SECTION 11XXX

COMPRESSED GAS MIXING SYSTEM

PART 1 - GENERAL

1.01 SCOPE. This section covers the furnishing of a compressed gas mixing system for the ***(Note to Specifier:*** (Insert Treatment Process) including compressors, control panels, header piping, nozzles, auxiliary equipment and accessories as specified herein.

1.02 DESCRIPTION. The system shall intermittently and sequentially inject compressed air through fixed nozzles located on the basin floor to create large bubbles which effectively mix the basin contents with negligible oxygen transfer from the mixing system to the bulk liquid.

1.03 NSF 61. All wetted components of the compressed gas mixing system, including but not limited to nozzles, pipe, fittings, gaskets, supports and assembly hardware shall be NSF/ANSI 61 certified.

1.04 REFERENCES.

A. ASTM International (ASTM)

1. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.

2. A276, Standard Specification for Stainless Steel Bars and Shapes.

3. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe

4. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

B. NSF International

1. NSF/ANSI 61, Drinking Water System Components – Health Effects

1.05 DEFINITIONS.

A. Basin: The structure within which mixing occurs; i.e., Anoxic/Swing Zones.

B. Header Supply Pipe: Piping between a valve control panel and respective nozzle headers.

C. Nozzle Header: Continuous (i.e., not branched) horizontal piping with nozzle offsets, with single inlet connection to header supply pipe and outlet offset connections to nozzles.

D. Nozzle Offset: Piping branching off nozzle header trunk piping and which connects to nozzles.

E. Nozzle: Floor-anchored, large bubble-emitting device.

F. Standard Cubic Feet per Minute (scfm): Air at 68° F, 14.7 psia, and 0 percent relative humidity as defined by the Compressed Air & Gas Institute.

G. Actual Cubic Feet per Minute (acfm): Terminology to quantify volume of air at the standardized reference condition (ISO 1217) delivered to the terminal point of the compressor package.

H. Valve Panel (VP): Control panel that controls the firing of integral solenoid valves, which intermittently emit compressed air bursts to the respective header supply pipes.

I. Master Control Panel (MCP): Single control panel that controls the firing of solenoids valves in one or more remote VPs.

1.06 SUBMITTALS.

A. The following items shall be submitted with the Shop Drawings:

1. Catalog data or illustrations showing principal parts and materials.

2. Detailed layout drawings.

3. Electrical schematics.

4. Operating and maintenance instructions and parts list

5. Compressor support locations and loads transmitted to bases and foundations.

6. Compressor electrical schematics and field termination wiring.

7. List of recommended spare parts other than those specified.

8. Field inspection reports.

9. Qualifications of field service engineer.

10. Recommendations for short and long-term storage.

11. Testing procedures.

12. Special tool requirements.

13. Installation reference list including a minimum of five (5) Compressed Gas Mixing Installations for which the Supplier furnished and integrated the complete Compressed Gas Mixing System, including at a minimum Nozzles, In-Basin Piping, Valve Control Panels and Compressor. Provide Facility Name/Location, Design Average Daily Flow, Contact Name/Telephone Number and Start-Up Date for each installation.

1.07 WARRANTY.

A. The Compressed Gas Mixing Manufacturer shall guarantee the equipment against

defects in materials and workmanship under normal use and service, to the original purchaser, for a period of twelve (12) months from date of equipment startup by an authorized technician or eighteen (18) months from date of equipment shipment, whichever is the lesser.

B. ***(Specifier Note: Optional Text)*** The airend of the compressor packages will be specially warranted for a period of thirty-six (36) months from date of compressor startup or forty-two (42) months from date of shipment, whichever is the lesser.

C. Requirements to maintain the compressor warranty are:
   1. Factory Authorized start-up by a representative of the Compressor Manufacturer distributor/factory store.
   2. OEM filters and oil used at the intervals described in the compressor O&M manual
   3. Oil samples are to be taken and analyzed every 2,000 hours of run-time as defined in compressor O&M manual
   4. Maintenance in accordance with compressor manufacturer's operating and maintenance instruction.

1.08 QUALITY ASSURANCE.

A. The compressed gas mixing system shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall be as manufactured by EnviroMix, Inc. of Charleston, SC, no exceptions. The Contractor shall obtain the nozzles, nozzle headers, header supply piping, valve control panels (VP's), compressors and appurtenances from the mixing system manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

B. Alternate Manufacturer's wishing to offer their equipment must submit the following information to the Engineer in a Pre-Qualification Package within fourteen (14) days prior to the published date of Bid Closing. Engineer will evaluate information and if in the Engineer's sole discretion, the Alternate Manufacturer's proposed compressed gas mixing system meets the specification, performance and offers equal quality and experience to the basis of design, the Alternate Manufacturer will be added to the compressed gas mixing specification via addendum.

   1. A complete set of drawings, specifications, catalogue cut sheets, and detailed descriptive material of proposed major equipment items. This information shall identify all technical and performance requirements stipulated on each drawing and in each specification section.

   2. Full scale test results from a minimum of two (2) U.S. installations demonstrating that the Compressed Gas Mixing System achieved homogeneous mixing as substantiated through statistical analysis of temperature samples yielding a Coefficient of Variation (Cv) of 10% or less.

   3. Test or performance data that the Compressed Gas Mixing System does not

contribute measureable oxygen into the process stream.

4. Full scale test results from a minimum of two (2) U.S. installations demonstrating that the Compressed Gas Mixing System does not negatively impact biological nitrogen and/or phosphorus removal.

5. Written confirmation from Authorized Officer of the Company that the proposed compressed gas mixing system includes complete Unit Responsibility with all components specified in Section 11XXX – Compressed Gas Mixing System as well as the specified Field Performance Testing and Guarantee.

6. Installation reference list including a minimum of five (5) Compressed Gas Mixing Installations for which the Supplier furnished and integrated the complete compressed gas mixing system, including at a minimum nozzles, in-basin piping, valve control panels and compressor. Provide Facility Name/Location, Design Average Daily Flow, Contact Name/Telephone Number and Start-Up Date for each installation.

7. List of recommended spare parts.

8. Information on equipment field installation requirements.

9. A maintenance schedule with projected labor hours showing the required maintenance, frequency of maintenance, lubricants and other items required at each regular preventative maintenance period.

10. Reviewed specification with each paragraph marked noting full compliance and detailed written documentation with discussion of all deviations from the specification.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements shall be as follows:

Basin Mixing shall be uniform throughout the basin with effective mixing confirmed through a Field Performance Test as specified.

Air Distribution and balancing shall be sufficient to maintain uniform temperature over entire depth of basins. VP shall allow operator-variable control of firing parameters (pressure, sequence, duration, and frequency) to achieve basin mixing.

Firing flow rate shall be manually adjustable via the throttling valve.

Air mixing system equipment and piping shall be sized to thoroughly mix the contents of the basins for which the systems are designed.

A. Treatment Process:

Basin	Zone 1
Basin Geometry	
Basin Dimensions	
Side Water Depth (SWD)	
Number of Basins	

Number of VPs per Basin	
Number of ACVs per VP	
Number of Nozzle Headers	
Number of Nozzles per Nozzle Header	
Minimum Number of Nozzles, Total per Basin	
Header Supply Pipe Dia. (in.)	

2.02 MATERIALS.

A. Header Supply Piping

1. Provide threaded connections only where required.

2. Sch 5S, stainless steel Press technology system (Victaulic, Viega, or equal), comprised of stainless steel Press technology fittings, couplings, and pipe, unless specified otherwise.

3. Maximum working pressure of 200 psi.

4. Couplings and fittings: Press technology products formed of Type 304/304L stainless steel tubing including a self-contained o-ring seal(s) molded of synthetic FKM rubber.

5. Pipe: Type 304/304L ASTM A312 stainless steel.

B. Nozzle Headers

1. Sch 10S, 304/304L stainless steel with 1” Sch 40S, Type 304 stainless steel nozzle offsets

2. Nozzle couplings: 1” NPT, 150 lb, 304 stainless steel

3. Delivered from the Manufacturer pre-assembled to the extent practicable to minimize field assembly error and installation time.

4. Pipe: Type 304/304L ASTM A312 stainless steel.

C. Nozzles

1. Top plate fabricated from 1/8” stainless steel plate, ASTM A240/A240M, Type 304 with a 2D finish.

2. Bottom plate fabricated from HDPE and gasketed to prevent air from leaking between the top plate and the bottom plate.

3. Top and bottom nozzle plates shall be joined together using Type 304 stainless steel hardware. Nozzles shall come pre-assembled.

4. Adequate strength to withstand vertical thrust of mixing air.

5. Threaded Rod Anchors: Use Hilti HIT-RE 500 adhesive or equal. A minimum of two threaded rods shall be installed per nozzle, one each on opposite diagonal

corners.

6. Nozzles shall be installed in the locations as shown on the Drawings.

D. Appurtenances

1. Miscellaneous: Nuts, bolts, washers, threaded rod, and other non-welded parts shall be stainless steel, ASTM A240/A240M, Type 304. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

E. Fabrication

1. The piping used for the air mixing system shall be Type 304 stainless steel unless otherwise noted.

2. Shop fabricate welded metal parts and assemblies from stainless steel, ASTM A240/A240M, Type 304 with a 2D finish.

3. Shop fabricate non-welded parts and pieces from sheets and plates of stainless steel, ASTM A240/A240M, Type 304 or from bars of stainless steel ASTM A276, Type 304, unless specified otherwise.

4. Welds and Welding Procedure

a. Shop weld with filler wire using MIG, TIG or shield-arc, or plasma-arc welding inert gas processes. Provide a cross-section equal to or greater than parent metal.

b. Provide full penetration butt welds to interior surface with gas shielding to interior and exterior of joint.

c. Provide smooth, evenly distributed interior weld beads with an interior projection not exceeding 1/16 inch beyond inner diameter of nozzle header or fittings.

d. Field welding is not permitted.

e. Clean all welded stainless steel surfaces and welds after fabrication to remove weld splatter and finish clean all exterior welds, carbon deposits and contaminants per ASTM A380 Section 6.2.11

5. Wetted Components

a. All wetted header supply piping, nozzle headers, nozzles and appurtenances shall be NSF/ANSI 61 certified.

2.03 CONTROL PANELS.

A. ***(Specifier Note: Choose MCP and NEMA 4X SS vs NEMA 12)*** Master Control Panel (MCP) Enclosure. MCP shall have UL-rated NEMA 12 painted steel enclosure. Control panels shall be sized to provide heat dissipation such that, at a 110 degree F ambient temperature, the operating temperature rating of the lowest-rated component in the panel is not exceeded.

B. Valve Panel (VP) Enclosures. VPs shall have UL-rated NEMA 4X 304 stainless steel enclosures. Control panels shall be sized to provide heat dissipation such that, at a 110 degree F ambient temperature, the operating temperature rating of the lowest-rated component in the panel is not exceeded.

C. ***Specifier Note: Delete if MCP and no remote HMI or indoor)*** VP Hinged Lockable Cover. The VP shall be provided with a hinged lockable cover for the Operator Interface to protect against sun damage and intrusion damage.

D. Power Connection. All panels shall accept a single source 120 VAC power connection. Lightning and surge protection shall be provided on the incoming line power. Lighting and surge protection shall be Phoenix Contact Mains Plugtrab or equal.

E. ***(Specifier Note: Choose MCP OIT)*** MCP Operator Interface Terminal (OIT). The MCP shall have an OIT to make operating parameter changes and acknowledge alarms. The OIT shall be a Schneider Electric 12.1" color touchscreen. The OIT shall have flash memory capacity, USB port, and Ethernet communication.

F. ***(Specifier Note: Choose VP OIT)*** VP Operator Interface Terminal (OIT). The VP shall have an OIT to make operating parameter changes and acknowledge alarms. The OIT shall be a Schneider Electric 5.7" color touchscreen. The OIT shall have flash memory capacity, USB port, and Ethernet communication.

G. Controller. Each control panel shall be equipped with a controller which controls the sequence, duration, and frequency of ACV openings via relay outputs. The controller shall also provide alarming functionality. The controller shall be equipped with the following features

Rated for Class I, Division 2 Hazardous Areas

10/100 BaseT Ethernet port with Modbus TCP/IP

H. Air Control Valves. The air control valves shall be poppet style valves, mounted to a common manifold. The valves shall have a life expectancy of 20,000,000 cycles.

I. Throttling Valve. Each VP shall be equipped with a throttling valve to adjust the volume of air released to the ACVs and corresponding header supply piping. The throttling valve shall be pre-plumbed into the VP.

J. ***(Specifier Note: Alternative Text)*** Proportional Pressure Controller. A proportional pressure controller shall be used to automatically adjust the pilot pressure to an air pressure regulator throttling valve. The Proportional Pressure Controller shall accept a 4-20 mA signal and shall be controlled by the PLC in the control panel.

K. Control Air Filter. Each VP shall include a pre-plumbed 5-micron filter with an auto-drain to remove fine particles, water vapor, and oil from the air supply. The filter shall be Watts F603D or approved equal.

L. Heater. Each control panel located outdoors shall be provided with a 120 VAC heater designed to maintain 40° F in an ambient outside temperature of 20° F. The heater shall be equipped with a thermostat to turn the heater off at temperatures above 40° F.

M. Nameplate. A stainless steel nameplate shall be provided on the control panel. The nameplate shall be securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, and serial number.

N. Asset Monitoring System. Each control panel shall have the ability to communicate asset-level detail including valve performance through alerts and notifications; information including remaining life of the valve, panel faults, and running data.

2.04 CONTROL AND OPERATION.

A. All control features shall be adjustable from the Operator Interface Terminal (OIT) provided by the mixing system manufacturer. Control features shall be adjustable at any time during the operation of the system. Control features shall be initially set according to manufacturer recommendations.

B. Mixing Parameters. Minimum control features shall include the following:

1. Sequence – Menu of preprogrammed operator selectable air control valve firing sequences.

2. Duration – Selection of the length of time the ACV is open during a firing. This value shall be adjustable and have a minimum value of 100 milliseconds and a maximum value of 2,000 milliseconds.

3. Frequency – Selection of the frequency at which each ACV is firing. This value shall be adjustable and have a minimum value of 1,000 milliseconds and a maximum value of 30,000 milliseconds.

4. Valve Status – Enable / Disable functionality of individual valves shall be provided.

C. Startup Modes. The Controller shall enable startup modes that utilize the manufacturer default settings, firing parameters set during the preceding mixing system operation, as well as new settings entered through the OIT.

D. Pressure Alarms. Each VP shall come equipped with a pressure transducer plumbed to the valve manifold. The pressure transducer shall transmit pressure anomalies to the controller. The controller shall interpret the pressures transmitted to provide low system pressure and high system pressure alarms.

E. Valve Failure Alarms. The ACV shall come equipped with a position sensor. The controller shall provide Valve Fail to Open and Valve Fail to Close alarms based on the ACV position.

F. Alarm Annunciation. When either the low system pressure, high system pressure, Valve Fail to Open, Valve Fail to Close alarms occur within a VP a red general alarm light shall be illuminated on the top of the VP. The specific alarm shall be indicated on the Operator Interface Terminal on VP. Each VP shall come equipped with a general FAIL alarm dry contact for remote alarm annunciation. The FAIL alarm dry contact shall close under the same circumstances that the amber general alarm light is illuminated. The FAIL alarm dry contact shall remain closed until the fault is corrected or the system is turned off.

G. Heartbeat Function. The controller shall have a register with a bit that toggles at a regular interval to act as a heartbeat for confirmation of continued controller operation and network communication

H. The controller shall communicate the following through Ethernet:

1. System pressure
2. Firing sequence
3. Firing frequency
4. Firing duration
5. System running
6. General alarm

I. The controller shall accept the following parameters through Ethernet:

1. Enable/Disable Mixing
2. Firing sequence
3. Firing frequency
4. Firing duration

2.05 AIR COMPRESSORS.

A. High Pressure Air Compressors

1. ***(Specifier Note: Indicate Quantity)*** Quantity air compressor modules shall be as noted in the Design Table below. Each shall include inlet filter, air compressor elements, drive motor, aftercooler, starter and regulation system. All components shall be mounted within a common six sided low sound enclosure, including solid base frame.

2. Each compressor package shall be made up of one compressor module consisting of a compressor element belt driven by an electric motor, and radial fan. The module shall be equipped with a temperature sensor to monitor the element housing temperature.

3. Each compressor element shall consist of a fixed scroll housing and an orbiting scroll rotor. The element and housing shall be pressure die cast aluminum. The crankshaft and pulley shall be cast iron. The element shall be V-belt driven using belts with XPZ profile. Bolts for adjusting belt tension shall be easily accessible via removable panels.

4. Each compressor module shall be belt driven by a High Efficiency, Totally Enclosed Fan Cooled motor for optimum performance and reliability. The motor insulation shall be Class F with a B rise.

5. The compressor element shall be equipped with a radial fan mounted as part of

the element to generate cooling air across the element. The compressor package shall be fitted with a finned copper tube aftercooler for cooling of compressed air.

6. The compressor shall be factory equipped with a direct on line starter. The starter shall be mounted and wired within the UL listed compressor control cubicle.

7. The compressor regulation system shall keep the net pressure between manually set limits by starting and stopping the compressor modules. Compressor protective functions shall include: element outlet temperature, drive overload.

8. A paper cartridge type filter shall be provided. The filter shall have a rated efficiency of SAE fine. The filter will remove 98% of all dust particles greater than 1 micron, 99.5% of particles greater than 2 microns and 99.9% of particles greater than 3 microns in size. The inlet filter shall be factory installed within compressor package.

9. The compressor module shall be enclosed in a steel sound insulated canopy with removable panels to provide access for maintenance. The sound insulating material shall be flame retardant polyurethane.

10. The compressors shall be as manufactured by Atlas Copco, Model SF1-4 Mono base mounted full-feature ***(Specifier Note: Specify Model)***, or equal.

B. Refrigerated Dryer

1. The compressor shall be fitted with an integrated refrigerated dryer.

2. The dryer must be integrated inside the compressor canopy and be controlled by the compressor's primary controller.

3. The dryer must use R134A refrigerant.

4. The refrigerant compressor shall be a hermetic piston type design.

5. The dryer shall include an air-to-air heat exchanger to pre-cool the incoming compressed air and re-heat the exiting compressed air.

6. The condenser shall have aluminum fins and copper tubes.

C. Integral Air Receiver

1. One air receiver shall be integrally mounted to each compressor. Each receiver shall include a 115 volt auto drain valve. The receivers shall be designed and constructed in accordance with the ASME Code of Unfired Pressure Vessels and shall bear the code stamp.

D. Compressor System Electrical

1. All electrical and control equipment for the air compressor module shall be furnished as required for a complete installation, requiring only field connection of 230 VAC, single phase power supply.

2. The compressor electric motor shall be rated 230 volts, 60 Hz, single phase.

E. Compressor System Filters

1. Replaceable-cartridge coalescing DD+, PD+ filter and activated carbon QD+ filters shall be provided for removing solid particles, liquid water, oil aerosols, oil vapor and hydrocarbon odors. The particulate filters shall be effective to 0.01 micron for particles, coolant removal to 0.01 mg/m^3 and the activated carbon filters shall be effective to 0.003 mg/m^3 at 21^{o}C.

2. The filters shall be rated for the maximum discharge capacity of the air compressor.

F. Compressor System Performance and Design Requirements

1. Design Requirements:

Service	***(Specifier Note: Specify Zone)***
Capacity @ 116 psig (acfm)	Specify

2. The compressed air equipment shall be designed for the following operating conditions:

Ambient Conditions		
	Max Air temperature, F	110
	Min Air temperature, F	35
	Relative humidity, percent	80
	Barometric pressure, psia	Specify
Compressors		
	Number required	Specify
	Maximum discharge pressure, psig	116
	Capacity at operating target pressure, acfm	Specify
	Motor size, hp	Specify
	Max motor shaft speed, rpm	1800
	Max free field noise level measured at 3 feet, dBA (with enclosure)	55
Receivers		
	Number required	1

	Design pressure, psig	200
	Nominal volume, gal	70
Filters		
	Type	Particulate, High Efficiency Oil Removal, Activated Carbon
	Number required	1 each/compressor (Exterior to each compressor package)

2.06 SPARE PARTS.

A. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. One (1) Air Control Valves (ACVs) rebuild kit
2. One (1) pressure regulator rebuild kit
3. One (1) pilot air filter assembly
4. One (1) solenoid
5. One (1) valve plug and cable assembly
6. One (1) relay and circuit breaker
7. One (1) 5-micron pilot air filter
8. Two (2) compressor intake air filter elements
9. Two (2) compressor air-oil separator filter elements
10. Two (2) each compressor primary/secondary elements
11. Any other standard parts recommended by the Manufacturer.

PART 3 – EXECUTION

3.01 INSTALLATION.

A. Install items in accordance with approved shop drawings, manufacturer's printed instructions and as indicated.

B. All nozzles on respective nozzle header shall be level within ½-inch of a common horizontal plane.

3.02 MANUFACTURER'S FIELD SERVICES.

A. The services of a qualified manufacturer's technical representative shall be provided for installation inspection, testing, startup and training. The mixing system manufacturer shall include the following site visits and days on site:

Service	Number of Trips	Number of Days/Trip
Installation Inspection and Testing	1	2
Compressor Installation Inspection and Testing	1	1
Startup and Training	1	2

3.03 FIELD PERFORMANCE TESTING AND GUARANTEE.

A. All mixer components shall be field tested with the respective basins full to the maximum water surface elevation.

B. Exposed air piping shall be tested by Contractor for leaks using soapy water on all joints and applying 100 psi test pressure. Buried air piping shall be tested using this method before the trench is filled. Air piping in the tanks may be tested by submersing the piping in non-potable water and pressurizing the piping to 100 psi, in lieu of using soapy water on all joints. Pressure testing requirement shall not apply to supply piping downstream from VP or pre-manufactured nozzle headers.

C. The Contractor shall operate each mixing system at the maximum water surface elevation in the basins for a continuous period of not less than 72 hours. The CONTRACTOR shall correct and resolve all operating problems, deficiencies, etc., determined as a result of the tests.

D. After the above testing is complete, field mixing performance testing of the installed Air Mixing System shall be performed by the manufacturer as described below.

1. Mixing performance testing shall be conducted in each of the tanks.

2. All personnel and equipment necessary to conduct and supervise all testing shall be provided by the mixer manufacturer. Engineer/Owner shall be notified of the test to witness at their option and expense.

3. Prior to performing the tests, the basin which will be tested must have been in normal operating mode for at least two days. No flow shall enter or exit the respective basin for two hours prior to and during the test.

4. The compressed gas mixing system manufacturer shall conduct temperature testing using a pole-mounted thermometer with digital readout.

5. Testing Procedure:

a. Four horizontal-plane sample sites for each of the basins to be tested shall be selected by the Engineer. At each sample site, three vertical samples shall be collected as follows: 24-inches from the surface, tank sidewall mid-point and 24-inches above the tank sidewall bottom. Each sample site must be a minimum of 4 ft away from any structure within the

tank. The samples for each location shall be analyzed as described above.

b. The Coefficient of Variation (Cv) shall be determined for the sample set, excluding the maximum and minimum samples. The Cv shall be calculated by taking the resultant set of ten (10) samples as follows: Cv = (100 x Standard Deviation of Ten Samples)/(Mean Value of Ten Samples)."

c. If the Cv is less than or equal to 10%, then the mixer performance shall be acceptable for that location.

d. If the Cv is greater than 10%, then the mixer performance shall be unacceptable for that location and the Contractor and/or Manufacturer shall make all necessary improvements (at no additional cost to the Owner) and repeat the testing procedure at no additional cost to the Owner until the Cv is less than or equal to 10% for that location.

END OF SECTION