UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

SECTION TABLE OF CONTENTS

DIVISION 46 - WATER AND WASTEWATER EQUIPMENT

SECTION 46 51 00.00 10

AIR AND GAS DIFFUSION EQUIPMENT

02/11

PART 1 GENERAL

1.1 REFERENCES
1.2 SUBMITTALS
1.3 QUALIFICATIONS
1.4 DELIVERY, STORAGE, AND HANDLING

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT REQUIREMENTS
2.1.1 Standard Products
2.1.2 Nameplates
2.1.3 Special Tools
2.1.4 Factory Painting
2.2 MATERIALS AND EQUIPMENT
2.2.1 Ductile Iron Pipe and Fittings
2.2.2 Steel Pipe and Fittings
2.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings
2.2.4 Stainless Steel Tubing and Fittings
2.2.4.1 Stainless Steel Tubing
2.2.4.2 Stainless Steel Tubing Fittings
2.2.4.3 Stainless Steel Tubing Joints
2.2.5 Pipe Hangers and Supports
2.2.6 Valves
2.2.6.1 Butterfly Valves
2.2.6.2 Gate Valves
2.2.6.3 Globe Valves
2.2.6.4 Relief and Unloading Valves
2.2.6.5 Check Valves
2.2.7 Expansion Couplings
2.3 AIR-SUPPLY EQUIPMENT
2.3.1 Centrifugal Blowers
2.3.1.1 Performance and Design Requirements
2.3.1.2 Casing
2.3.1.3 Impellers
2.3.1.4 Diffusers

2.3.1.5 Shaft
2.3.1.6 Shaft Seals
2.3.1.7 Internal Seals
2.3.1.8 Bearings
2.3.1.9 Pressure Oil Lubrication System
2.3.1.10 Splash Oil Lubrication System
2.3.1.11 Inlet Guide Vanes
2.3.1.12 Centrifugal Blower Speed Increasing Gears
2.3.2 Positive Displacement Blowers
2.3.2.1 Performance and Design Requirements
2.3.2.2 Casing
2.3.2.3 Impeller and Shaft
2.3.2.4 Timing Gears
2.3.2.5 Bearings
2.3.2.6 Seals
2.3.2.7 Lubrication
2.3.3 Drive Connection
2.3.4 Motors
2.3.5 Power Factor Capacitors
2.3.6 Blower - Motor Base
2.3.7 Concrete Foundation
2.3.8 Filters
2.3.9 Accessories
2.3.9.1 Silencers
2.3.9.2 Acoustical Insulation
2.3.9.3 Gauges
2.3.9.4 Thermometers
2.3.9.5 Temporary Screens
2.3.9.6 Inlet and Discharge Elbows
2.3.9.7 Expansion Couplings
2.3.10 Manual Control System
2.3.11 Automatic Control and Monitoring System
2.3.11.1 Panel Construction
2.3.11.2 Automatic Control
2.3.11.3 Indicators
2.3.11.4 Blower Protective Devices
2.3.11.5 Vibration Monitoring
2.3.11.6 Control Logic
2.4 AIR DISTRIBUTION SYSTEM
2.4.1 Air Main
2.4.2 Removable Header Air Distribution System
2.4.2.1 Air Supply Riser Assembly
2.4.2.2 Air Supply Lateral Assembly
2.4.2.3 Removable Header Assembly
2.4.2.4 Supports and Guides
2.4.3 Rotary or Swing Header Air Distribution System
2.4.3.1 Air Supply Assembly
2.4.3.2 Rotary or Swing Header Assembly
2.4.3.3 Supports and Guides
2.4.4 Fixed Header Air Distribution System
2.4.4.1 Drop Leg Assembly
2.4.4.2 Fixed Headers
2.4.4.3 Support System
2.4.5 Lagoon Air Distribution System
2.4.5.1 Fixed Air Distribution Headers
2.4.5.2 Supports
2.4.5.3 Airlift Purge System
2.4.5.4 Gas Cleaning System
2.5 DIFFUSERS

2.5.1 Diffuser Performance
2.5.2 Porous Diffusers
2.5.2.1 Porous Ceramic Discs
2.5.2.2 Porous Membrane Tubes with Supports
2.5.2.3 Porous Cloth Media with Plastic Tube Liner
2.5.3 Non-Porous Diffusers
2.5.3.1 Nozzle-Type Diffusers
2.5.3.2 Orifice-Type Diffusers
2.5.3.3 Valved Orifice Diffusers
2.5.4 Lagoon Aeration Diffuser Tubing
2.5.5 Spare Diffusers
2.6 HOIST
2.7 METERING AND INSTRUMENTATION

PART 3 EXECUTION

3.1 EXAMINATION
3.2 EQUIPMENT INSTALLATION
3.2.1 Blower Installation
3.2.2 Air Distribution System Installation
3.2.3 Diffuser Installation
3.3 WELDING
3.4 FRAMED INSTRUCTIONS
3.5 FIELD QUALITY CONTROL
3.5.1 Field Testing
3.5.1.1 Blower Test
3.5.1.2 Piping System Test
3.5.1.3 Diffuser Test
3.5.2 Manufacturer's Services
3.6 PAINTING
3.7 FIELD TRAINING
3.8 OPERATING AND MAINTENANCE MANUALS

-- End of Section Table of Contents --

****

USACE / NAVFAC / AFCEC / NASA | **UFGS-46 51 00.00 10 (February 2011)**

Preparing Activity: USACE | **Superseding UFGS-44 42 13.00 10 (April 2006)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

****

SECTION 46 51 00.00 10

AIR AND GAS DIFFUSION EQUIPMENT
02/11

****

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	(2016) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5	(2017) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.1	(2020) Power Piping
ASME B40.100	(2013) 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	(2012) Ductile-Iron and Gray-Iron Fittings for Water
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	(2017) Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C500	(20019) 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) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2020) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A240/A240M	(2020) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A480/A480M	(2020a) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
ASTM A524	(1996; R 2012) 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	(2016) 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	(2016) 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	(2014) 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	(2012) 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) 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	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) 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	(2018) Motors and Generators
NEMA ST 20	(2014) Dry-Type Transformers for General Applications

UNDERWRITERS LABORATORIES (UL)

UL 508	(2018) UL Standard for Safety Industrial Control Equipment
UL 845	(2005; Reprint Oct 2018) 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 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under which the welding is specified to be accomplished.

1.4 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT REQUIREMENTS

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. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

2.1.1 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 shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

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

2.1.3 Special Tools

One set of special tools, calibration devices, and instruments required for operation, calibration, and maintenance of the equipment shall be provided.

2.1.4 Factory Painting

Unless otherwise specified, all equipment shall be cleaned, primed, and given two coats of machinery enamel at the factory. Fiberglass, stainless steel, and galvanized components need not be painted.

2.2 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the following respective publications and other specified requirements.

2.2.1 Ductile Iron Pipe and Fittings

Ductile iron pipe shall conform to AWWA C115/A21.15 or AWWA C151/A21.51. Thickness class shall be as follows: up to 100 mm 4 inch diameter and over 750 mm 30 inch diameter shall be Class 5l; 150 mm 6 inch through 600 mm 24 inch diameter shall be Class 50. Mechanical joints shall conform to AWWA C111/A21.11 as modified by AWWA C151/A21.51. Flanged joints shall conform to AWWA C115/A21.15. Fittings shall conform to AWWA C110/A21.10. Buried piping shall have standard bituminous coating and lining.

2.2.2 Steel Pipe and Fittings

Steel pipe 150 mm 6 inch in diameter and larger shall be in accordance with AWWA C200. Steel pipe less than 150 mm 6 inch in diameter shall be threaded end, galvanized, in accordance with ASTM A53/A53M, standard weight. Mechanical joints shall conform to AWWA C200. Flanged joints shall conform to AWWA C207. Fittings for steel pipe 150 mm 6 inch in diameter and larger shall be in accordance with AWWA C200 and shall be fabricated in accordance with AWWA C208. For steel pipe less than 150 mm 6 inch in diameter, fittings shall be galvanized and shall be in accordance with ASME B16.3.

2.2.3 Polyvinyl Chloride (PVC) Pipe and Fittings

PVC pipe and fittings shall conform to ASTM D1785, Schedule [40] [80] [120], or ASTM D2241, SDR [2l] [26] [32.5]. Joints shall be solvent weld joints. Solvent weld joints shall conform to ASTM D2564.

2.2.4 Stainless Steel Tubing and Fittings

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

2.2.4.1 Stainless Steel Tubing

Stainless steel tubing shall conform to ASTM A778/A778M. Wall thicknesses shall be as follows: 250 mm 10 inch diameter and less shall be 1.59 mm 0.0625 inch (16 gauge) thick; 300 mm 12 inch diameter shall be 1.98 mm 0.078 inch (14 gauge) thick; 350 mm 14 inch through 450 mm18 inch diameter shall be 2.78 mm 0.109 inch (12 gauge) thick; 500 mm 20 inch diameter shall be 3.17 mm 0.125 inch (11 gauge) thick; 600 mm 24 inch diameter shall be 3.57 mm 0.140 inch (10 gauge) thick.

2.2.4.2 Stainless Steel Tubing Fittings

Stainless steel tubing fittings shall conform to ASTM A774/A774M, grade and schedule or wall thickness as specified for tubing.

2.2.4.3 Stainless Steel Tubing Joints

Stainless steel tubing joints shall be shop welded full penetration butt joints or Van Stone joints using angle face rings with backing flanges drilled in accordance with ASME B16.5, Class 125.

2.2.5 Pipe Hangers and Supports

Pipe hangers and supports shall conform to MSS SP-58.

2.2.6 Valves

2.2.6.1 Butterfly Valves

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

2.2.6.2 Gate Valves

Gate valves shall conform to AWWA C500, flanged or mechanical joint ends as required.

2.2.6.3 Globe Valves

Globe valves shall conform to MSS SP-80, Type 3, Class 150.

2.2.6.4 Relief and Unloading Valves

Combination relief and unloading valve shall be [carbon steel] [_____] body, shall allow blower unloading for startup, and shall be set for pressure relief at [_____] kPa psig.

2.2.6.5 Check Valves

Check valves shall be 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. Seal material shall be capable of handling temperatures from-29

to plus 121 degrees C -20 to plus 250 degrees F with tight shutoff capability.

2.2.7 Expansion Couplings

Expansion couplings for nonsubmerged locations in the aeration system shall be constructed of materials suitable for temperatures up to 121 degrees C 250 degrees F and pressures up to 103 kPa 15 psig. Couplings shall be of the filled arch type. Back-up or retaining rings shall be provided as required. Couplings shall be yoked to transmit tension loadings. Compressive and lateral movement of the joint shall not be impaired by the yoke system.

2.3 AIR-SUPPLY EQUIPMENT

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

2.3.1 Centrifugal Blowers

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

2.3.1.1 Performance and Design Requirements

Blowers shall be [multistage] [single stage] centrifugal, oil-free types designed for continuous duty with [closed backward-bladed] [open radial-bladed] impellers. Performance and design requirements shall be as shown.

2.3.1.2 Casing

Centrifugal blowers shall be 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. Horizontally split casings shall be machined at the split to be tight without a gasket. Vertically split casings shall consist of rigid cast iron sections held securely between cast iron inlet and outlet heads by steel tie rods. Tapped and plugged drains shall be provided at the lowest points of the casing. Inlet and discharge connections shall be ASME B16.1 [Class 125] [125 pound] [_____] drilled and tapped flanges and shall be an integral part of the head. Casing shall have lifting eyes capable of supporting blower.

2.3.1.3 Impellers

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

Impellers shall be cast of high grade [aluminum alloy] [steel], mounted and keyed to the shaft and secured by a locknut. Impeller hubs shall butt against each other either directly or through one piece metal spacers. There shall be ample clearance between the impeller and casing. Each

impeller shall be tested by being operated at a speed to [20] [_____] percent above operating speed and checked for cracks using the dye penetrant method or similar method of equal accuracy. The impeller and shaft assembly shall be 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 shall not exceed 0.025 mm 1.0 mil at the bearing housing with the blower operating. First critical speed shall be at least 150 percent of maximum operating speed.

2.3.1.4 Diffusers

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

2.3.1.5 Shaft

The shaft shall be ground and polished high grade [high alloy steel] [carbon steel] of sufficient diameter to operate below first critical speed.

2.3.1.6 Shaft Seals

Solid carbon ring shaft seals shall be provided where the shaft passes through the inlet and discharge heads. Seal design shall permit seal inspection or replacement without disconnecting suction or discharge piping.

2.3.1.7 Internal Seals

Labyrinth type seals shall be provided between stages.

2.3.1.8 Bearings

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

Each blower shall be provided with two [pressure oil lubricated sleeve type journal] [splash oil lubricated anti-friction type] bearings. Bearings shall be designed for both radial and thrust loads and sized for an L-10 life of 5 years continuous operation as defined by ABMA 9 or ABMA 11. It shall be possible to replace the bearings without disassembling the blower casing or disconnecting piping.

2.3.1.9 Pressure Oil Lubrication System

A console mounted pressure lubrication system shall be provided to oil the sleeve bearings. The system shall consist 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. The electric motor driving the auxiliary oil pump shall have Class F insulation, Type NEMA Design B, in accordance with NEMA MG 1, and shall be totally enclosed fan cooled; equipped with 120 volts space heaters; and control shall be in accordance with NEMA ICS 1. The lubrication system shall be completely piped and wired with only interconnecting piping between the console and the pump required in the field.

2.3.1.10 Splash Oil Lubrication System

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

2.3.1.11 Inlet Guide Vanes

Inlet guide vanes shall be provided for each single stage centrifugal blower.

2.3.1.12 Centrifugal Blower Speed Increasing Gears

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

2.3.2 Positive Displacement Blowers

****

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

****

2.3.2.1 Performance and Design Requirements

Blowers shall be positive displacement rotary, oil-free types, designed for continuous duty. Performance and design requirements shall be as shown.

2.3.2.2 Casing

Blower casing shall be one piece with separate head plates and shall be of close-grained cast iron, suitably ribbed to prevent distortion under the specified operating conditions. Casing shall be fabricated with lifting eyes for installation and maintenance purposes.

2.3.2.3 Impeller and Shaft

The impeller and shaft shall be a common ductile iron casting. Impellers shall be of the straight, two-lobe involute type and shall operate without rubbing, liquid seals, or lubrication. Peak vibration velocity of blower shall be less than 7.62 mm/second 0.30 inch/second.

2.3.2.4 Timing Gears

The impellers shall be positively timed by a pair of machined, heat-treated, spur tooth timing gears. Timing gears shall be mounted on the impeller shafts on a tapered fit and secured by a locknut.

2.3.2.5 Bearings

****

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

Each impeller shaft shall be supported 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.

2.3.2.6 Seals

A lip type oil seal shall be provided at each bearing to prevent lubricant from leaking into the air stream. Labyrinth seals shall be provided at the point where the shaft passes through the head. Ventilation of the impeller side of the oil seals to atmosphere shall be provided to eliminate any carry-over of lubricant into the air stream.

2.3.2.7 Lubrication

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

Drive and bearings shall be [grease lubricated and provided with a grease fitting] [splash oil lubricated]. Timing gears and gear end bearings shall be [pressure oil lubricated] [splash oil lubricated]. Oil level shall be regulated by a metering orifice.

[Full pressure lubrication system built into positive displacement blower shall be direct connected to oil pump and shall include oil strainer, oil reservoir, piping to bearings, and oil spray for gears with piping to air-to-oil cooler. Oil vents shall be designed so that oil vapors do not enter motor. System shall be designed to prevent leakage and dirt contaminants.]

2.3.3 Drive Connection

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

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

2.3.4 Motors

Motors shall be sized to be within their rated load under the specified operating conditions. Motors shall conform to NEMA MG 1 and shall be the squirrel cage induction Type NEMA Design B, Class B or F insulated, with a service factor of not less than 1.15. Motors shall be horizontal foot-mounted, totally enclosed fan-cooled, cast iron or aluminum construction and shall be a quiet series type with a noise level not

exceeding 80 dB (A Scale). The motor frame shall be the standard NEMA assigned frame size supplied for constant speed use on full voltage, fixed frequency line power. Resistance temperature detectors (RTD's) embedded in two phases of the stator windings shall be provided. Motor bearing shall have minimum L-10 life of 50,000 hours.

2.3.5 Power Factor Capacitors

All motors over 3.7 kW 5 hp shall be provided with power factor correcting capacitors. Capacitors shall be furnished complete with internal fusing and bleed-off resistors. Corrected power factor shall be not less than 95 percent at full load. Capacitors shall be installed in enclosures coordinated with the individual motor construction with leads terminated in the motor terminal box and identified as capacitor leads. Motor controls shall have overcurrent device settings properly reduced for the motor and capacitor combination.

2.3.6 Blower - Motor Base

A full length common base of steel box construction shall be provided for the blower and drive. The base shall be suitable for direct attachment to the foundation. Anchor bolts, [anti-vibration strips,] and grout shall be provided as required for proper installation.

2.3.7 Concrete Foundation

Concrete foundation shall be as indicated. The foundation shall be entirely separated from the surrounding floor. Concrete shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3.8 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.

****

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

2.3.9 Accessories

****

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

2.3.9.1 Silencers

Each blower shall be provided with [inlet] [and] [discharge] silencers. Silencers shall be for [standard] [critical] grade silencing. Intake silencers shall be of the [chamber] [absorption] type. Discharge silencers shall be of the [chamber] [absorption] [combination chamber-absorption] type. Silencer size shall be as recommended by the silencer manufacturer and shall be compatible with the blower requirements. Silencer connections shall match the adjacent piping. Mounting brackets shall be provided as required for silencer support. Silencer shall be constructed of heavy-duty rolled and welded steel plate with inner liner properly welded to outer shell for purpose of deadening outer shell.

2.3.9.2 Acoustical Insulation

Silencers, [interior air piping], [expansion joints,] [valves,] [and] [drive guards] shall be wrapped with 25 mm l inch thick high density woven glass fiber mat having a minimum density of 4.6 kg/square meter 15 ounces/square foot and shall be lagged 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.

2.3.9.3 Gauges

Gauges shall comply with ASME B40.100. Inlet gauges shall have a range of [0 to 762 mm] [_____] [0 to 30 inch] [_____] water gauge vacuum. Outlet gauges shall have a range of [0 to 103 kPa] [_____] [0 to 15 psi] [_____]. Gauges shall include all accessories for [control panel] [wall] [pipe] mounting.

2.3.9.4 Thermometers

Thermometers shall be provided to indicate [inlet air temperature,] [discharge air temperature,] [and] [lubrication oil temperature]. Thermometers shall be either red-reading mercury-in-glass type or dial type. Scale range shall include full range of expected operation and up to 125 percent, but not more than 150 percent of maximum.

2.3.9.5 Temporary Screens

A temporary screen, consisting of 16-mesh wire backed up by 6.4 mm 1/4 inch hardware cloth, shall be provided at the blower inlet connection. The screens shall be removed after initial blower start-up and testing.

2.3.9.6 Inlet and Discharge Elbows

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

2.3.9.7 Expansion Couplings

Couplings shall be 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.

2.3.10 Manual Control System

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

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

2.3.11 Automatic Control and Monitoring System

****
NOTE: Delete inapplicable control system.
****

Each blower shall be provided 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 shall be operated through this system.

2.3.11.1 Panel Construction

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

The automatic control and monitoring system shall be enclosed in a NEMA 250, [Type 12] [Type 3R] [Type 4] panel and shall be completely wired and tested with internal connections being made on terminal blocks. Power supply to the control panel shall be [_____] volts ac, [_____] phase, 60 Hz to a [_____] amp flange mounted disconnect. Internal voltages, including [120] [_____] volts ac, shall be derived from the [_____] volts ac, supply. Control power transformer shall be [_____] volts primary and [_____] volts secondary with kVA rating as recommended by the manufacturer. Instrument and control transformers shall comply with IEEE C57.13 and NEMA ST 20.

2.3.11.2 Automatic Control

a. Automatic controls shall be provided for all machine parts to ensure proper startup and shutdown sequences. A manual-off-automatic switch shall be provided for each blower. In addition, manual control switches shall be provided for the [auxiliary oil pump,] [unloading valve,] [and] [inlet butterfly valve]. Manual control switches shall be active only when the selector switch is in the manual position. When the selector switch is in the automatic position, the control system shall 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, the inlet butterfly valve shall open and the unloading valve shall close. The inlet butterfly valve shall open to a minimum set point slightly above the surge point. The inlet butterfly valve shall then be controlled 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, the auxiliary oil pump shall stop.

c. Upon turning the selector switch to the off position, the control panel shall 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.

2.3.11.3 Indicators

The following indicators shall be provided, 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. The indicator shall be an ammeter measuring the current draw of the blower motor and calibrated so that a given amount of current draw shall 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.

2.3.11.4 Blower Protective Devices

a. All blower protective devices, upon alarm condition, shall cause immediate de-energization of the motor, shall initiate the automatic shutdown sequence, and shall provide audible and visual alarm indication. Positive displacement blowers shall be equipped with automatic pressure relief valve.

b. 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 shall be provided. Upon excessively high temperature of any bearing, the system shall initiate protective shutdown and shall indicate which bearing is affected.

c. A protective device shall be provided to prevent the blower from operating in a surge condition. The device shall initiate automatic blower shutdown sequence when the blower is reduced to surge volume as

indicated by motor current draw and shall give visual indication of reason for shutdown. An override shall be provided as necessary for blower startup and shutdown.

d. A system shall be provided 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 shall monitor motor current input to a suitably conditioned and set-point controller.

2.3.11.5 Vibration Monitoring

Vibration pick-ups shall be provided for motor and blower bearings. Vibration monitoring system shall be provided on control panel. Centrifugal blowers shall have radial and axial vibration monitoring. Monitor shall consist of front panel and circuit board which shall include 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.

2.3.11.6 Control Logic

Control logic shall be provided 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).

2.4 AIR DISTRIBUTION SYSTEM

A system, including piping, valves, and supports shall be provided to distribute air from the blowers to the air diffusers. The system shall be of adequate capacity for the intended purpose and shall be adjustable for balancing of air distribution.

2.4.1 Air Main

The air main from the blowers to the air supply assemblies shall be as indicated. Eccentric reducers shall be provided at each change in air main diameter. The crown of the air main shall be maintained at the same elevation for the full length of the tank. Fittings and valves shall be provided as indicated. Air main piping 150 mm 6 inches in diameter and larger shall be ductile iron or Schedule 40 steel pipe. Air main piping less than 150 mm 6 inch in diameter shall be ductile iron or Schedule 40 galvanized steel pipe. Hangers and supports shall be provided as required for a complete installation.

2.4.2 Removable Header Air Distribution System

****

NOTE: Delete inapplicable header types and materials of construction.

****

Removable header air distribution systems shall be provided as indicated and each shall consist of an air supply assembly, removable header assembly, and supports. The system shall be compatible with the air main and the specified diffusers.

2.4.2.1 Air Supply Riser Assembly

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

An air supply riser assembly shall be provided for each removable header to connect the drop leg to the air main. The riser assembly shall consist 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.

2.4.2.2 Air Supply Lateral Assembly

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

An air supply lateral assembly shall be provided for each removable header to connect the drop leg to the air main. The lateral assembly shall consist of piping, a butterfly valve, and required supports and anchors.

2.4.2.3 Removable Header Assembly

The removable header assembly shall consist of a drop leg and a header. The upper end of the header assembly shall be a 90 degree elbow with face ring and neoprene gasket for connection to the air supply assembly. The connection to the air supply assembly shall be a quick coupling flange. The lower end of the drop leg shall be flanged for connection to the header. Headers shall have welded end caps and a beveled flange for connection to the drop leg. Diffuser connectors shall be provided for field installation of diffusers. The removable header assembly shall be designed to withstand a vertical load that results in a moment of 56.5 Nm 500 inch-pounds at the diffuser connection without permanent deformation. Lifting lugs shall be provided on the assembly as required for removal of the header. Removable header assembly shall be stainless steel systems or galvanized steel systems as follows:

a. Stainless Steel Systems: The removable header assembly shall be fabricated from 304L stainless steel complying with ASTM A240/A240M. Drop legs and headers shall have a nominal wall thickness of 2.78 mm 0.1094 inch (12 gauge). Header dimensions shall be as indicated with dimensional tolerances complying with ASTM A530/A530M and ASTM A554. Welded wrought stainless steel fittings and welded stainless steel tubular products shall be fabricated in accordance with ASTM A774/A774M and ASTM A778/A778M. All welding shall be performed in the shop. Filler wire shall be added to all welds to provide a cross section equal to the parent material. Butt welds shall have full penetration to the interior surface. Interior weld beads shall be smooth, evenly distributed, with an interior projection not exceeding 2 mm 1/16 inch. Outside weld areas shall be wire brushed with stainless steel brushes. After fabrication, the assembly shall be passivated by pickling and shall be completely neutralized. The quick-coupling flange shall be nickel plated ductile iron with a stainless steel hinge pin. Anchor bolts shall be 303 stainless steel.

b. Galvanized Steel Systems: The removable header assembly shall be

fabricated from Schedule 40 steel pipe conforming to ASTM A53/A53M. All welding shall be performed in the shop. Butt welds shall be full penetration welds with an interior projection not exceeding 2 mm 1/16 inch. Welding shall conform to AWS D1.1/D1.1M. The assembly shall be hot-dip galvanized after fabrication. Anchor bolts shall be 303 stainless steel. The quick-coupling flange shall be nickel plated ductile iron with a stainless steel hinge pin.

2.4.2.4 Supports and Guides

Each removable header shall be supported by two adjustable supports with vee-shaped guides. Supports shall be fabricated from 6 mm 1/4 inch steel plate and shall have at least 25 mm 1 inch vertical adjustment. The supports shall support the weight of the assembly so that the quick-coupling can be easily disconnected.

2.4.3 Rotary or Swing Header Air Distribution System

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

Rotary or swing header air distribution systems shall be provided as indicated and shall consist of an air supply assembly, rotary or swing-type air header assembly, and supports. The system shall be compatible with the air main and the specified diffusers.

2.4.3.1 Air Supply Assembly

An air supply assembly shall be provided for each rotary or swing header to connect the upper swing joint to the air main. The assembly shall consist of the required pipe and fittings, a butterfly valve, and a combination connector and support for the upper swing joint.

2.4.3.2 Rotary or Swing Header Assembly

The rotary or swing header assembly shall consist of an upper swing joint, a knee joint, hanger pipes, and a header. The upper swing joint shall connect to the air supply assembly and shall include connectors for field installation of diffusers. The rotary or swing header assembly shall be designed to withstand a vertical load that results in a moment of 56.5 Nm 500 in-lb at the diffuser connection without permanent deformation. Lifting lugs shall be provided on the assembly as required to lift the header assembly out of the tank. Rotary or swing header assembly shall be stainless steel systems, carbon steel systems, galvanized steel systems, or fiberglass systems as follows:

a. Stainless Steel Systems: The upper swing joint and knee joint shall be cast stainless steel. Connection between the two sections shall be by means of a stainless steel pin working in a graphite bronze bushing. Bearings shall be graphite impregnated cast bronze complying with ASTM B584. Brass seal rings with labyrinth grooves between the two joint sections shall be provided. A grease fitting to lubricate the seal rings shall be provided. An adjustable stop to prevent the knee joint from opening beyond 180 degrees shall be provided. The hanger pipes and air headers shall be fabricated from 304L stainless steel in accordance with ASTM A240/A240M. The upper hanger pipes shall be Schedule 10S. Lower hanger pipes shall be Schedule 5S. Air

header pipes shall be 12 gauge. Header dimensions shall be as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Welded wrought stainless steel fittings and welded stainless steel tubular products shall be fabricated in accordance with ASTM A774/A774M and ASTM A778/A778M. All welding shall be performed in the shop. Filler wire shall be added to all welds to provide a cross section equal to the parent material. Butt welds shall have full penetration to the interior surface. Interior weld beads shall be smooth, evenly distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Outside weld areas shall be wire brushed with stainless steel brushes. After fabrication, the assembly shall be passivated by pickling and shall be completely neutralized. The hanger pipes shall be welded to the upper swing joint and knee joint. The header pipe shall be flange connected to the hanger pipe. Diffuser connectors shall be welded to the header. The header shall have welded end caps.

b. Carbon Steel Systems: The upper swing joint and knee joint shall be cast steel. Connection between the two sections shall be by means of a stainless steel pin working in a graphite bronze bushing. Bearings shall be graphite impregnated cast bronze in accordance with ASTM B584. Brass seal rings with labyrinth grooves shall be provided between the two joint sections. A grease fitting to lubricate the seal rings shall be provided. An adjustable stop to prevent the knee joint from opening beyond 180 degrees shall be provided. The hanger and header pipes shall be schedule [40] [80] carbon steel pipe in accordance with ASTM A524. Header dimensions shall be as indicated. Welding shall be performed in the shop. After fabrication, the assembly shall be painted with the manufacturer's standard finish. The hanger pipes shall be welded to the upper swing joint and knee joint. The header pipe shall be flange connected to the hanger pipe. Diffuser connectors shall be welded to the header. The header shall have welded end caps.

c. Galvanized Steel Systems: The upper swing joint and knee joint shall be cast iron. Connection between the two sections shall be by means of a stud equipped with a spring to maintain seal between the faces. Graphite impregnated bronze seal rings and bearings in accordance with ASTM B584 shall be provided. Grease fittings for lubrication shall be provided. The hanger and header pipes shall be schedule [40] [80] galvanized steel pipe in accordance with ASTM A53/A53M. Header dimensions shall be as indicated. The header shall consist of two lengths of pipe, flange connected to a cast iron tee. The hanger pipes shall be screw connected to the upper swing joint and knee joint, and flange connected to the header tee. Diffuser connectors shall be welded to the header. The header shall have gasketed, screwed end caps.

d. Fiberglass Systems: The upper swing joint and knee joint shall be 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. All areas of high stress shall be ribbed to provide increased strength. Each rotating bearing surface shall be provided with ring type air seals. The assemblies shall be held together by a 13 mm 1/2 inch diameter stainless steel rod with locking nuts. The hanger and header pipes shall be reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. The pipe shall be 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. Ultraviolet protection shall be provided for the pipe material. The liner resin shall be 85 to 89 percent resin with glass filler and shall be at least 0.51 mm 0.020 inch thick. Joints shall be filled epoxy adhesive joints. Header dimensions shall be as indicated. The hanger shall be flange connected to the header.

2.4.3.3 Supports and Guides

Supports and guides shall be provided as required for support and leveling of the header.

2.4.4 Fixed Header Air Distribution System

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

A fixed header air distribution shall be provided as indicated and shall consist of a dropleg assembly, fixed headers, and supports. The system shall be compatible with the air main and the specified diffusers.

2.4.4.1 Drop Leg Assembly

A drop leg assembly shall be provided to connect the fixed headers to the air main. The assembly shall be of the dimensions indicated.

2.4.4.2 Fixed Headers

The fixed headers shall be of the dimensions and configuration indicated. Header connections shall be of a type allowing rotational adjustment of individual header sections and shall be of sufficient strength to transmit the longitudinal forces caused by expansion and contraction of the header. The headers shall be designed to allow expansion and contraction over a temperature range of 70 degrees C 125 degrees F without damage to the system. Rotation of the header due to thermal expansion and contraction shall be prevented. Fixed headers shall be stainless steel systems or fiberglass systems as follows:

a. Stainless Steel Systems: All welded parts of the system shall be fabricated from 304L stainless steel in accordance with ASTM A240/A240M. [Stainless steel pipe shall have a 2D finish in accordance with ASTM A480/A480M.] Pipe wall thickness shall be as follows: 250 mm 10 inch diameter and less shall be 1.59 mm 0.0625 inch (16 gauge) thick; 300 mm 12 inch diameter shall be 1.98 mm 0.0781 inch (14 gauge) thick; 350 mm 14 inch through 450 mm 18 inch diameter shall be 2.78 mm 0.l094 inch (12 gauge) thick; 500 mm 20 inch diameter shall be 3.18 mm 0.1250 inch (11 gauge) thick; 600 mm 24 inch diameter shall be 3.57 mm 0.1406 inch (10 gauge) thick. Header dimensions shall be as indicated with dimensional tolerances in accordance with ASTM A530/A530M and ASTM A554. Welded stainless steel fittings and welded stainless steel tubular products shall be fabricated in accordance with ASTM A774/A774M and ASTM A778/A778M. All welding shall be performed in the shop. Filler wire shall be added to all welds to provide a cross section equal to the parent material. Butt welds shall have full penetration to the interior surface. Interior weld beads shall be smooth, evenly

distributed, and with an interior projection not exceeding 2 mm 1/16 inch. Outside weld area shall be wire brushed with stainless steel brushes. prior to fabrication, each part of the assembly shall be passivated by pickling and completely neutralized. Bolts, washers, follower flanges, and other non-welded parts shall be 304 stainless steel. Nuts shall be low silicon bronze in accordance with ASTM B98/B98M.

b. Fiberglass Systems: Piping shall be reinforced thermosetting resin pipe in accordance with ASTM D2310, Type I, Grade l, Class F, ASTM D2992, and ASTM D2996. The pipe shall 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. Ultraviolet protection shall be provided for the pipe material. The liner resin shall be 85 to 89 percent resin with glass filler and shall be at least 0.51 mm 0.020 inch thick. Joints shall be filled epoxy adhesive joints. Header dimensions shall be as indicated. A 25 mm 1 inch drain leg at each end of each section of pipe shall be provided.

2.4.4.3 Support System

A system for support and anchoring of the headers shall be provided. The system shall be compatible with the expansion and contraction control design. The support system shall provide for a minimum of 100 mm 4 inch vertical adjustment and 25 mm 1 inch lateral adjustment of the header. The system shall be contoured to fit the bottom 90 degrees of the pipe and shall have a bearing surface at least 50 mm 2 inch wide.

2.4.5 Lagoon Air Distribution System

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

2.4.5.1 Fixed Air Distribution Headers

Fixed air distribution headers shall be provided to connect the air main to the lagoon aeration diffuser tubing. Header and feeder piping shall be PVC with flanged or threaded connections. The air distribution system shall be one of the following:

a. Dual Header System: The system shall consist 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 shall consist 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.

2.4.5.2 Supports

Adjustable supports that allow free longitudinal movement with little or no lateral or vertical movement shall be provided for the air header piping. All ferrous metal in the support system shall be galvanized.

2.4.5.3 Airlift Purge System

A plastic airlift, complete with integral plastic air jet, shall be provided as indicated. The system shall include air supply tubing and piping connected to the main air header. A control valve on the air supply pipe shall be provided.

2.4.5.4 Gas Cleaning System

A complete system as required for gas cleaning of the air diffusion system shall be provided. The system shall have a single valve to control flow to all points.

2.5 DIFFUSERS

****

NOTE: Aeration tanks should be identified on the drawings. Diffuser performance requirements should be inserted.

****

2.5.1 Diffuser Performance

a. Air flow rate shall be [_____] standard L/second/28.3 cubic meters scfm/1000 cubic feet of tank volume.

b. Oxygen transfer shall be [_____] 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 at20 degrees C 68 degrees F and zero dissolved oxygen.

c. Submergence shall be [_____] mm feet.

d. Maximum allowable headloss shall be [_____] mm inch of water, excluding submergence.

2.5.2 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.

****

Diffusers shall have a mean permeability rating of [_____] and shall be one of the following types:

2.5.2.1 Porous Ceramic Discs

Porous ceramic plate diffusers shall be 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. Diffuser plates shall each provide [_____] square mm square inch of horizontal diffuser area.

2.5.2.2 Porous Membrane Tubes with Supports

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

2.5.2.3 Porous Cloth Media with Plastic Tube Liner

Porous cloth media shall be a tubular flexible synthetic fiber cloth sheath that is open at one end and closed at the other. The media shall fit over a plastic tube liner and shall be clamped to a cast iron nozzle with a stainless steel clamp. The cast iron nozzle, except for the threads for attaching to the header, shall be vinyl coated. The diffuser media shall be [_____] mm inch in length and a diameter of [_____] mm inch.

2.5.3 Non-Porous Diffusers

****

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

****

2.5.3.1 Nozzle-Type Diffusers

Diffusers shall be nozzle type and shall be one of the following:

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

b. Diffuser of molded plastic and consisting of 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.

2.5.3.2 Orifice-Type Diffusers

Diffusers shall be nonvalved orifice type and shall be one of the following:

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. The deflector shall direct the liquid along the diffuser's outer walls.

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

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

2.5.3.3 Valved Orifice Diffusers

Diffusers shall be of the valved orifice type and shall be one of the following:

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.

2.5.4 Lagoon Aeration Diffuser Tubing

****

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

****

Diffuser tubing shall be [13] [_____] mm [1/2] [_____] inch inside diameter flexible polyethylene tubing containing small, precise, orifices or slots in the lower side of the tubing at [38] [_____] mm [1-1/2]

[_____] inch maximum spacing. The orifice shall be small enough to prevent particulate matter from flowing through the orifice during negative diffuser pressure. The tubing shall be preweighted by a continuous lead strip in the bottom of the tube and encapsulated in polyethylene.

2.5.5 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.
****

Not less than [_____] percent of the installed quantity of diffusers shall be furnished as replacements. Diffusers shall be complete with all parts required for installation.

2.6 HOIST

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

Portable hoist designed to raise and lower the [removable] [rotary or swing] air distribution system shall be provided. Hoist shall be furnished by the aeration system manufacturer. The hoist shall be on wheels or casters [and shall have a suitable steering attachment]. The unit shall be powered by [hand] [hand pump] [battery operated motor] [air operated motor] [electric motor] [gasoline engine]. Means shall be provided to hook the hoist in place during the hoisting operation. The lifting arm shall have a quick latching arrangement to securely grip the air diffusion unit without the use of tools. The hoist shall be of sufficient capacity for the required service.

2.7 METERING AND INSTRUMENTATION

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

Metering and instrumentation shall be as specified in Section [_____].

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

Blowers shall be installed 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.

****

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

3.2.3 Diffuser Installation

Diffusers shall be installed as indicated and in accordance with the manufacturer's written recommendations.

3.3 WELDING

****

NOTE: Retain the applicable welding requirements.

****

[Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded 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.]

3.4 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall 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. The framed instructions shall be posted before acceptance testing of the system.

3.5 FIELD QUALITY CONTROL

3.5.1 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. Each test report shall indicate the final position of controls.

3.5.1.1 Blower Test

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

3.5.1.2 Piping System Test

All piping shall be tested 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. All leaks shall be repaired and the system shall be retested until no leakage is discovered.

3.5.1.3 Diffuser Test

After diffuser installation, the diffusers shall be covered with clear water to a depth of approximately 600 mm 2 feet. Air shall be released through the diffusers and the system shall be inspected for uniform air distribution. Diffusers shall be replaced as required to obtain uniformity.

3.5.2 Manufacturer's Services

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 PAINTING

Field painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.7 FIELD TRAINING

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

3.8 OPERATING AND MAINTENANCE MANUALS

Provide [six] [_____] copies of operation and [six] [_____] copies of

maintenance manuals for the equipment furnished. One complete set shall prior to performance testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be approved prior to the field training course.

-- End of Section --