

SECTION 44 45 16.02
FINE BUBBLE AIR DIFFUSER SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 2, Measurement of Oxygen Transfer in Clean Water.
2. American Society of Mechanical Engineers (ASME): B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
3. ASTM International (ASTM):
 - a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.
 - c. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
 - e. D573, Standard Test Method for Rubber—Deterioration in an Air Oven.
 - f. D1171, Standard Test Method for Rubber Deterioration—Surface Ozone Cracking Outdoors (Triangular Specimens).
 - g. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - h. D2240, Standard Test Method for Rubber Property—Durometer Hardness.
 - i. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - j. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - k. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - l. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - m. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
 - n. F442/F442M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).

- o. F438, Standard Specification for Socket-Type Chlorinated (Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
- p. F439, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

1.02 DEFINITIONS

- A. Adequate Mixing: Variation in mixed liquor suspended solids (total residue) of less than 15 percent between mean value of samples taken at any two depths along any vertical line extending between water surface and elevation of the top of diffusers.
- B. Aeration System Backpressure: Air pressure at top of dropleg necessary to satisfy air supply and distribution requirements. Account for all pressure losses incurred by aeration system when new.
- C. (Bioreactor) Basin: Structure within which aeration occurs. Typically, multiple basins operate in parallel or in series.
- D. Bay: Portion of grid on each side of dropleg and manifold assembly.
- E. Cell: Portion of basin physically separated from other portions of basin. A cell may contain an aeration zone or a portion of an aeration zone.
- F. Diffuser Assembly: Flexible membrane or ceramic diffuser with an element holder and retaining device.
- G. Diffuser Density: Ratio of diffuser area (AD) to tank floor area (AT). Diffuser area is the horizontal projection above the membrane disks through which compressed air is diffused. Diffuser density is the reciprocal of AT/AD.
- H. (Distribution) Header or Lateral: Piping between manifold and diffuser assemblies.
- I. Dropleg: Connection between air source to manifold.
- J. Dynamic Wet Pressure (DWP): Pressure differential across diffuser element, not including flow control orifice.
- K. Grid: Configuration of diffuser system in a zone.
- L. Manifold: Single run of piping that connects dropleg with header(s).
- M. Specific Permeability Rating: Number of cubic feet of air per minute at 70 degrees F (plus or minus 5 percent) and 10 percent to 50 percent relative humidity that will pass through 1 square foot of diffuser element materials, 1-inch thick with a differential pressure of 2-inch water column (ceramic only).

- N. Standard Conditions for Air: 20 degrees C, 14.7 pounds per square in absolute (psia), and 36 percent relative humidity.
- O. Standard Airflow: Airflow at standard conditions, expressed as standard cubic feet per minute (scfm).
- P. Standard Conditions for Oxygen Transfer: Tap water at 20 degrees C, zero residual dissolved oxygen (DO), 1,000 mg/L total dissolved solids (TDS), and barometric pressure of 760 millimeters mercury (mm Hg) (dry air).
- Q. Standard Oxygen Transfer Efficiency (SOTE): Fraction of oxygen in an injected air stream dissolved under standard conditions for oxygen transfer.
- R. Standard Oxygen Transfer Rate (SOTR): Mass of oxygen per unit time dissolved in a volume of water by an oxygen transfer system operating under standard conditions for oxygen transfer.
- S. Zone: Area within an aeration basin used to provide a type or level of treatment. One or more cells may be included in a zone.

1.03 DESIGN REQUIREMENTS

- A. Furnish fixed header, fine bubble, diffused air aeration equipment system as a complete package including, but not necessarily limited to, dropleg(s); air manifold(s); distribution headers; diffusers; diffuser pressure monitoring system(s); supports; drain line, sump, and airlift purge; header joints; accessories; connections for gas cleaning system; and miscellaneous appurtenances.
- B. Furnish complete, engineered systems. Drawings indicate air manifold, header, and diffuser orientations only. Details such as air manifold sizes, air header sizes and spacing, air manifold and header supports and spacing, and diffuser spacing, shall be defined by and be responsibility of Contractor and shall be consistent with requirements in this section.
- C. Design aeration equipment so that upon completion of installation, diffusers are level to within plus or minus 3/8 inch of a common horizontal plane.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Make, model, and weight of each equipment assembly.
 - b. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.

- c. Detailed mechanical drawings showing equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work, and weights of associated equipment.
- d. A detailed drawing of proposed aeration equipment layout for each basin showing air line sizes and lengths, distances between air distribution headers (center to center), and location of diffusers, supports, and expansion joints.
- e. Diffuser, diffuser connector, balancing orifices, and system head loss curves covering range of airflow rates specified and required. Include graph showing dynamic wet pressure versus airflow per diffuser, with and without pressure drop through proposed flow control orifice.
- f. Clean water test results for a minimum of five designs with similar diffuser submergence, spacing, and airflow per diffuser demonstrating that the proposed design will meet specified requirements for standard oxygen transfer rate. Testing shall have been performed in accordance with ASCE 2 and shall be certified by a registered professional engineer.
- g. Provide, for Contracting Officer's consideration, a credit to the Government for waiving clean water oxygen transfer tests specified under Source Quality Control. Decision to waive these tests will be at Contracting Officer's sole discretion and will consider test results submitted under previous item.
- h. Calculations showing distribution and balancing of air to diffusers fed from each dropleg for minimum and peak airflow rates specified and required.
- i. Heat loss calculations and certification that design provides sufficient cooling between top of drop leg and first section of plastic pipe, given proposed air velocities and specified maximum air supply and water temperatures.
- j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

- 1. Calculations by a registered professional engineer to demonstrate design complies with requirements of this section.
- 2. Calculations relating to proposed anchor spacing, diameter, and embedment.
- 3. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
- 4. Factory test results, reports, and certifications. Include oxygen transfer performance test.
- 5. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 03, Equipment - Basic Requirements.

6. Special shipping, storage and protection, and handling instructions.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
 - a. Include manufacturer's printed installation instructions with erection drawings indicating, by piece marking, how entire assembly (for each basin service) is to be shipped and field assembled.
 - b. Include manufacturer's printed instructions for functional testing.
8. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
9. Manufacturer's special guarantee.
10. Service records for maintenance performed during construction.

1.05 EXTRA MATERIALS

- A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	Quantity
Ceramic diffuser sealing gaskets	Min. 1% of number installed
Flexible membrane diffuser elements	Min. 5% of number installed
Diffuser element retainers	Min. 5% of total number installed
Element tighteners	3
Diffuser element holders	Min. 0.25% of number installed
Air distribution pipe support assemblies	Min. 1% of each type and size installed
Air distribution pipe expansion joints	Min. 1% of each type and size installed
Tool sets, if required, for removal and replacement of diffuser assemblies.	2

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Equipment, materials, and accessories in this specification must be purchased from a single manufacturer.

2.02 SERVICE CONDITIONS

A. System:

1. Plant influent is domestic wastewater.
2. Material being aerated is screened degritted raw wastewater mixed with return activated sludge.
3. Temperature in Mixed Liquor 10 degrees C to 25 degrees C.
4. pH of Mixed Liquor: 6.5 to 7.5 standard units.
5. Mixed Liquor Suspended Solids Concentration: 5,000 mg/L to 10,000 mg/L.
6. Basin Sidewater Depth: 15 feet for sidewater depth in each zone.
7. Allowable Diffuser Mounting Distance Above Basin Floor (Floor to Top of Diffuser Element): Nine inches to 12 inches.
8. Available Backpressure at Top of Dropleg 7 psig.
9. Maximum Compressed Air Temperature at Top of Dropleg 260 degrees F.

2.03 PHYSICAL CHARACTERISTICS

A. Stainless Steel Pipe, Fittings, and Supports:

1. Shop fabricate welded parts and assemblies from Type 316L stainless steel with a 2D finish conforming to ASTM A240/A240M.
2. Shop fabricate nonwelded parts and pieces from sheets, plates, or bars of Type 316L stainless steel conforming to ASTM A240/A240M, unless specified otherwise.
3. After fabrication, pickle and passivate stainless steel assemblies and parts in accordance with ASTM A380.

B. Polyvinyl Chloride (PVC) Pipe and Fittings:

1. Produce from PVC compounds with minimum tensile strength of 7,000 psi.
2. Four-inch diameter and smaller shall be SDR 33.5 or SDR 32.5, conforming to ASTM D3915, ASTM D3034, and Class 124524; or Schedule 40, conforming to ASTM D1784, ASTM D1785, ASTM D2466, and Class 12454-B.
3. Six-inch diameter and larger shall be Schedule 40, conforming to ASTM D1784, ASTM D1785, ASTM D2466, and Class 12454-B.
4. Add two parts by weight of titanium dioxide per 100 parts of resin.
5. Factory solvent weld all joints and fittings.
6. All fixed and expansion joint O-ring gaskets shall be natural rubber/SBR with a Shore A durometer of 45, plus or minus 5.

C. Droplegs, Manifolds, Distribution Headers, and Saddles:

1. Droplegs:
 - a. Provide Type 316L stainless steel dropleg from air supply (termination point shown on the Drawings) to the manifold. Connection of dropleg to air supply shall be a rotating lap-collar type flange with 150-pound bolt pattern.
 - b. Provide support from its upper connection, with additional support at lower elbow and as needed to limit spacing between supports to maximum 20 feet. Supports shall prevent transmission of lateral loads from dropleg to its connection to air supply.
 - c. Stainless steel drop leg shall transition to PVC pipe 2 feet above the manifold using a fully-encapsulating, bolted band clamp coupling of same material as drop leg and having an EPDM gasket. Provide 1/2-inch diameter stub 6 inches long with a 125-pound PVC flange on PVC portion of dropleg for diffuser cleaning system connection.
 - d. Stainless steel cooling loop(s) of the same material as droplegs shall be provided as part of the diffuser system if required to meet temperature requirements.
2. Manifolds:
 - a. Perpendicular to air distribution headers, same nominal pipe size as dropleg, and located at same centerline elevation as distribution headers.
 - b. Fabricate with minimum 4-inch-diameter fixed joint connections to each header. Fabricate manifolds in sections up to 20 feet.
 - c. Construct from Schedule 80 PVC or Schedule 40 PVC if stub to distribution header is reinforced with a solvent welded saddle tee.
3. Headers:
 - a. Header spacing shall be no less than 12 inches and no greater than 4 feet center to center. For access to diffuser element holders, center of each holder shall be within 18 inches of a minimum 18-inch wide walkway that is clear of equipment.
 - b. Fabricate in sections up to a maximum of 24 feet, with fixed joints or expansion joints as required.
4. Saddles:
 - a. Saddle (diffuser) spacing on headers shall be no more than 4 feet center to center.
 - b. Factory solvent welded or mechanically attached in field to crown of header.
 - c. One-piece construction, high-strength PVC, glass-fiber reinforced polypropylene, or other suitable material.
 - d. Solvent welded saddles shall be threaded for mounting diffuser element holders. Mechanically attached saddles shall include an air inlet port, positive locking mechanism to locate and lock

assembly to header, and an O-ring seal for air-tight connection to header.

5. Include expansion/contraction system consisting of fixed or flanged joints and guide supports. Guide supports shall allow for longitudinal movement.

D. Flexible Membrane Diffuser Assemblies:

1. Fine bubble, disk type with flexible perforated air release membrane.
2. Backplate with central orifice to support membrane when air supply is off to prevent liquid from passing into diffuser assembly and air piping.
3. Membrane Diffuser Elements: Ethylene propylene diene monomer (EPDM) with an ultraviolet inhibitor and chemical resistant compounds.
 - a. Exterior surface shall be smooth to restrict biological film growth.
 - b. Perforated over entire surface to release fine bubbles uniformly.
 - c. Nominal Diameter: 9 inches.
4. Physical properties:
 - a. Durometer: 58 plus or minus 5 percent (ASTM D2240).
 - b. Modulus of Elasticity: 500 psi (ASTM D412).
 - c. Tensile Strength: 1,200 psi minimum (ASTM D412).
 - d. Elongation at Failure: 350 percent minimum (ASTM D412).
 - e. Ozone Resistance (72 hours, 40 degrees C, 50 parts per hundred million): No cracks at two times magnification (ASTM D1171, Test A).
 - f. Heat Resistance (70 hours at 100 degrees C): Minus 25 percent maximum tensile strength (loss); minus 25 percent maximum acceptable elongation at failure (loss) (ASTM D573).
5. Diffuser Element Holders: One-piece construction, UV-resistant, PVC, glass-filled polypropylene, or other suitable material. Threaded for connection to saddle on air distribution piping.
 - a. Air plenum chamber below diffuser element.
 - b. Mechanism to attach diffuser element to holder.

E. Supports:

1. Fabricate from 0.250-inch minimum Type 304 stainless steel plate. Use Type 304L stainless steel for welded parts.
2. Provide suitable supports in locations that diffused aeration equipment could be affected by mixers or other equipment, as shown on the Drawings.
3. Provide plus or minus 1/2-inch lateral and plus or minus 2-inch vertical adjustment of header. Adjustment shall be continuous and possible without removing air piping from support. Each air piping section shall have a minimum of two supports and additional supports as necessary to maintain level. Support height shall be sufficient to provide diffuser

elevation shown on the Drawings. Each support shall provide a bearing surface contoured to fit 360 degrees of air piping.

4. Manifold Supports:

- a. Maximum spacing between supports of 8 feet.
- b. Include manifold hold down, guide straps, anchor bolts, and supporting structure.
- c. Bearing surface shall be a minimum of 2 inches wide.

5. Header Supports:

- a. Maximum spacing between supports of 7 feet 6 inches.
- b. Guide supports shall consist of self-limiting hold down and sliding mechanism. Mechanism shall provide 1/8-inch clearances around header and be self-limiting if mechanism is overtightened.
- c. Fixed supports shall consist of a hold down mechanism and self-limiting clamp device.
- d. Bearing surface shall be a minimum of 1.5 inches wide.

F. Drainline, Sump, and Airlift Purge:

1. PVC System to Drain Entire Submerged Aeration Piping System: Each grid with air supply from a raised manifold (centerline higher than laterals) shall have a 4-inch diameter drain line terminating at a sump. Each grid with air supply from an in-line manifold (same centerline as laterals) shall have a sump that is integral to the manifold.

2. Sump:

- a. Bottom elevation shall be lower than invert of air distribution headers and drainline.
- b. Connect to a Type 304 stainless steel 1-inch-diameter airlift eductor line extending from drainline invert elevation to a point approximately 5 feet above basin water level and terminate with a Type 304 stainless steel ball valve.

G. Header Joints:

1. Special Flanged Joints or Slip Joints between Sections of Air Distribution Header:
 - a. Flanged Joints for Stainless Steel Piping: Face ring-follower flange type with through-bolts.
2. Fixed Joints for PVC Piping: Spigot section solvent welded to one end of Distribution Header, threaded socket section welded to mating distribution header, and O-ring gasket and threaded screw-on retainer ring.

H. Appurtenances:

1. Couplings: rotating lap-collar type flanges ASTM A182/A182M stainless steel (same material as pipe) drilled 150-pound ASME B16.5 Standard.
2. Face Rings: Type 304L stainless steel, ASTM A240/A240M, inside diameter (ID) drilled 1/16-inch larger than pipe outside diameter (OD).
3. Gaskets: Polychloroprene, 45 durometer to 55 durometer.
4. Miscellaneous Nuts, Bolts, Washers, and Other Nonwelded Parts: Type 304 stainless steel, ASTM A240/A240M. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling. Provide double or self-locking nuts.
5. Post-Installed Anchors: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.04 FUNCTIONAL CHARACTERISTICS

A. Air Distribution and Balancing: Control using orifices and proper header size selection only. Do not use flow distribution control devices requiring automatic or manual operation.

B. Flexible Membrane Diffuser Assemblies:

1. Each Basin consists of two zones with one grid of flexible membrane diffuser assemblies in each zone. The first zone of each basin shall contain a minimum of 120 equally spaced diffuser assemblies and the second zone shall contain a minimum of 70 diffuser assemblies for a tapered aeration system. Spacing between diffuser assemblies shall provide for uniform mixing of contents. For diffuser diameters other than 9 inches, quantities shall be adjusted to provide the same total diffuser area.
2. Membrane Diffuser Elements:
 - a. Provide resistance to chemical attack, weathering, and aging, suitable for application to continuous aeration of activated sludge mixed liquor without significant increase in DWP.
 - b. Replaceable without use of any special tools.
 - c. Inflate during aeration and deflate when airflow is discontinued, further restricting biological film growth.
 - d. Cleanable in-place with water from a hose. Acid or other chemical cleaning methods shall not be required to restore diffuser to like-new performance conditions.
3. Diffuser Element Holders: No special tool required to attach diffuser element holder to saddle.

C. Supports:

1. Manifold Supports: Resist thrust generated by expansion or contraction of headers.
2. Header Supports:
 - a. Allow longitudinal movement of header section to prevent stress buildup in header because of thermal expansion/contraction forces.
 - b. Allow longitudinal movement of header section to prevent stress buildup in header because of thermal expansion/contraction forces.
 - c. Sliding mechanism shall provide minimum resistance to movement of header under full buoyant uplift load.
 - d. Clamping shall positively grip header when tight and be self-limiting to prevent overstressing header if clamp is overtightened.

D. Header Joints:

1. Special Flanged Joints or Slip Joints between Sections of Air Distribution Header:
 - a. Individual header sections shall rotate independently of adjacent header sections for alignment.
 - b. Flanged Joints for Stainless Steel Piping: capable of transmitting longitudinal forces caused by expansion and contraction in air distribution header.
 - c. Slip joints shall allow for expansion and contraction of air distribution header.

2.05 PERFORMANCE CHARACTERISTICS

- A. Saddles: Connections between diffuser element holders and saddles shall resist 150-foot-pounds applied torque about polar axis of holder and 100-foot-pounds about longitudinal axis.
- B. Polyvinyl Chloride (PVC) Pipe and Fittings: Design to withstand 130 degrees F (PVC) or 200 degrees F (CPVC) inside wall temperature, or as recommended by the pipe manufacturer for proposed pressures, whichever is lower.
- C. Manifold/Header Support Systems:
 1. Allow for expansion and contraction over a temperature range of 125 degrees F.
 2. Guide straps shall resist not less than 550 pounds uplift force per support without exceeding 24,000 psi design stress.
 3. Maximum horizontal thrust of 20 pounds shall initiate movement of header relative to mechanism under full buoyant uplift load.

- D. Airflow Distribution: Shall not differ by more than 10 percent, at all specified conditions, for any two diffusers supplied from the same dropleg (based on diffuser with lower flow rate).
- E. Mixing: Adequate throughout each zone of each bioreactor at mixed liquor suspended solids concentrations between 5,000 mg/L and 10,000 mg/L at stated minimum available airflow.
- F. System Aeration Requirements:
1. Diffuser Airflow:
 - a. Minimum greater than or equal to 0.5 scfm.
 - b. Maximum less than or equal to 4.5 scfm.
- G. System Zoned Aeration Requirements:

1. Available Airflow per Bioreactor (scfm):

Zone	2045 Max Month Max Diurnal (3 bioreactors)	2045 Min Month Min Diurnal (2 bioreactors)	St. Up. Max Month Max Diurnal (2 bioreactors)	St. Up. Min Month Min Diurnal (2 bioreactors)
1.	350	100	370	80
2.	210	60	240	40

2. SOTR Required per bioreactor (Pounds O₂ per hour):

Zone	2045 Max Month Max Diurnal (3 bioreactors)	2045 Min Month Min Diurnal (2 bioreactors)	St. Up. Max Month Max Diurnal (2 bioreactors)	St. Up. Min Month Min Diurnal (2 bioreactors)
1.	100	40	110	30
2.	60	20	70	10

3. Dimensions and Minimum Diffuser Counts per Bioreactor:

Zone	Sidewater Depth (ft)	Width (ft)	Length (ft)	Minimum Diffuser Quantity*
1.	15	12.5	18	120
2.	15	12.5	18	70
*For diffuser diameters other than 9 inches, quantities shall be adjusted to provide the same total diffuser area.				

H. Appurtenances:

1. Gaskets: locate at expansion joints and couplings to form an airtight connection at 20 psig minimum.
2. Lifting Lugs: Suitably attached for equipment assemblies and components weighing over 100 pounds.

2.06 SOURCE QUALITY CONTROL

A. Diffuser Longevity:

1. Longevity of proposed membrane diffusers shall have been demonstrated at no fewer than three full-scale municipal wastewater treatment plants operating continuously for a minimum of 3 years. No fewer than 10,000 diffusers (total) shall have been installed at these plants.
2. For each installation, a test report by an independent testing agency shall indicate compliance with the following maximum allowed changes in membrane properties. A minimum of three diffusers shall have been tested at each installation.
 - a. Durometer: Plus or minus 5 percent.
 - b. Weight: Plus or minus 5 percent.
 - c. Permanent Set: Plus or minus 0.5 percent.

B. Shop Performance Validation Tests:

1. At least 2 weeks before beginning testing, furnish advance written notice to the Contracting Officer. Testing shall be performed between 8:00 a.m. and 5:00 p.m., shall begin on a Monday or Tuesday, and shall be performed on consecutive days. Contracting Officer shall have option to witness testing. Contracting Officer's attendance of initial tests will be at Government's expense. Contracting Officer's attendance at any subsequent tests will be at supplier's expense.
2. Provide all facilities needed for the tests including but not limited to a test tank, a calibrated process air supply system, chemicals and chemical mixing system, dissolved oxygen probes, and laboratory facilities and equipment necessary for dissolved oxygen and total dissolved solids measurements.
3. Perform tests on one aeration system identical to those furnished.
4. Oxygen Transfer Performance Testing Procedure: In accordance with ASCE 2. Contracting Officer must approve specific details of test procedure and any deviation from requirements stated below.
 - a. Nonsteady-state reaeration tests shall be performed for the diffuser configurations in grid Number 1 and Number 2. For each grid, perform a minimum of three reaeration test runs at the 2045 max month max diurnal airflow condition (i.e., equivalent

air demand for middle of the day, middle of the summer in 2045) and three tests at the startup min month min diurnal airflow condition.

- b. SOTR for each airflow condition shall be average of SOTRs obtained for multiple reaeration tests.
 - c. Test Facilities: Provided by manufacturer and subject to approval of the Contracting Officer. Test facility shall provide sidewater depths and diffuser submergences specified under Article Service Conditions. Test aeration tank shall be a minimum of 200 square feet.
 - d. Diffuser density for each test shall be equal to or less than diffuser density proposed by manufacturer for aeration system being tested.
 - e. Airflow control orifice used in the test shall match orifice used in proposed equipment.
 - f. For each system being tested, test airflow rate per diffuser shall be less than or equal to airflow rate per diffuser proposed for manufacturer's system.
- 5. SOTR results shall be normalized to 1,000 mg/L TDS using the exponential equation in ASCE 2, Annex G, Commentary B.
 - 6. Obtain approval of test reports from the Contracting Officer prior to shipment of any equipment.
 - 7. If proposed diffused aeration equipment fails to meet requirements, it shall be modified such that it meets all requirements. Such modifications include any structural or piping modifications necessary to accommodate the modified equipment. All modifications shall be made at no cost to the Government. After modification, diffused aeration equipment shall be retested at no cost to the Government.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with manufacturer's written instructions.
- B. Accurately place anchor bolts using templates furnished by manufacturer and in accordance with Section 05 50 00, Metal Fabrications.

3.02 CORROSION PROTECTION

- A. Atmospheric exposed plastic surfaces shall be field prepared and painted in accordance with Section 09 90 00, Painting and Coating.

3.03 FIELD TESTING AND FACILITY STARTUP

- A. Field Testing and Facility Startup shall be in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. Facility startup specifies the order and prerequisites for the following tests of the equipment:
 - 1. Field functional testing.
 - 2. Software operational testing.
 - 3. Performance testing.
 - 4. Demonstration testing.
- C. All Field Testing and Facility Startup shall be performed using a qualified representative provided by the Manufacturer as specified in Section 01 91 14, Equipment Testing and Facility Startup, Section 01 43 33, Manufacturers' Field Services, and as elaborated upon in this section.

3.04 FIELD QUALITY CONTROL

- A. Functional Tests: Conduct on each aeration system following supplier's written instructions.
- B. Flow Distribution and Diffuser/Piping Integrity Test:
 - 1. When system has been installed and visually inspected, fill tank with clean water (in a manner that ensures diffusers are not damaged) to a level approximately equal to height of diffusers.
 - 2. Inspect level of diffusers, and if any variations are evident beyond tolerances allowed in specification or by manufacturer, drain tank and make necessary adjustments.
 - 3. When diffuser levels have been verified, fill tank with clean water (in a manner that ensures diffusers are not damaged) to a level approximately 1 foot above diffusers.
 - 4. Ensure isolation valves on each aeration grid are closed. Arrange for process air system to be pressurized.
 - 5. Slowly open isolation grid to allow air into diffuser grids, one at a time. Position isolation valve to obtain a near-constant flow of about 2 scfm per diffuser.
 - 6. Visually check distribution system and diffusers to identify maldistribution and any failures in pipe joints or diffuser holders.
 - 7. Where any failures are noted, drain tank, perform necessary repairs, and repeat test.

C. Functional and Mixing Validation Test:

1. Conduct on each aeration system.
2. Perform under actual or approved simulated operating conditions after mixed liquor has been introduced. Airflow shall be as measured by plant instrumentation. Calibrate airflow instrumentation as part of testing procedure.
3. Test for a continuous 3-hour period without malfunction. At least three times through test period, visually inspect and photograph basin surfaces and record airflow rates. Identify any obvious leaks or maldistribution.
4. Adjust, realign, or modify units and retest if necessary.
5. Test as follows:
 - a. Pressure Test: Measure air pressure immediately upstream of elbow located at top of each dropleg, and at specified peak airflows and submergences.
 - b. Mixing Test:
 - 1) Perform at specified minimum airflows.
 - 2) Select three vertical lines and two depths in each basin (subject to Contracting Officer approval).
 - 3) Take three Samples at each of two depths along each vertical line using Van Dorn or Kemmerer sampler.
 - 4) Independent testing laboratory approved by the Contracting Officer shall perform total suspended solids (TSS) test on each Sample. Mean value of TSS for three Samples at each depth will be used to determine conformance with requirements.
 - 5) Testing and sampling shall conform to procedures established in latest edition of Standard Methods for Examination of Water and Wastewater.
 - 6) If proposed diffused aeration equipment fails to meet all requirements, it shall be modified such that it meets all requirements. Such modifications include any structural or piping modifications necessary to accommodate the modified equipment. All modifications shall be made at no cost to the Government. After modification, diffused aeration equipment shall be retested at no cost to the Government.

3.05 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site or classroom designated by Contracting Officer for minimum person-days listed below, travel time excluded:
 - a. 1 person-day to train installation staff on correct procedures. Provide certificate that staff understand procedures and are qualified to perform the installation.
 - b. 3 person-days for installation assistance and inspection.
 - c. 5 person-days for functional testing and completion of Manufacturer's Certificate of Proper Installation.
 - d. 2 person-days for prestartup classroom or Site training.
 - e. 5 person-days for facility startup.
 - f. 1 person-day for post-startup training of Contracting Officer's personnel approximately 6 months after startup. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Contracting Officer.
 - g. 3 person-days for aeration equipment inspection approximately 1 year after startup. Contracting Officer will drain and clean each basin to permit entry and inspection, adjustment, and repair of the equipment.

B. See Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

