
NOTE: Blowers should be identified on the drawings by type and operating characteristics.
****

2.2.1.1.1 Performance and Design Requirements

Provide blowers that are [multistage] [single stage] centrifugal, oil-free types designed for continuous duty with [closed backward-bladed] [open

radial-bladed] impellers. Provide with performance and design requirements as shown.

2.2.1.1.2 Casing

Provide centrifugal blowers of modular design with the casing either vertically or horizontally split and with the required number of compression stages to comply with the specified operating requirements. Machine all horizontally split casings at the split to be tight without a gasket. Vertically split casings are to include rigid cast iron sections held securely between cast iron inlet and outlet heads by steel tie rods. Provide tapped and plugged drains at the lowest points of the casing. Ensure inlet and discharge connections comply with ASME B16.1 [Class 125] [125 pound] [_____] drilled and tapped flanges and are an integral part of the head. Provide casing with lifting eyes capable of supporting blower.

2.2.1.1.3 Impellers

****

NOTE: Other impeller materials, such as steel, are available. Consult with various manufacturers for recommendations.

****

Provide impellers cast of high grade [aluminum alloy] [steel], mounted and keyed to the shaft and secured by a locknut. Install impeller hubs to be butted against each other either directly or through one piece metal spacers. Provide ample clearance between the impeller and casing. Test each impeller by operating at a speed to [20] [_____] percent above operating speed and check for cracks using the dye penetrant method or similar method of equal accuracy. Ensure the impeller and shaft assembly are statically and dynamically balanced as a unit. Removing of metal from the impeller by boring is not an acceptable means of balancing the impeller and shaft unit. Vibration is not allowed to exceed 0.025 mm 1.0 mil at the bearing housing with the blower operating. First critical speed is required to be at least 150 percent of maximum operating speed.

2.2.1.1.4 Diffusers

Provide diffuser vanes, cast into each section of the blower casing, to receive air from the impeller and direct the air to the next impeller for multi-stage type blowers.

2.2.1.1.5 Shaft

Provide a shaft of ground and polished high grade [high alloy steel] [carbon steel][stainless steel] of sufficient diameter to operate below first critical speed.

2.2.1.1.6 Shaft Seals

Provide solid carbon ring shaft seals where the shaft passes through the inlet and discharge heads. Design seals to permit seal inspection or replacement without disconnecting suction or discharge piping.

2.2.1.1.7 Internal Seals

Provide labyrinth type seals between stages.

2.2.1.1.8 Bearings

****
NOTE: Delete inapplicable lubrication method.
Verify bearing L-10 life requirements.
****

Provide each blower with two [pressure oil lubricated sleeve type journal] [splash oil lubricated anti-friction type] bearings. Design bearings for both radial and thrust loads and size for an L-10 life of 5 years continuous operation as defined by ABMA 9 or ABMA 11. Design bearings to allow replacement without disassembling the blower casing or disconnecting piping.

2.2.1.1.9 Pressure Oil Lubrication System

Provide a console mounted pressure lubrication system to oil the sleeve bearings. The lubrication system consists of a main oil pump mounted on and driven by the blower shaft, an auxiliary electric motor driven oil pump, an oil cooler, an oil filter, a 3-minute retention time oil reservoir, and all required switches, temperature sensors, and gauges. Ensure the electric motor driving the auxiliary oil pump has Class F insulation, Type NEMA Design B, in accordance with NEMA MG 1, and is totally enclosed fan cooled; equipped with 120 volts space heaters; and controlled in accordance with NEMA ICS 1. Completely pipe the lubrication system and wire with only interconnecting piping between the console and the pump required in the field.

2.2.1.1.10 Splash Oil Lubrication System

Provide a simple splash lubrication system with each bearing having its own oil reservoir integral with the bearing housing. Maintain proper oil level by a constant level oiler located on each bearing housing. Provide a slinger on the shaft to splash oil into the bearing when the compressor is running. Provide a sight level gauge in the bearing housing. Provide a labyrinth seal combined with an atmospheric vent to prevent oil contamination of the air stream.

2.2.1.1.11 Inlet Guide Vanes

Provide inlet guide vanes for each single stage centrifugal blower.

2.2.1.1.12 Centrifugal Blower Speed Increasing Gears

Provide high speed, single stage centrifugal gears made of hardened, helical, alloy steel, manufactured in accordance with AGMA 6011 with a minimum 1.5 service factor applied to full horsepower rating of blower.

2.2.1.2 Positive Displacement Blowers

****
NOTE: Blowers should be identified on the drawings
by type and operating characteristics.
****

2.2.1.2.1 Performance and Design Requirements

Provide positive displacement rotary blowers, oil-free types, designed for continuous duty. Performance and design requirements are to be as shown.

2.2.1.2.2 Casing

Provide a one piece blower casing with separate head plates constructed of close-grained cast iron, suitably ribbed to prevent distortion under the specified operating conditions. Fabricate casing with lifting eyes for installation and maintenance purposes.

2.2.1.2.3 Impeller and Shaft

Provide impeller and shaft constructed of a common ductile iron casting. Provide impellers of the straight, two-lobe involute type that operate without rubbing, liquid seals, or lubrication. Ensure the peak vibration velocity of blower is less than 7.62 mm/second 0.30 inch/second.

2.2.1.2.4 Timing Gears

Positively time impellers by a pair of machined, heat-treated, spur tooth timing gears. Mount timing gears on the impeller shafts on a tapered fit and secured by a locknut.

2.2.1.2.5 Bearings

****
NOTE: Verify bearing L-10 life requirements.
****

Support impeller shaft by antifriction [spherical ball] [roller] bearings sized for a minimum L-10 life of [30,000] [50,000] hours as defined by ABMA 9 or ABMA 11.

2.2.1.2.6 Seals

Provide a lip type oil seal at each bearing to prevent lubricant from leaking into the air stream. Provide labyrinth seals at the point where the shaft passes through the head. Provide ventilation of the impeller side of the oil seals to atmosphere to eliminate any carry-over of lubricant into the air stream.

2.2.1.2.7 Lubrication

****
NOTE: Delete inapplicable lubrication system. Use bracketed sentences if "pressure oil lubricated" is to be used in the lubrication system.
****

Provide drive and bearings of the [grease lubricated type and also provide with a grease fitting] [splash oil lubricated type]. Provide timing gears and gear end bearings of the [pressure oil lubricated type] [splash oil lubricated type]. Regulate oil level by a metering orifice.

[If using a full pressure lubrication system built into positive displacement blower, direct connect to oil pump and include oil strainer, oil reservoir, piping to bearings, and oil spray for gears with piping to air-to-oil cooler. Design oil vents so that oil vapors do not enter motor. Design system to prevent leakage and dirt contaminants.]

2.2.1.3 Drive Connection

****
NOTE: Verify cubic meter/second cfm increments for additional sheaves.
****

[Connect the blower to the motor by a heavy-duty flexible forged steel spacer coupling, keyed or locked to the shaft.] [Connect the blower to the motor by a V-belt drive capable of transmitting the motor power to the blower. Provide additional sheaves so that the blowers output can be varied in [0.189] [_____] cubic meter/second [40] [_____] cfm increments between minimum and maximum flow conditions.] Cover the drive with an acoustically treated sheet metal guard.

2.2.1.4 Motors

Size motors to be within their rated load under the specified operating conditions. Ensure all motors conform to NEMA MG 1 and are the squirrel cage induction Type NEMA Design B, Class B or F insulated, with a service factor of not less than 1.15. Motors are required to be horizontal foot-mounted, totally enclosed fan-cooled, cast iron or aluminum construction and a quiet series type with a noise level not exceeding 80 dB (A Scale). The motor frame is required to be the standard NEMA assigned frame size supplied for constant speed use on full voltage, fixed frequency line power. Provide resistance temperature detectors (RTD's) embedded in two phases of the stator windings. Provide motor bearings with a minimum L-10 life of 50,000 hours.

2.2.1.5 Power Factor Capacitors

Equip all motors over 3.7 kW 5 hp with power factor correcting capacitors. Furnish capacitors complete with internal fusing and bleed-off resistors. Provide for a corrected power factor of not less than 95 percent at full load. Install capacitors in enclosures coordinated with the individual motor construction with leads terminated in the motor terminal box and identified as capacitor leads. Provide overcurrent device settings within the motor controls that are properly reduced for the motor and capacitor combination.

2.2.1.6 Blower - Motor Base

Provide a full length common base of steel box construction for the blower and drive. Ensure the base is suitable for direct attachment to the foundation. Provide anchor bolts, [anti-vibration strips,] and grout as required for proper installation.

2.2.1.7 Concrete Foundation

Provide a concrete foundation as indicated. Ensure the foundation is entirely separated from the surrounding floor. Provide concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.2.1.8 Filters

****
NOTE: Consult diffuser manufacturers to verify the percent efficiency required for the diffusers specified. Use of prefilter blanket increases

filter life.

Delete the last sentence for warm climate projects.
****

Provide filters of the [washable dry type,] [disposable dry type,] rated to be at least 90 percent efficient when tested in compliance with ASHRAE 52.2 dust spot method. Ensure filter has at least 0.093 square meter 1 sq. ft. of filter area per 0.0118 cubic meter/second 25 cfm of air flow. Use polyester felt filter material with 25 mm 1 inch pleat separation. For filters located outside of the building, provide a weather hood designed to keep rain, snow, and other foreign articles away from the filter element. Design the weather hood for inlet velocities between the hood and the filter element of 2.54 m/second 500 ft/min or less. Provide a manometer or differential pressure gauge on the filter unit to indicate when the filter element requires cleaning or replacing. [Provide a filter element by-pass with counter-weighted doors to prevent destruction of the element in the event freezing moisture clogs the filter].

2.2.1.9 Accessories

****
NOTE: Consult the blower manufacturer to determine silencer requirements.
****

2.2.1.9.1 Silencers

Provide each blower with [inlet] [and] [discharge] silencers. Provide silencers for [standard] [critical] grade silencing. Provide intake silencers of the [chamber] [absorption] type. Provide discharge silencers of the [chamber] [absorption] [combination chamber-absorption] type. Size silencer as recommended by the silencer manufacturer and ensure compatibility with the blower requirements. Ensure silencer connections match the adjacent piping. Provide mounting brackets as required for silencer support. Construct silencer of heavy-duty rolled and welded steel plate with inner liner properly welded to outer shell for purpose of deadening outer shell.

2.2.1.9.2 Acoustical Insulation

Wrap silencers, [interior air piping,] [expansion joints,] [valves,] [and] [drive guards] with 25 mm 1 inch thick high density woven glass fiber mat having a minimum density of 4.6 kg/square meter 15 ounces/square foot and lag with a 0.41 mm 0.0l6 inch thick aluminum jacket. Comply with EPA requirements in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.

2.2.1.9.3 Gauges

Provide gauges that comply with ASME B40.100. Ensure inlet gauges have a range of [0 to 762 mm] [_____] [0 to 30 inch] [_____] water gauge vacuum. Ensure outlet gauges have a range of [0 to 103 kPa] [_____] [0 to 15 psi] [_____]. Provide all accessories for [control panel] [wall] [pipe] mounting of the gauges.

2.2.1.9.4 Thermometers

Provide thermometers to indicate [inlet air temperature,] [discharge air temperature,] [lubrication oil temperature,] [and] [diffuser point of discharge temperature for three locations within the system]. Thermometers of either red-reading mercury-in-glass type or dial type are acceptable. Provide a scale range covering the full range of expected operation and up to 125 percent, but not more than 150 percent of maximum.

2.2.1.9.5 Temporary Screens

Provide a temporary screen, consisting of 16-mesh wire backed up by 6.4 mm 1/4 inch hardware cloth, at the blower inlet connection. Remove the screens after initial blower start-up and testing.

2.2.1.9.6 Inlet and Discharge Elbows

Provide inlet and discharge elbows of the long sweep type constructed of cast iron with ASME B16.1, Class 125 flanges.

2.2.1.9.7 Expansion Couplings

Provide couplings of the extra heavy gauge rubber, wire reinforced type suitable for temperature range of -29 to plus 121 degrees C -20 to plus 250 degrees F and pressure range from 381 mm 15 inch of mercury vacuum to 103 kPa 15 psig.

2.2.1.10 Manual Control System

****

NOTE: Delete inapplicable control system. NEMA 3R and NEMA 4 Types are exterior panel types.

****

Provide each blower with a control panel containing all starters, circuit breakers, disconnects, and other equipment required for manual starting and stopping of the blower. Ensure controls and motor control centers conform to NEMA ICS 1, NEMA ICS 2, NEMA ICS 3, NEMA ICS 4, NEMA ICS 6, UL 508, and UL 845. Ensure circuit breakers conform to IEEE C37.13. Provide the control panel in a NEMA 250, [Type 12] [Type 3R] [Type 4] enclosure. Ensure all materials and construction complies with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

2.2.1.11 Automatic Control and Monitoring System

****

NOTE: Delete inapplicable control system.

****

Provide each blower with an automatic control and monitoring system to control start-up and shut-down sequences, to indicate various operation parameters, and to actuate blower protective devices. All accessory devices are required to be operated through this system.

2.2.1.11.1 Panel Construction

****

NOTE: NEMA 3R and NEMA 4 Types are exterior panel types.

****

Enclose the automatic control and monitoring system in a NEMA 250, [Type 12] [Type 3R] [Type 4] panel and that is completely wired and tested with internal connections being made on terminal blocks. Provide a power supply to the control panel rated at [_____] volts ac, [_____] phase, 60 Hz to a [_____] amp flange mounted disconnect. Derive internal voltages, including [120] [_____] volts ac, from the [_____] volts ac, supply. Provide control power transformer rated at [_____] volts primary and [_____] volts secondary with kVA rating as recommended by the manufacturer. Ensure instrument and control transformers comply with IEEE C57.13 and NEMA ST 20.

2.2.1.11.2 Automatic Control

a. Provide automatic controls for all machine parts to ensure proper startup and shutdown sequences. Provide a manual-off-automatic switch for each blower. In addition, provide manual control switches for the [auxiliary oil pump,] [unloading valve,] [and] [inlet butterfly valve]. Ensure the manual control switches are active only when the selector switch is in the manual position. When the selector switch is in the automatic position, initiate the control system sequence startup of the blower as follows:

   (1) Start auxiliary oil pump and allow to run for 3 minutes.

   (2) Open unloading valve and close inlet butterfly valve.

   (3) Start main drive motor.

b. When the motor reaches full speed, open the inlet butterfly valve and close the unloading valve. Open the inlet butterfly valve to a minimum set point slightly above the surge point. Control the inlet butterfly valve from then on by a 4 to 20 mA dc signal from the control system to maintain the desired flow. When the shaft-driven main oil pump reaches specified pressure setting, stop the auxiliary oil pump.

c. Upon turning the selector switch to the off position, initiate the control panel sequence shutdown of the blowers as follows:

   (1) Open the unloading valve and close the inlet butterfly valve.

   (2) De-energize the drive motor.

d. When the shaft-driven oil pump pressure drops, start the auxiliary oil pump and allow to run for [30] [_____] minutes to provide for post lubrication and cooling.

2.2.1.11.3 Indicators

Provide the following indicators, mounted on the control panel:

a. Inlet and outlet pressure gauges.

b. Valve position indicators for the unloading valve (open or closed) and the inlet butterfly valve (in percentage open).

c. Inlet air volume in cfm indicator. Provide an ammeter measuring the

current draw of the blower motor and calibrated so that a given amount of current draw correspond to the volume of air being handled by the blower.

d. Lights to indicate the auxiliary oil pump is running and is as required for the protective devices.

2.2.1.11.4 Blower Protective Devices

a. All blower protective devices, upon alarm condition, are required to cause immediate de-energization of the motor, initiation of the automatic shutdown sequence, and provide audible and visual alarm indication. Equip positive displacement blowers with automatic pressure relief valve.

b. Provide bearing temperature protection consisting of encapsulated temperature switches in milled slots directly over each blower bearing, a control relay, a selector switch and test pushbuttons, and a running light. Upon excessively high temperature of any bearing, initiate protective shutdown and indicate which bearing is affected.

c. Provide a protective device to prevent the blower from operating in a surge condition. Initiate automatic blower shutdown sequence when the blower is reduced to surge volume as indicated by motor current draw and give visual indication of reason for shutdown. Provide an override as necessary for blower startup and shutdown.

d. Provide a system to control blower overload by opening and closing the inlet [butterfly valve] [inlet guide vanes on single stage centrifugal blower] based upon the current draw of the motor. The system is required to monitor motor current input to a suitably conditioned and set-point controller.

2.2.1.11.5 Vibration Monitoring

Provide vibration pick-ups for motor and blower bearings. Provide vibration monitoring system on control panel. Equip centrifugal blowers with radial and axial vibration monitoring. Monitor consists of front panel and circuit board and includes switches for display of signal and alarm levels, LED indicators for annunciation of OK and alarm status, calibration and alarm adjustments, and connectors for output signals.

2.2.1.11.6 Control Logic

Provide control logic to monitor dissolved oxygen level signals and select the number and [inlet guide vane setting for single stage centrifugal blowers] [rotation speed of positive displacement blowers] to provide for sufficient air to maintain desired dissolved oxygen level in aeration tank(s).

2.2.2 Air Distribution System

Provide a system, including piping, valves, and supports to distribute air from the blowers to the air diffusers. Ensure the system is of adequate capacity for the intended purpose and is adjustable for balancing of air distribution.

2.2.2.1 Air Main

Supply the air main from the blowers to the air supply assemblies as indicated. Provide eccentric reducers at each change in air main diameter. Ensure the crown of the air main is maintained at the same elevation for the full length of the tank. Provide fittings as indicated. For air main piping 150 mm 6 inches in diameter and larger, provide be ductile iron or Schedule 40 steel pipe. For air main piping less than 150 mm 6 inch in diameter, provide ductile iron or Schedule 40 galvanized steel pipe. Provide hangers and supports as required for a complete installation.

2.2.2.2 Removable Header Air Distribution System

****
NOTE: Delete inapplicable header types and materials of construction.
****

Provide removable header air distribution systems as indicated that consist of an air supply assembly, removable header assembly, and supports. Ensure the system is compatible with the air main and the specified diffusers.

2.2.2.2.1 Air Supply Riser Assembly

****
NOTE: Include this paragraph if distribution system is mounted on a T-wall.
****

Provide an air supply riser assembly for each removable header to connect the drop leg to the air main. The riser assembly consists of a vertical pipe projecting from the air main through a floor sleeve cast in the concrete T-wall, an elbow, a butterfly valve between the elbow and the drop leg, and required supports and anchors.

2.2.2.2.2 Air Supply Lateral Assembly

****
NOTE: Include this paragraph if distribution system is mounted on a Y-wall.
****

Provide an air supply lateral assembly for each removable header to connect the drop leg to the air main. The lateral assembly consists of piping, a butterfly valve, and required supports and anchors.

2.2.2.2.3 Removable Header Assembly

The removable header assembly consists of a drop leg and a header. The upper end of the header assembly contains a 90 degree elbow with face ring and neoprene gasket for connection to the air supply assembly. The connection to the air supply assembly is required to be a [quick coupling flange][grooved coupling system]. Provide a flanged connection for the lower end of the drop leg for connection to the header. Provide welded end caps and a beveled flange on the headers for connection to the drop leg. Provide diffuser connectors for field installation of diffusers. Design the removable header assembly to withstand a vertical load that

results in a moment of 56.5 Nm 500 inch-pounds at the diffuser connection without permanent deformation. Provide lifting lugs on the assembly as required for removal of the header. Fabricate the removable header assembly of stainless steel or galvanized steel as follows:

a. Stainless Steel Systems: Fabricate the removable header assembly from 304L stainless steel complying with ASTM A240/A240M. Ensure drop legs and headers have a nominal wall thickness of 2.78 mm 0.1094 inch (12 gauge). Use the header dimensions as indicated with dimensional tolerances complying with ASTM A530/A530M and ASTM A554. Fabricate welded wrought stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure all interior weld beads are smooth, evenly distributed, with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld areas with stainless steel brushes. After fabrication, passivate the assembly by pickling and ensure it is completely neutralized. Use nickel plated ductile iron for the quick-coupling flange and equip with a stainless steel hinge pin. Provide anchor bolts made of 303 stainless steel.

b. Galvanized Steel Systems: Fabricate the removable header assembly from Schedule 40 steel pipe conforming to ASTM A53/A53M. Perform all welding in the shop. Ensure all butt welds are full penetration welds with an interior projection not exceeding 2 mm 1/16 inch. Ensure welding conforms to AWS D1.1/D1.1M. Hot-dip galvanized the assembly after fabrication. Provide anchor bolts made of 303 stainless steel. Use nickel plated ductile iron for quick-coupling flange and equip with a stainless steel hinge pin.

2.2.2.2.4 Supports and Guides

Support removable header by two adjustable supports with vee-shaped guides. Fabricate supports from 6 mm 1/4 inch steel plate and provide at least 25 mm 1 inch vertical adjustment. The supports are required to support the weight of the assembly so that the quick-coupling can be easily disconnected.

2.2.2.3 Rotary or Swing Header Air Distribution System

****
NOTE: Delete inapplicable header types and materials of construction.
****

Provide rotary or swing header air distribution systems as indicated consisting of an air supply assembly, rotary or swing-type air header assembly, and supports. Ensure system compatibility with the air main and the specified diffusers.

2.2.2.3.1 Air Supply Assembly

Provide an air supply assembly for each rotary or swing header to connect the upper swing joint to the air main. The assembly consists of the required pipe and fittings, a butterfly valve, and a combination connector and support for the upper swing joint.

2.2.2.3.2 Rotary or Swing Header Assembly

The rotary or swing header assembly consists of an upper swing joint, a knee joint, hanger pipes, and a header. The upper swing joint connects to the air supply assembly and includes connectors for field installation of diffusers. Design the rotary or swing header assembly to withstand a vertical load that results in a moment of 56.5 Nm 500 in-lb at the diffuser connection without permanent deformation. Provide lifting lugs on the assembly as required to lift the header assembly out of the tank. Fabricate the rotary or swing header assembly of stainless steel systems, carbon steel systems, galvanized steel systems, or fiberglass systems as follows:

a. Stainless Steel Systems: Provide upper swing joint and knee joint of cast stainless steel. Connect between the two sections by means of a stainless steel pin working in a graphite bronze bushing. Provide graphite impregnated cast bronze bearings complying with ASTM B584. Provide seal rings with labyrinth grooves between the two joint sections. Provide a grease fitting to lubricate the seal rings. Provide an adjustable stop to prevent the knee joint from opening beyond 180 degrees. Fabricate the hanger pipes and air headers from 304L stainless steel in accordance with ASTM A240/A240M. Fabricate the upper hanger pipes from Schedule 10S. Fabricate the hanger pipes from Schedule 5S. Fabricate air header pipes from 12 gauge. Provide header dimensions as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Fabricate welded wrought stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure interior weld beads are smooth, evenly distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld areas with stainless steel brushes. After fabrication, passivate the assembly by pickling and ensure it is completely neutralized. Weld the hanger pipes to the upper swing joint and knee joint. Flange connect the header pipe to the hanger pipe. Weld diffuser connectors to the header. Provide the header with welded end caps.

b. Carbon Steel Systems: Provide the upper swing joint and knee joint of cast steel. Connect between the two sections by means of a stainless steel pin working in a graphite bronze bushing. Use graphite impregnated cast bronze bearings in accordance with ASTM B584. Provide brass seal rings with labyrinth grooves between the two joint sections. Provide a grease fitting to lubricate the seal rings. Provide an adjustable stop to prevent the knee joint from opening beyond 180 degrees. Fabricate the hanger and header pipes from schedule [40] [80] carbon steel pipe in accordance with ASTM A524/A524M. Provide header dimensions as indicated. Perform welding in the shop. After fabrication, paint the assembly with the manufacturer's standard finish. Weld the hanger pipes to the upper swing joint and knee joint. Connect the header pipe to the hanger pipe. Weld diffuser connectors to the header. Provide the header with welded end caps.

c. Galvanized Steel Systems: Provide the upper swing joint and knee joint made from cast iron. Connect between the two sections by means of a stud equipped with a spring to maintain seal between the faces. Use graphite impregnated bronze seal rings and bearings in accordance with ASTM B584. Provide grease fittings for lubrication. Fabricate

the hanger and header pipes from schedule [40] [80] galvanized steel pipe in accordance with ASTM A53/A53M. Provide header dimensions as indicated. The header consists of two lengths of pipe, flange connected to a cast iron tee. Screw connect the hanger pipes to the upper swing joint and knee joint, and flange connected to the header tee. Weld the diffuser connectors to the header. Provide the header with gasketed, screwed end caps.

d. Fiberglass Systems: Provide the upper swing joint and knee joint of the trunnion sleeve type manufactured of glass reinforced synthetic resin capable of continuously operating in pH levels of 5.0 to 9.0 and at gas temperatures up to 108 degrees C 225 degrees F. Rib all areas of high stress to provide increased strength. Provide each rotating bearing surface with ring type air seals. Hold the assemblies together by a 13 mm 1/2 inch diameter stainless steel rod with locking nuts. Fabricate the hanger and header pipes from reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. Provide pipe in accordance with the following: 275.8 MPa 40,000 psi minimum hoop stress; 65.5 MPa 9,500 psi minimum tensile strength; 131.0 MPa 19,000 psi minimum axial compression strength; minimum 55 Barcol hardness; 54.75 degree wind angle; 2.8 mm 0.110 inch minimum wall thickness. Provide ultraviolet protection for the pipe material. Provide liner resin that is 85 to 89 percent resin with glass filler and at least 0.51 mm 0.020 inch thick. Use filled epoxy adhesive joints. Provide header dimensions as indicated. Flange connect the hanger to the header.

2.2.2.3.3 Supports and Guides

Provide supports and guides as required for support and leveling of the header.

2.2.2.4 Fixed Header Air Distribution System

****
NOTE: Delete inapplicable header types and materials of construction.
****

Provide a fixed header air distribution as indicated consisting of a drop leg assembly, fixed headers, and supports. Ensure the system is compatible with the air main and the specified diffusers.

2.2.2.4.1 Drop Leg Assembly

Provide a drop leg assembly to connect the fixed headers to the air main. Provide the assembly of the dimensions indicated.

2.2.2.4.2 Fixed Headers

Provide fixed headers of the dimensions and configuration indicated. Provide header connections of a type allowing rotational adjustment of individual header sections of sufficient strength to transmit the longitudinal forces caused by expansion and contraction of the header. Design the headers to allow expansion and contraction up to a maximum temperature of 52 degrees C 125 degrees F without damage to the system. Prevent rotation of the header due to thermal expansion and contraction. Provide fixed headers of stainless steel systems or fiberglass systems as follows:

a. Stainless Steel Systems: Fabricate all welded parts of the system from 304L stainless steel in accordance with ASTM A240/A240M. [Provide stainless steel pipe with a 2D finish in accordance with ASTM A480/A480M.] Provide pipe wall thickness as follows: for 250 mm 10 inch diameter and less, supply 1.59 mm 0.0625 inch (16 gauge) thick pipe; for 300 mm 12 inch diameter, supply 1.98 mm 0.0781 inch (14 gauge) thick pipe; for 350 mm 14 inch through 450 mm 18 inch diameter, supply 2.78 mm 0.l094 inch (12 gauge) thick pipe; for 500 mm 20 inch diameter, supply 3.18 mm 0.1250 inch (11 gauge) thick pipe; for 600 mm 24 inch diameter, supply 3.57 mm 0.1406 inch (10 gauge) thick pipe. Provide header dimensions as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Fabricate welded stainless steel fittings and welded stainless steel tubular products in accordance with ASTM A774/A774M and ASTM A778/A778M. Perform all welding in the shop. Add filler wire to all welds to provide a cross section equal to the parent material. Ensure butt welds have full penetration to the interior surface. Ensure interior weld beads are smooth, evenly distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Wire brush outside weld area with stainless steel brushes. Prior to fabrication, passivate each part of the assembly by pickling and ensure it is completely neutralized. Provide bolts, washers, follower flanges, and other non-welded parts made of 304 stainless steel. Provide low silicon bronze nuts in accordance with ASTM B98/B98M.

b. Fiberglass Systems: Provide reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. All pipe is required to be in accordance with the following: 65.5 MPa 9,500 psi minimum tensile strength; 110.3 MPa 16,000 psi minimum axial compression strength; minimum 55 Barcol hardness; 54.75 degree wind angle; 2.8 mm 0.110 inch minimum wall thickness. Provide ultraviolet protection for the pipe material. Use liner resin with 85 to 89 percent resin with glass filler and is at least 0.51 mm 0.020 inch thick. Use filled epoxy adhesive joints. Provide header dimensions as indicated. Provide a 25 mm 1 inch drain leg at each end of each section of pipe.

2.2.2.4.3 Support System

Provide a system for support and anchoring of the header. Ensure the system is compatible with the expansion and contraction control design. Ensure the support system provides for a minimum of 100 mm 4 inch vertical adjustment and 25 mm 1 inch lateral adjustment of the header. Contour the system to fit the bottom 90 degrees of the pipe while maintaining a bearing surface at least 50 mm 2 inch wide.

2.2.2.5 Lagoon Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

2.2.2.5.1 Fixed Air Distribution Headers

Provide fixed air distribution headers to connect the air main to the lagoon aeration diffuser tubing. Construct header and feeder piping using PVC with flanged or threaded connections. Provide one of the following

types of air distribution systems:

a. Dual Header System: The system consists of a dual header supported above the side slopes, one on each side of the lagoon with feeder tubes connecting to each end of the diffuser tubing.

b. Single Header System: The system consists of a single header, supported above the lagoon bottom in the center of the lagoon with feeder tubes connecting to one end of the diffuser tubing.

2.2.2.5.2 Supports

Provide adjustable supports that allow free longitudinal movement with little or no lateral or vertical movement for the air header piping. Ensure all ferrous metal in the support system is galvanized.

2.2.2.5.3 Airlift Purge System

Provide a plastic airlift, complete with integral plastic air jet. Include air supply tubing and piping connected to the main air header. Provide a control valve on the air supply pipe.

2.2.2.5.4 Gas Cleaning System

Provide a complete system as required for gas cleaning of the air diffusion system. Provide a single valve to control flow to all points.

2.2.3 Diffusers

****

NOTE: Aeration tanks should be identified on the drawings. Diffuser performance requirements should be inserted. Maximum allowable headloss should not exceed 14 inches of water.

****

2.2.3.1 Diffuser Performance

a. Provide an air flow rate of [_____] standard L/second/28.3 cubic meters scfm/1000 cubic feet of tank volume.

b. Provide an oxygen transfer rate of [_____] kg pounds of oxygen per day per 28.3 cubic meters 1000 cubic feet of tank volume at the specified air flow rate in clear water at 20 degrees C 68 degrees F and zero dissolved oxygen.

c. Set maximum allowable headloss in the system to [_____] mm inch of water, excluding submergence.

2.2.3.2 Porous Diffusers

****

NOTE: Delete inapplicable types of diffusers and materials of construction.

The mean permeability rating of the porous diffusers will be inserted. The permeability rating is defined as the number of cubic meters per second cfm of air, at 21 degrees C 70 degrees F and 10 to 25

percent relative humidity, that will pass through 0.093 square meter 1 square foot of diffuser area to the atmosphere, under a differential pressure equivalent to 508 pascals 2 inches of water below the plate or within the tube when it is tested dry in a room maintained at a temperature of 21 degrees C 70 degrees F and a relative humidity between 30 and 50 percent. To date, this is the accepted method of measuring the ability of porous diffuser media to diffuse air and provide a desirable rate of oxygen absorption. Lower permeability should produce smaller bubbles, which should result in higher rates of oxygen absorption. Lower permeability rating, however, requires higher air pressure and results in more rapid clogging and higher pressure losses. Consequently, any benefits obtained initially by specifying a permeability rating may be offset by the higher maintenance and operating costs. The best balance between desired oxygen absorption and operating and maintenance cost is afforded by a permeability rating of from 0.203 to 0.406 40 to 80. Non-porous diffusers do not have a permeability rating.

****

Provide one of the following types of diffusers with a mean permeability rating of [_____]:

2.2.3.2.1 Porous Ceramic Discs

Provide porous ceramic plate diffusers composed of silica sand bonded together with a synthetic silicate, fused alumina, or an organic bond; grains of crystalline aluminum oxide bonded with high alumina glass; aluminum silicate grains ceramically bonded at high temperature; crushed porcelain grains bonded together with alumina glass or electrically fused aluminum grains bonded together with alumina glass. Ensure all diffuser plates provide [_____] square mm square inch of horizontal diffuser area.

2.2.3.2.2 Porous Membrane Tubes with Supports

Provide porous membrane media composed of a tubular flexible synthetic membrane sheath that is open at one end and closed at the other. Ensure the tubular sheath fits over a tubular air duct/air plenum frame or is supported by a one-piece semicircular corrosion resistant support rod. Clamp the sheath to a nozzle with a corrosion resistant removable clamp. Ensure the sheath is capable of flexing from its unexpanded shape to its expanded inflated convex hollow cylindrical shape when air is diffused through it to slough foulants. Ensure apertures of the sheath close whenever the air flow is shut off and purge themselves when air is restarted. Supply each diffuser with a check valve for wastewater backflow prevention. Ensure the nozzle is compatible with the diffuser connector on the air header.

2.2.3.2.3 Porous Cloth Media with Plastic Tube Liner

Provide porous cloth media composed of a tubular flexible synthetic fiber cloth sheath that is open at one end and closed at the other. The media fits over a plastic tube liner and is clamped to a cast iron nozzle with a stainless steel clamp. Vinyl coat the cast iron nozzle, except for the

threads attaching it to the header. Provide diffuser media [_____] mm inch in length and a diameter of [_____] mm inch.

2.2.3.3 Non-Porous Diffusers

****
NOTE: Delete inapplicable types of diffusers and materials of construction.
****

2.2.3.3.1 Nozzle-Type Diffusers

Provide one of the following nozzle type diffusers:

a. Diffuser consisting of a molded plastic body with four high velocity, short tube orifices, each discharging at right angles to the adjacent orifice. [Equip the diffuser with a deflector ring above the discharge orifices and include a control orifice to ensure proper headloss.]

b. Diffuser consisting of molded plastic and including a top piece containing inverted V-shaped air shear slots and an upward sloping air deflector and a bottom piece containing a control orifice and an air header connector.

2.2.3.3.2 Orifice-Type Diffusers

Provide one of the following non-valved orifice type diffusers:

a. Diffuser constructed of stainless steel and consisting of a balancing nozzle, an inverted air reservoir, air exit ports located on horizontal planes on two levels, and a deflector. Ensure the deflector directs the liquid along the diffuser's outer walls.

b. Diffuser consisting of an open bottom, molded plastic, rectangular box containing tapered air release holes. Ensure air entering the diffuser is controlled by a control orifice.

c. Diffuser consisting of an elongated, peaked dome air chamber with steep inverted V-shaped serrations on both sides. Ensure air exiting the header is controlled by an orifice.

2.2.3.3.3 Valved Orifice Diffusers

Provide one of the following valved orifice diffusers:

a. Diffuser consisting of a molded plastic body with an air flow control orifice and a PVC disc cap retained by a stainless steel ring.

b. Diffuser consisting of a stainless steel body containing a control orifice, a polytetrafluroethylene ball, and a stainless steel deflector disc.

c. Diffuser consisting of a molded plastic body with air release orifices, a ball check valve, and a screw-in cap that allows varying the quantity of orifices through which air can exit.

d. Diffuser consisting of a cone-shaped plastic base with a flexible elastomer cover held in place by a center bolt.

e. Diffuser consisting of a rubber body with a molded control orifice (pinch valve) that is normally closed and is actuated by specific pressures applied to the backside of the diffuser.

2.2.3.4 Lagoon Aeration Diffuser Tubing

****
NOTE: Delete inapplicable types of diffusers and materials of construction.
****

Use [13] [_____] mm [1/2] [_____] inch inside diameter flexible polyethylene diffuser tubing containing small, precise, orifices or slots in the lower side of the tubing at [38] [_____] mm [1-1/2] [_____] inch maximum spacing. Ensure the orifice is small enough to prevent particulate matter from flowing through the orifice during negative diffuser pressure. Pre-weight the diffuser by a continuous lead strip in the bottom of the tube encapsulated in polyethylene.

2.2.3.5 Spare Diffusers

****
NOTE: The percentage of replacements required will be inserted. A sound policy would require sufficient media to enable the operator to replace all media in any one aeration tank.
****

Furnish not less than [_____] percent of the installed quantity of diffusers as replacements. Furnish diffusers complete with all parts required for installation.

2.2.4 Materials and Equipment

Ensure materials and equipment conform to the following respective publications and other specified requirements.

2.2.4.1 Ductile Iron Pipe and Fittings

Provide ductile iron pipe conforming to AWWA C115/A21.15 or AWWA C151/A21.51. Provide thickness class as follows: Class 51 for pipe up to 100 mm 4 inch diameter and over 750 mm 30 inch diameter; Class 51 for pipe 150 mm 6 inch through 600 mm 24 inch diameter. Provide mechanical joints that conform to AWWA C111/A21.11 as modified by AWWA C151/A21.51. Provide flanged joints that conform to AWWA C115/A21.15. Provide fittings that conform to AWWA C110/A21.10. Ensure all buried piping has standard bituminous coating and lining.

2.2.4.2 Steel Pipe and Fittings

Provide steel pipe 150 mm 6 inch in diameter and larger in accordance with AWWA C200. Provide steel pipe less than 150 mm 6 inch in diameter with threaded end, galvanized, in accordance with ASTM A53/A53M, standard weight. Ensure mechanical joints conform to AWWA C200. Ensure flanged joints conform to AWWA C207. Provide fittings for steel pipe 150 mm 6 inch in diameter and larger in accordance with AWWA C200 and fabricated in accordance with AWWA C208. For steel pipe less than 150 mm 6 inch in diameter, provide galvanized fittings in accordance with ASME B16.3.

2.2.4.3 Polyvinyl Chloride (PVC) Pipe and Fittings

****
NOTE: The Designer must use caution when specifying PVC air piping. PVC pipe and fitting use is normally reserved for low pressure, low temperature environments where ultraviolet exposure is limited. PVC tends to become brittle with age and even air pressures much lower than the rated pressure class of the pipe can cause catostrophic failure.
****

Ensure PVC pipe and fittings conforming to ASTM D1785, Schedule [40] [80] [120], or ASTM D2241, SDR [2l] [26] [32.5]. Use solvent weld joints conforming to ASTM D2564.

2.2.4.4 Stainless Steel Tubing and Fittings

Unless shown or specified otherwise, provide stainless steel tubing in accordance with the following.

2.2.4.4.1 Stainless Steel Tubing

Ensure stainless steel tubing conforms to ASTM A778/A778M. Provide wall thicknesses as follows: tubing 250 mm 10 inch diameter and less, provide 1.59 mm 0.0625 inch (16 gauge) thick tubing; tubing 300 mm 12 inch diameter, provide 1.98 mm 0.078 inch (14 gauge) thick tubing; tubing 350 mm 14 inch through 450 mm 18 inch diameter, provide 2.78 mm 0.109 inch (12 gauge) thick tubing; tubing 500 mm 20 inch diameter, provide 3.17 mm 0.125 inch (11 gauge) thick tubing; tubing 600 mm 24 inch diameter, provide 3.57 mm 0.140 inch (10 gauge) thick tubing.

2.2.4.4.2 Stainless Steel Tubing Fittings

Provide stainless steel tubing fittings conforming to ASTM A774/A774M, grade and schedule or wall thickness as specified for tubing.

2.2.4.4.3 Stainless Steel Tubing Joints

Fabricate stainless steel tubing joints by shop welding full penetration butt joints or Van Stone joints using angle face rings with backing flanges drilled in accordance with ASME B16.5, Class 125.

2.2.4.5 Pipe Hangers and Supports

Provide pipe hangers and supports conforming to MSS SP-58.

2.2.4.6 Valves

2.2.4.6.1 Butterfly Valves

Ensure butterfly valves and operators conform to AWWA C504, air service class [25A] [_____], flanged or mechanical joint ends as required.

2.2.4.6.2 Gate Valves

Ensure gate valves conform to AWWA C500, flanged or mechanical joint ends as required.

2.2.4.6.3 Globe Valves

Ensure globe valves conform to MSS SP-80, Type 3, Class 150.

2.2.4.6.4 Relief and Unloading Valves

Provide combination relief and unloading valves with [carbon steel] [_____] body, that allow blower unloading for startup, and are set for pressure relief at [_____] kPa psig.

2.2.4.6.5 Check Valves

Provide check valves of double door type, flange or wafer style, capable of handling 862 kPa 125 psig cold working pressure (CWP) with cast iron body and aluminum bronze internal parts, low torque spring for low pressure air service. Ensure seal material is capable of handling temperatures from -29 to plus 121 degrees C -20 to plus 250 degrees F with tight shutoff capability.

2.2.4.7 Expansion Couplings

Construct expansion couplings for nonsubmerged locations in the aeration system of materials suitable for temperatures up to 121 degrees C 250 degrees F and pressures up to 103 kPa 15 psig. Use couplings of the filled arch type. Provide back-up or retaining rings as required. Yoke couplings to transmit tension loadings. Ensure the compressive and lateral movement of the joint is not impaired by the yoke system.

2.2.5 Hoist

****

NOTE: Coordinate with type of air distribution system specified. Delete steering attachment where not required.

****

Provide portable hoist designed to raise and lower the [removable] [rotary or swing] air distribution system. Hoist is to be furnished by the aeration system manufacturer. Mount the hoist on wheels or casters [and provide a suitable steering attachment]. Power the unit by [hand] [hand pump] [battery operated motor] [air operated motor] [electric motor] [gasoline engine]. Provide a means to hook the hoist in place during the hoisting operation. Equip the lifting arm with a quick latching arrangement to securely grip the air diffusion unit without the use of tools. Provide a hoist of sufficient capacity for the required service.

2.2.6 Metering and Instrumentation

****

NOTE: Insert section number and title or delete sentence and insert metering and instrumentation requirements.

****

Metering and instrumentation is specified in Section [_____].

2.2.7 Purge System

****
NOTE: Coordinate specific purge system requirements with equipment manufacturer.
****

Provide a purge system incorporated into the aeration system. Locate purge valves at the low points in the system to allow bleeding off of condensed water that builds up in the air piping. Purge valves may be incorporated into an automatic pump system when low points occur below water level.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.2 EQUIPMENT INSTALLATION

Submit drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show in the drawings proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

3.2.1 Blower Installation

Install blowers as indicated and in accordance with the manufacturer's written instructions.

3.2.2 Air Distribution System Installation

****
NOTE: The range of adjustment of the system on the header is dependent on various design parameters such as header size and basin shape and size. Consult various manufacturers for proper dimension.
****

Install the air distribution system as indicated and in accordance with the manufacturer's written instructions. Perform all excavation, trenching, and backfilling in accordance with the applicable requirements of Section 31 00 00 EARTHWORK. Maintain the crown of the air main at the same elevation. Adjust the system such that all diffusers on a header are within [_____] mm inch of a common horizontal plane.

3.2.3 Diffuser Installation

Install diffusers as indicated and in accordance with the manufacturer's written recommendations.

3.2.4 Framed Instructions

Post framed instructions containing wiring and control diagrams under

glass or in laminated plastic where directed. Show wiring and control diagrams and complete layout of the entire system in the instructions. Also include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation and procedures for safely starting and stopping the system. Post the framed instructions acceptance testing of the system.

3.2.5 Welding

****
NOTE: Retain the applicable welding requirements.
****

[Weld piping in accordance with qualified procedures using performance qualified welders and welding operators. Ensure the procedures and welders are qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer are acceptable to the extent permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests perform all tests at the work site if practical. Instruct the welder or welding operator to apply his assigned symbol near each weld he makes as a permanent record. Weld structural members in accordance with AWS D1.1/D1.1M.] [Welding and non-destructive testing procedures are specified in Section 40 05 13.96 WELDING PROCESS PIPING.]

3.2.6 Electrical Work

Ensure all electrical work is performed in accordance with the National Electric Code (NFPA 70, Latest Edition).

3.3 FIELD QUALITY CONTROL

3.3.1 Field Testing

Submit performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate the final position of controls in each test report.

3.3.1.1 Blower Test

After the air distribution and diffusion systems have been installed, test each blower at the specified operating conditions to determine compliance with the specifications and proper operation.

3.3.1.2 Piping System Test

Test all piping with air at a minimum of two times the normal design pressure for at least 60 minutes and such additional time as is required for the Contracting Officer to inspect the piping for leaks. Repair all leaks and retest and the system until no leakage is discovered.

3.3.1.3 Diffuser Test

After diffuser installation, cover the diffusers with clear water to a depth of approximately 600 mm 2 feet. Release air through the diffusers and inspect the system for uniform air distribution. Replace diffusers as required to obtain uniformity.

3.3.2 Manufacturer's Services

Provide the services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified. Ensure that the representative supervises the installation, adjustment, and testing of the equipment.

3.4 CLOSEOUT ACTIVITIES

3.4.1 Field Training

Provide a field training course for designated operating and maintenance staff members. Provide training for a total period of [_____] hours of normal working time and start training after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the operating and maintenance manuals in the field training.

3.4.2 Operating and Maintenance Manuals

Provide [six] [_____] copies of operation and [six] [_____] copies of maintenance manuals for the equipment furnished. Submit one complete set prior to performance testing and the remainder upon acceptance. Ensure the operating manuals detail the step-by-step procedures required for system startup, operation, and shutdown. Ensure operating manuals include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Ensure the maintenance manuals list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Have all manuals approved prior to the field training course.

3.5 PAINTING

Conduct all field painting as specified in Section 09 90 00 PAINTS AND COATINGS.

-- End of Section --