BIOLOGICAL ENGINEERED ADSORBENT SCRUBBER TECHNOLOGY
DUAL-STAGE ODOR CONTROL SYSTEM

SPECIFICATION XXXXXX

1.01 SCOPE OF WORK

A. Furnish a dual-technology bio-trickling filter with a high capacity engineered adsorbent polishing odor control system (System) complete with all appurtenances as specified herein.

1. Manufacturer shall furnish bio-trickling filter and polishing equipment including blower and filter vessel complete with media, nutrient addition system, water addition system, electronic bed monitor (EBM), H_2S gas sensors on the inlet and outlet of the bio-trickling filter and the outlet of the polishing system, and control panel along with VFD, instrumentation and controls prewired for a fully functioning system. To comply with NFPA 820, controls shall be mounted on a separate panel stand ≥ 3' from all foul air ductwork and the odor control system vessel.

2. Manufacturer shall provide shop drawings and O&M manuals.

3. Manufacturer shall provide startup and performance testing services as specified.

4. Placement, installation, bolting to the pad and connection of ductwork, water piping, drainage piping, and power shall be provided by the Owner.

B. The System shall comprise the following major components:

1. Multi-stage scrubber technology to include a biological tower in series with a final high capacity engineered adsorbent polishing system. The systems shall be constructed of FRP and shall house the various stages of treatment in a single complete system. The biological tower media zone shall house the inert porous bio-medium and a single water/nutrient injection spray system.

2. Structured, engineered, silica foam media shall be designed to optimize mass transfer and facilitate the growth of bacteria necessary for biological oxidation of odorous compounds. The media bed shall be uniform and structured throughout and made entirely of a glass based, synthetic, non-reactive material.

3. A multi-stage high capacity engineered adsorbent system shall be provided for final adsorption polishing of the airstream before discharge to atmosphere.

4. A UL, factory-labeled electrical control panel shall be provided housing a single Programmable Logic Controller (PLC) system, VFD and other components required for the control and monitoring of the System.

5. A Water Control Panel (WCP) to include the components necessary for control and monitoring of the media irrigation system.

6. An odor control blower to move the odorous air from the source which can compensate for all pressure losses at design airflow.

1.02 OWNER'S RESPONSIBILITY

Owner is responsible for installation of Manufacturer supplied components, including placement and bolting of system to concrete pad, mounting of electrical and water control panels, connection of ductwork, water piping, drainage piping, power and control wiring, all in accordance with the Manufacturer's installation instructions, plus the following:

A. Supply of odorous air ductwork including flex connectors leading to the vessel inlet.

B. Site preparation and construction of concrete equipment pad, including anchor bolts.

C. External water piping to the irrigation water control system.

D. Power supply to the electrical control panel.

E. Drainage piping from the System and sump to a pump station or wet well.

F. Heat tracing and insulation of air ductwork and water pipes as required.

G. Temporary piping for startup of the System.

1.03 PROCESS DESCRIPTION

A. The odor control System shall remove hydrogen sulfide, organic reduced sulfur compounds (RSCs) and other odorous compounds from the foul air stream using a biological tower operating followed by an engineered dry adsorbent system. Prior to discharge to atmosphere, the treated airstream shall be further polished by a multi-stage high capacity engineered adsorbent media system. The biological tower shall be operated under vacuum with the blower mounted after the biological tower and before the engineered dry adsorbent media stage.

B. The foul air shall enter the System at the bottom of each biological tower through a high efficiency mist & grease filter and flow upward through the media layers. The media bed shall be intermittently irrigated from above using suitable reclaimed plant effluent or potable water, and a sump shall be provided to collect the drain water at the bottom of the reactor. The biological tower must recirculate the water/nutrients within the system; therefore, once through systems are not allowed. The hydrogen sulfide shall be oxidized by the autotrophic bacteria resident on the lower media layer(s). As the foul air passes through the upper media layer(s), the resident heterotrophic bacteria shall oxidize other organic odorous compounds. The airstream shall then pass through the blower then entering the polishing system before being released to the atmosphere via an exhaust stack.

1.04 REFERENCES

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

a. American Society for Testing and Materials (ASTM).

b. American Society of Civil Engineers (ASCE).

c. Anti-Friction Bearing Manufacturers Association (AFBMA).

d. ASTM E679 - Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.

e. National Electrical Manufacturers Association (NEMA).

f. National Fire Protection Agency (NFPA).

g. Underwriters Laboratories (UL).

1.05 SUBMITTALS

A. The Manufacturer shall submit information as required to show complete compliance with these specifications, which at a minimum shall include:

1. Manufacturer's catalog/data sheets, descriptive literature and process narrative.

2. Technical data on each major piece of equipment including weight.

3. Manufacturer's warranty, including guarantee total System noise s 75 dBA@ 5'.

4. Detailed bill of materials complete with material of construction.

5. Dimensional plan and elevation drawings showing the System and connections.

6. Equipment offloading and installation instructions with enough detail to allow the Owner to complete installation of all System components.

7. Annual utility and nutrient usage calculations.

8. Information on hazards associated with the System and appropriate safety precautions, including Material Safety Data Sheets (MSDS).

B. The Manufacturer shall submit the following information, as a minimum, for the Operation and Maintenance Manuals:

1. As-built dimensional drawings showing plan and elevation views of the System and applicable connections.

2. Detailed bill of materials along with specification of system components and materials of construction. The list is to include the make, model number and descriptive literature of all items furnished by the Manufacturer.

3. Performance data for odor control blower, to include curves showing capacity, pressure, horsepower, demand and efficiency over the entire operating range, including blower manufacturer's descriptive literature and blower model number.

4. Special precautions for components or materials associated with the System and its operation subject to safety precautions, including MSDS.

5. Manufacturer's warranty, service department contact information and order form.

6. System startup and restart instructions.

7. Special maintenance procedures, including recommended weekly, monthly and annual preventative maintenance requirements.

8. Troubleshooting guide.

9. Individual Operation and Maintenance instructions for major System components.

1.06 SHIPPING, DELIVERY, STORAGE & HANDLING

A. All equipment and materials shall be properly protected such that no damage will occur from the time of shipment until delivery to the Owner.

B. All exposed openings shall be protected to prevent entrance of debris, moisture or water during transportation and storage.

C. The Owner shall be responsible for offloading all shipped equipment and shall inspect all equipment upon arrival. The Owner shall promptly notify the Manufacturer of any damage to equipment or surface finish due to shipping.

D. The Owner shall store all equipment such that, for the duration of the storage period, there will be no deterioration in equipment appearance or performance. Manufacturer shall supply detailed storage instructions, as necessary, at the time of shipment.

1.07 WARRANTY

A. The bio-trickling filter Manufacturer shall warrant the equipment supplied meets, and will perform in accordance with these specifications, and that it is new and free from defects in materials and workmanship. This warranty shall be for two (2) years from the delivery date. If it is determined a defect exists, the Manufacturer shall repair or replace, at their discretion, the defective components. This warranty shall be void if it is determined that the defect is a result of misuse by the Owner or its agents.

B. The odor control system Manufacturer shall warrant the synthetic media against defects in material and workmanship for ten (10) years from equipment delivery. In the event it is determined a defect exists, the Manufacturer shall repair or replace, at their discretion, the defective components. This warranty shall be void if it is determined that the defect is a result of misuse by the Owner or its agents.

PART 2- PRODUCTS

2.01 GENERAL

Odor control equipment shall be provided by a single Manufacturer who shall be solely responsible for the design, delivery and performance of the System. The equipment shall be new and meet the detailed specifications and warranty requirements stated herein.

2.02 QUALITY ASSURANCE

The System Manufacturer is responsible for the coordination of all equipment specified herein. System shall be as manufactured by PureAir Filtration, LLC, or approved equal. Other manufacturers' systems must be pre-approved by the engineer 21 days prior to bid date.

1. Systems using masking agents will not be considered.
2. Systems using single-use spray water in the biological stage will not be considered.
3. Systems using chemicals will not be considered.
4. Biological media that compresses will not be considered.
5. Biological systems using structured media shall not be considered.
6. Biological systems requiring multiple media support trays shall not be considered.

A. Experience Requirements

The System Manufacturer shall be experienced in design, manufacture, installation and operation of structured synthetic media biological towers and high capacity engineered adsorbent media systems designed to remove hydrogen sulfide and organic RSCs from municipal wastewater odor sources. The System Manufacturer shall have a minimum of five (5) years of experience producing odor control systems and shall show evidence of at least five (5) systems in satisfactory operation for at least five (5) years in the United States.

B. Substitution

Substitutions or deviations in equipment or arrangement from that specified herein shall be the Manufacturer's responsibility. A request for substitution or deviation shall be submitted to the Owner and Engineer for review 21 days prior to bid opening and be accompanied by detailed structural, mechanical and electrical drawings and additional

supporting data. There shall be no additional costs to the Owner due to substitutions or deviations.

C. Acceptable Manufacturers

Where a Manufacturer's standard equipment name is used in these specifications, the intent is to establish a minimum standard in terms of equipment quality, performance, functionality and experience. Substitution requests shall be submitted in writing and include supporting documentation and information as follows:

1. Provide project specific drawings showing arrangement of components.

2. Provide project specific Process and Instrumentation Diagram (P&IDs).

3. Estimates of operating costs, including power, water, nutrients, bio-media replacement, engineered adsorbent replacement, etc.

4. List at least five (5) similar installations that have been in satisfactory operation in the United States. List to include:

    a. Owner, contacts and phone numbers
    b. Length of time in service
    c. Volume of air being treated and equipment capacity
    d. Media volume and type
    e. Performance data for a minimum of one-week
    f. H_2S removal percentage
    g. Empty Bed Residence Time (EBRT)

5. Detailed information on local service center within two-hour travel time.

6. Qualifications of key individuals.

7. Company financial information, D&B report, etc.

8. Company brochures, bulletins, customer letters and published industry technical papers, etc. that may aid the evaluation process.

2.03 OPERATING CONDITIONS

The System shall be suitable for treating a continuous supply of air coming from the odorous source. Equipment must be suited to the operating conditions to which it will be subjected and various compounds and substances it could reasonably be expected to meet. The operating conditions, at a minimum, include the following:

A. Duty - Continuous (air supply and odor source)
B. Location - Outdoors
C. Inlet air temperature - 55 - 100 °F
D. Inlet air relative humidity - 60 - 100%
E. Contaminants - H_2S, organic RSC's, ammonia, methyl mercaptan & sulfuric acid.

2.04 DESIGN REQUIREMENTS

The System shall meet the following minimum performance criteria:

A. Number of vessels – Two

B. Model – See Chart in Appendix A

C. Flowrate – See Chart in Appendix A

D. Design of the biological stage shall provide a minimum factor of safety of two, but in no case will an Empty Bed Residence Time (EBRT) of less than 8 seconds be approved.

E. Maximum pressure drop across the system – 10.5 inch water column.

F. Contaminant concentration:

   1. Average hydrogen sulfide concentration - 100 ppmv

   2. Peak hydrogen sulfide concentration - 200 ppmv

G. Irrigation Water- xxx gpm @ 35 psi.

H. Biological Stage Performance requirements - The System shall have passed the performance test if either of the following conditions is true:

   1. H_2S removal efficiency ≥ 99% @ inlet air H_2S concentrations 50 - 100 ppmv.

   2. Outlet H_2S concentration is 0.5 ppmv@ inlet air H_2S concentrations of 50 ppmv.

I. Total System Performance requirements - Odor criteria shall be based on ASTM E679 with a presentation rate of 20 l/min. The System shall have passed the performance test if either of the following conditions is true for H_2S & odor removal:

   1. Odor removal efficiency ≥ 95% @ inlet air odor concentration 4,000 - 60,000 DT.

   2. Outlet odor concentrations ≤ 200 DT @ inlet air odor concentrations is 4,000 DT.

2.05 SYSTEM COMPONENTS (Biological Tower)

A. Mist and grease eliminator (99.95% removal rate) shall be provided to remove greases and mists. One spare pad shall be shipped with the unit.

   1. The mist and grease eliminator must be the permanent washable type and retain a 99.95% removal rate after cleaning. The filter is to be serviced through

an access door complete with heavy weight compression gaskets and quick release, snap acting type pressure latches. Bolted access panels are not acceptable.

B. The biological tower shall consist of one or more stages of Sulphasorb Si media. The vessel shall be constructed from fiberglass reinforced plastic (FRP) and designed to support the required media volume. The exterior color shall be white. The System skid shall be provided with stainless steel hold down lugs to account for all loads, including wind, in accordance with ASCE 7, Minimum Design Loads for Buildings and Other Structures.

C. The structured media shall be Sulphasorb Si, a high porosity, chemically resistant, engineered synthetic porous material, or approved equal. Media characteristics, available surface area, density and pressure drop, shall be structured and uniform throughout the media bed. Media shall resist compaction or swelling due to varying moisture levels and not degrade when subjected to pH < 2. The uniform structure of the media shall minimize potential short circuiting and encourage uniform water and airflow over the entire media cross section. Enough media shall be provided to ensure the performance requirements are met. Media shall be loaded into the FRP vessel after installation.

D. Irrigation system in each reactor shall be configured with at least one irrigation point which shall distribute the irrigation water evenly over the entire upper media surface layer. Each irrigation system shall be tested by the Manufacturer and a certificate of conformity issued showing the nozzle has been tested and meets the Manufacturers standards for uniform distribution. The irrigation system shall be supplied with a nutrient addition system to provide the macro and micronutrients required by the bacteria for optimal metabolism of the odorous compounds being treated. The biological tower must recirculate the water/nutrients within the system. Once through systems are not allowed.

E. The electrical control panel (ECP) enclosure shall be NEMA 4X and constructed of FRP, and the panel shall be mounted back to back with the water control panel (WCP) and mounted on a SS panel stand. The ECP shall house the necessary electronic components and a programmable logic controller (PLC) with for control and monitoring of the irrigation system. The system shall be controlled based on time for the irrigation cycle and irrigation time and shall be adjustable to sustain conditions appropriate to the activity of the bacteria. Dry contacts shall be provided for external alarm notification. Alarms, at a minimum, shall be provided for low irrigation water flow, high irrigation water flow, no nutrient flow and blower failure. An alarm beacon shall be mounted on top of the ECP. There shall be a provision to manually operate the irrigation spray valve for routine maintenance checks. The ECP shall include a variable frequency drive for control of the blower. A 120V, 15A circuit shall be provided to power the heat trace being provided by others. The ECP shall require a single electrical connection of 480V/3Phase/60Hz. Transformers shall be provided as necessary for power and control voltages.

F. The water control panel (WCP) shall be constructed of FRP and mounted back to back with the ECP as above. The WCP shall include valves, motorized ball valves, strainers, instruments and piping for the control of the irrigation system and shall operate from control signals from the ECP. The WCP shall contain a panel heater, valves, motorized ball valves, strainers, instruments and piping for the control of the irrigation system and shall operate from control signals from the ECP. The WCP shall contain, without exception, a pulse generating, paddlewheel water flow meter. Irrigation water flow shall be monitored and recorded to ensure proper operation and aid in troubleshooting. Monitoring irrigation water pressure alone is not acceptable. The WCP shall allow for a single connection to either a potable water source or suitable final effluent plant water source. The WCP shall include the nutrient addition system.

2.06 SYSTEM COMPONENTS (Dry Engineered Adsorbent System)

A. Furnish all labor, materials, equipment and incidentals required to install odor control system for the control of atmospheric H_2S, Ammonia, VOC and other noxious odors as shown on drawings and specified herein. The odor control system shall be an engineered dry media system consisting of a media containment vessel, centrifugal fan, dry media, interconnecting ductwork and other appurtenances for a complete operating system.

B. The entire system shall be a skid mounted, packaged system consisting of the following major components:

1. Air Exhaust Fan
2. Interconnecting Ductwork as required
3. Media Containment Vessel
4. Dry Media
5. Electronic Bed Monitoring (EBM).
6. Control Panel
7. High Efficiency Mist & Grease Filter

C. Furnish all other necessary supply and exhaust ductwork between the dry engineered adsorbent media system and the point of generation and the point of exhaust using materials and system like the Interconnecting ductwork on the system. This includes but is not limited to all penetrations, flashings, and supports.

D. The malodorous air shall enter the all FRP, completely self-contained, horizontal system with customized inlet adapter, and shall flow through independent chemical media sections containing a densely packed bed of high capacity engineered adsorbent media. The dry media shall remove hydrogen sulfide and other odor causing constituents. The air shall continue through the vessel and be exhausted through the outlet.

E. In order to ensure unity of responsibility, skid, fan, ducting, vessel, control panel, water panel, dry media and other miscellaneous system appurtenances shall be furnished by a single manufacturer.

F. Unit Construction

1. The unit shall be constructed of fiberglass reinforced plastic (FRP). The base frame shall be FRP structural channel.
2. A side access section containing a 2 micron 99.95% 3 stage mist and grease eliminator pad followed by an air tempering and mix section.
3. A minimum of (2) two independent media chambers shall be provided with media specific for the removal of complex contaminants. Each media chamber shall include a quick connect vacuum unloader and hinged access door.
4. All access doors and hatches shall use closed cell neoprene gasketing to prevent any air leakage.
5. All gasket material shall be 1/4” thick by 0.75” wide open cell neoprene foam.
6. Service doors and all unit access shall be oriented to suit field conditions or requirements.
7. Hinges shall be of continuous piano type pin and constructed of 300 series stainless steel. Doors shall be held closed with quick release, snap acting type, positive pressure latches.

2.07 SYSTEM ACCESSORIES (Dry Engineered Adsorbent Media)

A. Mist and grease eliminator (99.95% removal rate) shall be provided to remove greases and mists. One spare pad shall be shipped with the unit.

   1. The mist and grease eliminator must be the permanent washable type and retain a 99.95% removal rate after cleaning.
   2. The filter is to be serviced through an access door complete with heavy weight compression gaskets and quick release, snap acting type pressure latches. Bolted access panels are not acceptable.

B. Differential Pressure Gauge - A Series 2000 differential pressure gauge as manufactured by Dwyer Instruments shall be provided to continuously monitor the pressure drop across the mist and grease eliminator and carbon bed. The differential pressure gauge shall be mounted on the vessel.

C. Sample Ports - Each bed shall have one (1) 1" diameter sample port which shall extend into the bed a minimum of twelve inches. The sample probes shall be blocked off with a cap constructed of PVC.

D. Real Time Media Life Rod- The carbon adsorber shall include an electronic carbon consumption monitor which will measure the actual carbon consumption in real time. The system shall provide consumption resolution of one percent. The carbon consumption shall be displayed on a local NEMA 4X panel at the odor control unit as well as provide SCADA remote alarm and communicate percent value of the carbon consumption. The monitoring system shall also have the capability to send monthly monitoring reports via SMS or wireless email which provide the following information at a minimum on a monthly basis:

   a. Unit Identification/Location/Serial Number

b. Carbon Install Date
c. Carbon Consumption
d. Predicted Carbon Depletion Date

The electronic carbon consumption monitor shall be manufactured by PureAir Filtration (Norcross, GA), or pre-approved equal. Prequalification criteria shall include the successful implementation of ten installations of a qualifying device which have been in place for two life cycles of the carbon. Systems which rely on prediction of theoretical capacity and inlet concentration or do not actually measure carbon consumption shall not be considered. Systems which rely on break-through sampling of hydrogen sulfide shall not be considered.

E. Removable Lids - Each media section shall be supplied with a bulk loading access hatch. Access hatches shall be on the top of the unit and complete with quick release, snap acting type positive pressure latches with heavy weight compression gaskets. Bolted hatches are not acceptable.

F. Exhaust Stack – The system shall be provided with a straight outlet with rain cap, to prevent rainwater from entering into the system.

G. Anchor Bolts - The VTS System shall be provided with properly sized epoxy HILTI anchor system.

H. Equipment Tags - The vessel shall be provided with an I.D. Tag with the following minimum information: Media Type, Vessel Dimensions, Date of Manufacture, and Design Conditions.

2.08 DRY MEDIAS

A. The engineered dry adsorbent system shall contain two types of media to provide complete removal of noxious odors. Single media type systems will not be accepted.

B. Sulphasorb XL was recently developed to provide our customers with the highest extended life. While it targets the same gases as Sulphasorb, Sulphasorb XL has a capacity for Hydrogen Sulfide (H_2S) which is roughly 70 percent greater than any other product in the market. Pure Air starts with the highest grade activated carbon. This ensures that the greatest possible adsorption capacity is reached. The carbon is then impregnated with an acid gas neutralizing compound and two proprietary reagents which improve its neutralizing and adsorption efficiency.

C. Sulphasorb XL Media shall have the following physical properties:

H_2S Removal Capacity (by volume): 0.30 g/cc
Removal Capacity (by weight): H_2S: 89%
CTC value: 70% min
Surface Area: 1050 m2/g
Density: 580 kg/m3

Moisture Content: 15%
Hardness: 95 min
Ignition Temperature: 425 C

D. Sulphasorb XL Media shall consist of spherical or cylindrical porous pellets formed from a combination of powdered activated alumina and other binders, suitably impregnated with potassium permanganate to provide optimum adsorption, absorption, and oxidation of a wide variety of gaseous contaminants.

E. Sulphasorb XL Media shall be UL Class 2 listed.

F. Sulphasorb XL Media shall be capable of absorbing and removing odorous gases throughout the entire pellet.

G. CPS12 Blend Media shall have the following physical properties:

Removal Capacity:

Hydrogen Sulfide: 0.20 g/cc min (24% by weight)
Sulfur Dioxide: 0.11 g/cc min (12% by weight)
Nitric Oxide: 0.06 g/cc min (7.5% by weight)
Nitrogen Dioxide: 0.024 g/cc min (3.0% by weight)
Formaldehyde: 0.04 g/cc min (5.0% by weight)

Manufacturing Quality Assurance Standards:

Leach Test (indication of porosity)- 180 minute or less
Permanganate Content: 12 % minimum
Moisture Content: 20 % maximum
Crush Strength: 40 to 60 %
Abrasion Loss: 3.0 % maximum
Nominal Pellet Diameter: 1/8” (approximately 4 mm), 85% after screening
Nominal Density: 50 lbs/ft^3 (0.80 g/cc)

H. CPS12 Blend Media shall be UL Class 1 listed.

I. CPS12 Blend Media shall be capable of absorbing and removing odorous gases throughout the entire pellet.

J. The system fan shall be factory wired to a FRP control panel of NEMA 3R construction. The control panel shall have a fan control switch with a pilot lamp to indicate the fan running status. The power supplied to the panel shall be 480V, 3 phase, 60 Hz. The panel shall be provided with a power disconnect switch, motor starter and control transformer. The system will be equipped with an explosion proof selector switch mounted on the unit.

K. The odor control blower shall be a pressure blower as designed and manufactured by PureAir Filtration or approved equal. Housings shall be heavy

duty construction. All units shall be built with an adjustable discharge housing which can be field rotated to any of eight standard positions. The wheel shall be of the radial bladed backplate or backward curved design and shall be FRP construction. Wheels shall be suitable for exhaust purposes for low volume and high-pressure applications. Fan motors shall be foot-mounted or C-Face NEMA Design B, standard industrial, inverter duty and continuous duty, ball bearing, variable torque type suitable for operation on voltage, phase and hertz, as listed in the fan schedule. Motor bearings shall have a minimum L-10 life, as defined by AFBMA, of at least 40,000 hours (200,000 hours average life). The odor control blower shall utilize an “oil-bath” design for lubrication of the bearings in lieu of grease fittings. The “oil-bath” design will ensure continuous lubrication. Prior to shipment all fans shall be completely assembled and test run as a unit at the operating speed. Final balance of the completed fan assembly shall be taken by electronic equipment. Records of the vibration readings in the axial, vertical, and horizontal planes shall be maintained, and a written copy of this record shall be available upon request. Blower noise 5' from the System shall be < 75 dBA.

L. Acoustical enclosures shall be provided by the fan manufacturer on all the odor control fans. All fans are exterior, and the acoustical enclosure shall also be weatherproof and resistant to UV, meeting the same flame spread and corrosion requirements as the FRP fans themselves. Acoustical enclosures shall be made of all fiberglass reinforced plastic construction with acoustical treatments. Enclosures shall come with access doors, and acoustical ventilating louvers sized for adequate cooling of the enclosed fan and motor. Enclosures shall provide full access to all fan components. Enclosures shall come with factory applied, gel coat, ultraviolet resistant finish coat. Enclosures shall reduce sound pressure levels a minimum of 10 dBA at a distance of 3 feet. All fastening and mounting hardware shall be stainless steel. Portion of cover shall be Lexan to allow for visibility of the fan. The belts shall have markings so that visual inspection can indicate rotation. Acoustic enclosures shall be as manufactured by PureAir Filtration or equal.

M. The Manufacturer shall furnish spare parts which shall be handed over to the Owner at start-up, including a set of fuses, a set of lamp lenses and a strainer.

2.09 HYDROGEN SULFIDE (H_2S) SENSORS

A. There shall be a total of three (3) hydrogen sulfide (H_2S) monitors for the odor control system. The first will be located at the inlet of the biological tower, the second sensor will be located at the outlet of the biological tower, and the third sensor will be located at the outlet of the polishing scrubber. The discharge gas monitoring system shall include, but not be limited to, a gas sensor, transmitter, and controller for monitoring the presence of chemical gas throughout the scrubber system. The transmitter shall provide alarm output signals (dry contacts) upon sensing chemical gas in the system more than the maximum specified scrubber system chemical gas discharge concentration and upon monitoring system fail (trouble/fault).

B. Transmitter and Sensor

1. The sensor shall be mounted in the three (3) locations as described above and the transmitter shall be remote mounted in a NEMA 4X, Type 316 stainless steel enclosure (minimum 12" wide x 12" high x 6" deep), with full hinged door, painted steel back panel, pad-lockable hasp, and terminal strip suitable for stanchion mounting on strut channel-type supports. The sensor shall be provided with mounting brackets as necessary for mounting to the exhaust discharge stack. Equipment Supplier shall provide monitoring system manufacturer's recommended cable shall be provided for connecting the sensor to the transmitter.

2. The transmitter shall include a three (3) 1/2" digit LCD display. The transmitter shall alternate between displaying the gas being monitored and the concentration of the gas. The transmitter shall include three (3) LEDs for indicating normal operation (measure mode), fault condition, and alarm condition.

3. The transmitter shall be provided with three (3) SPDT relays for adjustable alarm set points, one (1) SPDT relay for transmitter fail (trouble/fault), and one (1) 4-20 mA + HART output (3-wire) fully programmable over transmitter operating range. The relay outputs shall be rated 5 amps at 30 VDC and 220 VAC. The transmitter and sensor shall be explosion proof (UL listed; Class I, Divisions 1 and 2, Groups A, B, C, and D; Class II, Division 1, Groups F and G; and Class III); and shall be rated for continuous use in an ambient temperature range of -30°C to 60°C and relative humidity of 15% to 95%. Transmitter and sensor enclosures shall be NEMA 4X (IP66) rated and constructed of Type 316 stainless steel. Transmitter shall operate on power from the scrubber system unit control panel (UCP).

C. Controller

Manufacturer shall provide a portable controller for accessing and programming the gas monitoring system. Controller shall be capable of setting alarm levels; changing span-gas values; displaying date of latest calibration; displaying minimum, maximum, and average gas values; providing basic calibration functions; and providing password protection.

D. Calibration Kit

Manufacturer shall provide calibration kit as required for calibrating the gas monitoring system. Calibration kit shall include all connections, tubing, and pressure regulating equipment and shall include gas (if necessary) for calibrating the hydrogen sulfide gas monitoring system.

E. Gas monitoring system shall be Ultima XE as manufactured by MSA, or approved equal.

PART 3- EXECUTION

3.01 FACTORY ACCEPTANCE TEST

A. The reactor vessel shall be inspected prior to shipping for conformance to the following:

1. Dimensions match those shown on submittal drawings and are within Manufacturer's specified tolerances.

2. Flanges and connections between reactor parts fit securely without improper bending or stressing of parts.

3. Damage or imperfections.

4. Manufacturer shall provide airflow modeling results confirming uniform airflow distribution throughout the media.

5. Manufacturer shall keep a record of the quality control document for each reactor vessel(s) that is available to the Engineer upon request.

B. The electrical control panel shall be inspected prior to shipping for conformance to the following:

1. NEMA rating according to Section 2.050 and bear the UL508 label.

2. PLC program and HMI shall be tested for communication and functionality.

3. PLC digital and analog inputs shall be electrically tested to ensure input recognition in the proper area of the PLC program.

4. All wiring between panel components and terminal strips shall be checked for proper labeling and connection.

C. The irrigation water control panel, water piping and other pre-installed piping shall be tested prior to shipping for conformance to the following:

1. System shall have no leaks when subjected to a pressure test at 80 psi for a minimum of 1 hour

2. All installed instruments, sensors, pumps, actuated valves, and other electrical components shall be tested for proper operation

3. All wiring from terminal strips to all electrical components shall be tested to ensure proper wiring

4. Irrigation system and spray nozzles tested to ensure uniform distribution

3.02 INSTALLATION & EQUIPMENT START-UP

To the greatest extent possible, equipment shall be pre-assembled prior to shipment.

The Manufacturer shall provide the Owner with required clearances, tolerances and limitations, such as concrete pad finish and shall be available to answer questions.

Installation of all equipment will be conducted by the Owner and must be in accordance with Manufacturer's written installation and start-up instructions and by workers experienced in the handling of fiberglass reinforced plastic (FRP) vessels, electrical work, plumbing and instrumentation. The Manufacturer shall inspect and certify the final installation.

Once the installation has been certified by the Manufacturer, the Owner, with assistance from the Manufacturer, shall start the System to begin the biological acclimation period. This start-up period may take six (6) weeks, but at any point during this start-up period at the Manufacturer's sole discretion may direct the Owner to switch over to normal operation. Any minor re-piping or plumbing required will be clearly detailed in the Manufacturer's installation and start-up manual and will be performed by the Owner.

Any special tools or materials required for this start-up/acclimation period shall be provided by the Manufacturer. After satisfactory start-up and the corresponding switch over to normal operation, the Manufacturer shall, in the presence of the Engineer, conduct the performance test as detailed below.

3.03 PERFORMANCE TESTING

Performance testing shall not commence until the Manufacturer, Owner and Engineer agree that the System has been satisfactorily started-up and sufficient time has been allowed for acclimation of bacteria. After the odor control System has been satisfactorily started-up and switched to normal operation, the Manufacturer shall demonstrate to the Owner and Engineer that the System performs as specified herein. The Manufacturer shall provide the Engineer with a written test protocol and the performance test shall be conducted only if it has been reviewed and approved by the Engineer. The Manufacturer shall supply, install and operate all equipment, sensors and instrumentation required to complete the performance test in accordance with the following:

A. H_2S Testing procedure

1. Measure airflow into each unit and, if necessary, adjust to the design airflow of XXX cfm +/- 10%. Airflow may be witnessed by the Engineer and/or Owner if desired. Airflow shall be measured at the beginning of the test period. The set position on the VFD(s) will be marked or noted. Airflow will not change as long as VFD(s) remain in position.

2. Measure pressure drop across each bio-trickling filter at start of test period.

3. Measure H_2S at inlet, midpoint & outlet; plus, ambient air temp & relative humidity.

4. Performance test period shall begin at a noted time and last one week. H_2S data from the inlet, midpoint and outlet of the odor control System will be measured and logged once every 10 minutes to demonstrate performance during the test period. The midpoint is defined as the end of the biological tower stage.

    a. The inlet H_2S data will be logged with a pre-calibrated Odalog gas data logger with appropriate range and accuracy for the inlet air stream (0-1000 ppmv or 0 - 200 ppmv range, 1 ppm display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution).
    b. The midpoint H_2S data will be logged with a pre-calibrated Odalog gas data logger with appropriate range and accuracy for the midpoint air stream. (0.00- 2.00 ppmv range, 0.01 ppmv display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution).

    c. The outlet H_2S data will be logged with a pre-calibrated Odalog gas data logger with appropriate range and accuracy for the outlet air stream. (0.00 - 2.00 ppmv range, 0.01 ppmv display resolution or 0.0 - 50.0 ppmv range, 0.1 ppmv display resolution).

B. H_2S Acceptance criteria:

The System's H_2S removal efficiency shall be determined by calculating the average inlet H_2S concentration and the average outlet H_2S concentration and using the following formula: H_2S removal efficiency (%) = (1 - (average outlet H_2S concentration/average inlet H_2S concentration)) x 100.

The System shall have passed the H_2S performance test if the H_2S removal efficiency of the biological stage is 99% or more for inlet air H_2S concentrations ≥ 50 ppmv but ≤ 350 ppmv, or the average outlet air H_2S concentration is s 0.5 ppmv, whichever is greater, and, in the event that the maximum H_2S concentration during the test period exceeds the maximum allowable H_2S concentration as listed in this Specification, the H_2S acceptance criteria shall not apply and the System shall be considered to have passed the performance test.

C. Odor Testing procedure

1. Measure airflow into each unit and adjust to design airflow of XXX cfm. Airflow balancing shall be witnessed by the Owner and Engineer. Airflow shall be measured at the beginning of the test period. The set position on the VFD shall be noted. Airflow shall not change if the VFD remains in position.

2. Measure pressure drop across each biological tower at start of test period.

3. Measure temperature and relative humidity of the inlet, outlet and ambient air.

4. Three (3) sets of air samples (at the beginning, middle and end of a single day of the one-week test period), each consisting of one inlet air sample and

one outlet air sample from each odor control System, will be collected in 10-liter Tedlar bags with an air sampling chamber. Without exception, inlet and outlet samples will be collected simultaneously. Each set of samples shall be collected in duplicate to minimize the risk of sample loss during shipping. Duplicate samples shall not be tested unless necessary due to sample loss. Bag samples will be shipped to St. Croix Sensory (Lake Elmo, MN) or equal laboratory via UPS Next Day Air for analysis within 30 hours in accordance with ASTM E679. The airflow presentation rate shall be 20 l/min.

D. Odor Acceptance criteria

The System's odor removal efficiency shall be determined by calculating the average inlet odor Detection Threshold and the average outlet odor Detection Threshold and using the following formula: odor removal efficiency (%) = (1 - (average outlet odor Detection Threshold / average inlet odor Detection Threshold)) x 100.

The System shall have passed the odor performance test if the average (if more than one sample per System) inlet and outlet odor Detection Thresholds indicate 95% removal of odors for inlet air odor Detection Thresholds ≥ 4,000 but ≤ 60,000. If the inlet air has an average odor Detection Threshold of < 4,000 then the outlet air will have an average Detection Threshold of ≤ 200.

If the maximum odor Detection Threshold during the four (4) hour test period exceeds the maximum allowable odor Detection Threshold listed in the Specification, the odor acceptance criteria shall not apply, and the System shall be considered to have passed the performance test.

3.04 FIELD PAINTING & CORROSION PROTECTION

If painted surfaces are damaged during shipment, off-loading or installation, as long as the damage is surface only and in no way affects the integrity of the equipment or its ability to perform, these blemishes, scratches or other imperfections shall be touched up by the Owner in accordance with instructions from the Manufacturer. Materials used shall be compatible with the original coating material in quality and color.

3.05 MANUFACTURERS SERVICES

The Manufacturer or a trained representative shall provide complete monitoring and maintenance of the odor control system. The services will include the following:

- Monitoring the H_2S levels throughout the system.
- Monitoring the airflow in the system and adjusting the flow using a variable frequency drive (VFD) if needed.
- Monitoring the remaining media life of the polishing scrubber using the electronic bed monitor (EBM).
- Media replacement services to ensure a complete turnkey system

In addition, to being available to assist the Owner during the off-loading, installation, and startup of the equipment, the following Manufacturer's services shall be provided with the number of trips and days on site as a minimum.

Startup assistance and training - One Trip involving Two (2) days on site
Performance testing and training - Two Trips each involving One (1) day on site

Notwithstanding the above, the Manufacturer shall continue to assist the Owner and Engineer until the System is installed and performing satisfactorily.

3.06 EQUIPMENT NAME PLATES

Each piece of equipment shall be furnished with a unique name plate identifying the Manufacturer, model and serial number, date of manufacturing, capacity and performance data. Name plates shall be plastic, or approved equal, firmly affixed to the exterior surface of the equipment in an accessible, easily read location.

END OF TECHNICAL SPECIFICATION