SECTION 11584
ODOR CONTROL (BIOTOWER) 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 for Testing Materials (ASTM):
   a. E544; Standard Practices for Referencing Suprathreshold Odor Intensity.
   b. E679; Standard Practice for the Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Method of Limits.
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. Institute of Electrical and Electronic Engineers (IEEE).
5. National Electrical Manufacturers Association (NEMA).
6. National Electrical Code (NEC).
7. National Fire Protection Association (NFPA): 820; Fire Protection in Wastewater Treatment and Collection Systems.
8. National Bureau of Standards (NBS).

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:

1. BOD: Biochemical Oxygen Demand.
2. COD: Chemical Oxygen Demand.
3. DT: Detection Threshold.
4. dB: Decibel.
5. FRP: Fiberglass Reinforced Plastic.
6. HDPE: High Density Polyethylene.
7. OU: Odor Units.
8. P&I: Process and Instrumentation.
9. PLC: Programmable Logic Controller.
10. ppbv: Parts Per Billion, volume.
11. PVC: Poly Vinyl Chloride.
12. TSS: Total Suspended Solids.
13. WG: Water Gauge.
14. WWTP: Waste Water Treatment Plant.

1.03 SYSTEM DESCRIPTION

A. General: Refer Contract Drawings for additional information to Supplement this Section.

B. Design Requirements:

1. Design shall be prepared and sealed by designer meeting requirements of Article Qualifications.
2. Design the biotower vessel including material selection, wall thickness, methods and locations of support, and stiffener requirements.
3. Design entire odor control system and coordinate all items including bioscrubbing towers and media, recirculation pumps, nutrient metering pumps, controls, ductwork, and all appurtenances necessary for a complete system.
4. All motors and electrical equipment shall be designed and constructed in complete accordance with the latest edition and revision of all applicable codes and regulations, including the following:
   a. IEEE.
   b. NEMA.
   c. NEC.
   d. NFPA.
5. All control components located within 3 feet of potential odorous air leakage sources shall be listed for use in Class 1, Division 2, Group D hazardous area and shall be installed in compliance with NEC 500, 501.
6. All mechanical components shall be designed and constructed in accordance with the latest edition and revision of all applicable codes and regulations, including the following:
   a. NBS.
   b. ASTM.
   c. ANSI.
   d. ASME.
7. Equipment Materials:
   a. All components of the System shall be compatible with the conditions and chemicals to which they will be subjected to during normal operation.
   b. Compounds with which the materials of construction must be compatible include, but are not limited to:
      1) Hydrogen sulfide.
      2) Sulfuric acid.
8. Equipment Structural Supports: In accordance with wind and seismic design requirements as specified in Section 01600, Materials and Equipment, and Structural Drawings.

C. Unit Responsibility and Scope of Supply:

1. The Work requires that the odor control system manufacturer/supplier furnish all of the items required to provide a properly functioning system, including but not limited to the biotower reactors (the vessels), biotower media, irrigation system and associated piping and spray nozzles, and control systems complete with all accessories and appurtenances.
2. A total of three odor control systems are to be provided. One for Lift Station 6, one for Lift Station 7, and one for Lift Station 50.
3. The products shall be the end product of one responsible system manufacturer or responsible system supplier.
4. The Biotower Manufacturer shall provide media and components suitable for the service conditions listed herein.
5. The Biotower Manufacturer shall provide and guarantee the required hydrogen sulfide and general odor removal rate performance listed herein.
6. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features and functions.
7. The Biotower Manufacturer is responsible for the biotower vessel design including all layouts, structural calculations for floors and walls and any reinforcing steel/FRP sizing.
8. The system supplier will provide one portable H_2S monitoring system.
9. The Contractor shall be responsible for coordinating with Biotower Manufacturer for Contractor's Scope of Supply.
10. The Contractor shall be responsible for, but not limited to, the following:
    a. Odorous Air Blowers: Refer to Section 11583, Odor Control Blowers.
    b. Odorous air ductwork including manual or actuated dampers.
    c. Installation and assembly of all equipment and instrumentation components for a complete system including labor.
    d. Site preparation and clearing of materials.
    e. External water piping and drain piping to and from Biotower System. Heatrace, insulate and aluminum jacket all exposed water lines, heat trace and insulated valves and appurtenances.
    f. Utility requirements, including main electrical service and field wiring outside the main Biotower Control Panel, water supply, sanitary drain.
    g. Balancing of foul air system per Section 15950, Foul Air Collection System Testing, Adjusting, and Balancing.

1.04 EQUIPMENT TAG NUMBERS

	Lift Station		
Component	**No. 6**	**No. 7**	**No. 50**
Biotower	M-6-1-1	M-7-1-1	M-50-1-1
Control Panel	FP-6-1-2	FP-7-1-2	FP-50-1-2
Water Panel	FP-6-1-1	FP-7-1-1	FP-50-1-1

1.05 SUBMITTALS

A. Action Submittals; Submit Shop Drawings as Follows:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Drawings and Calculations:
   a. All Drawings and calculations shall be signed and sealed by a professional engineer, meeting requirements of Article Qualifications.
   b. Provide detailed Structural and Mechanical Layout Drawings showing system fabrication, dimensions, size and locations of connections to other work and fully describing system operation.
   c. Provide complete process mechanical design calculations for odor control system, which shall include but not be limited to the following:
      1) Estimated annual utility and nutrient usage.
      2) Estimated nutrient monthly cost.
      3) Biotower pressure drop calculations.
      4) Calculations showing that the media(s) as provided will meet the required performance criteria.
   d. Provide structural calculations and drawings for the vessels, which shall include, but not be limited to, consideration of the following:
      1) Dead loads.
      2) Live loads.
      3) Environmental loads (wind, snow, seismic).
      4) Anchor lug attachment to shell.
      5) Anchor bolt size and embedment requirements.
      6) Consideration of effect of all cutouts and openings into the vessel wall.
      7) Attachment lugs for piping, structural members, and other appurtenances.
      8) Packing support design.
      9) Deflection of the vessel at the point of connection with the ductwork.

4. Process and Instrumentation Drawings (P&ID) showing all components, flow rates, and unit requirements.
5. System Controls: Submittal shall comply with specific requirements of Section 13390, Package Control Systems.
6. Manufacturer's catalog information, descriptive literature, specifications, and identification of materials of construction.
7. Reactor vessel data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of irrigation nozzle designs.
8. Manufacturer's Information on the Biotower Media:
    a. Pressure drop data through media.
    b. Media Physical Characteristics, Including:
        1) Media Volume/stage.
        2) Media Depth/stage.
        3) Number of stages per biotower.
    c. Information on expected settling rates of the media.
9. External utility requirements such as air, water, power, drain, etc., for each component.
10. Fabricator's detailed requirements for biotower system and temporary recirculation tank(s) foundations.
11. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
12. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
13. Power and control wiring diagrams, including terminals and numbers.
14. Shop and Field Painting Systems: Include manufacturer's descriptive technical catalog literature and specifications.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01640, Manufacturers' Services.
2. Operation and Maintenance Data as specified in Section 01430, Operation and Maintenance Data.
3. Manufacturer's Certificate of Proper Installation, in accordance with Section 01640, Manufacturers' Services.
4. Detailed Performance Testing Plan which Includes:
    a. Test equipment and apparatus.
    b. Calibration and setup procedures.
    c. The specific testing methodology to be used.
    d. The sampling and analysis procedures.
5. Final Report:
    a. Narrative of the sampling activities, a copy of the original sampling log, photographs showing locations of velocity and

pressure measurements, tabular summary of velocity, airflow rates, pressure, H_2S and Odor removal data, calculated results, and conclusions of these results.

b. Revise the report according to the Engineer's written comments, and resubmit.

6. All deviations and/or exceptions to this Specification, detailed and explained with the reason for the deviation and the affect of the deviation on the operation and/or performance of the equipment.
7. Manufacturer's Training Program.
8. Equipment Testing and Field Startup Report.
9. Installation list showing experience with similar installations, as required by Article, Quality Assurance.
10. Statement of Warranty.
11. If requested by Owner, an Extended Performance Guarantee Proposal.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. The Designer shall be a registered professional engineer.
2. The Manufacturer shall be recognized in the design, production and operation of biological air treatment systems in the United States.
3. The Manufacturer shall have at least 5 years experience in design and fabrication of odor control systems similar to the type specified for this Project.
4. Upon request, the Manufacturer shall provide a list of three biological air treatment installations associated with the removal of hydrogen sulfide and/or other typical organic municipal wastewater odors. The list shall include contact names, telephone numbers and length of service for each named installation. Installations shall be of comparable size to the type specified for this Project (700 cfm per vessel or greater).
5. The Manufacturer's place of business shall be open for inspection.
6. The Manufacturer must be able to provide the Owner with training and monitoring support service during the first year of operation. Additional monitoring support to be available on a renewable annual basis, upon request by Owner.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01600, Material and Equipment.

B. All exposed equipment openings shall be properly protected.

C. Appropriate measures shall be taken to prevent the entrance of moisture or water to equipment during shipment and storage onsite.

1.08 SPECIAL GUARANTEE

A. General:

1. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee.
2. The Manufacturer shall warrant that the System shall be supplied in accordance with these specifications and shall perform as described herein.
3. The Manufacturer shall warrant that the System will be free from defects in materials and workmanship for a period of 24 months from final completion.
4. At the Manufacturer's discretion, the Manufacturer shall repair or provide replacement for any defective components under this warranty provided that any such defect was not the result of misuse of the component by the Owner or the Owner's Agents.
5. The Manufacturer shall warrant the integrity of the reactor vessel and media for a period of 10 years.

B. Performance Guarantee:

1. Biotower System supplier shall guarantee that the Biotower System shall provide consistent odor and H_2S removal in accordance with the specified removal efficiencies on a continuous basis for a period of 2 years from the date of final completion.
2. Biotower System Supplier shall have the capability to provide to the Owner, an Extended Performance Guarantee to cover consistent odor and H_2S removal performance during Year's 3 through 10 inclusive. The Extended Performance Guarantee will be consistent with requirements specified in Paragraph Service Conditions. Cost information for this guarantee shall be provided to the Owner as specified in Paragraph Submittals, Item 11. Acceptance and execution of the Extended Performance Guarantee shall be at the Owner's discretion**.**
3. This performance guarantee is valid only if the biotower is operated and maintained in accordance with the specified design criteria and the manufacturers operation and maintenance manuals and as detailed in Paragraph Service Conditions.
4. It is the responsibility of the Owner to maintain records of these parameters in accordance with the instructions provided in the manufacturer's operation and maintenance manuals.
5. In the event that it has been demonstrated by the Owner, any representative of the Owner or by Biotower System supplier, that the specified odor and/or H_2S removal efficiency is not being obtained, Biotower System Supplier shall undertake the following actions at no cost to the Owner:

a. Review plant records and verify that the Biotower System is being operated and maintained in accordance with the specified design criteria and the manufacturers operating and maintenance instructions as outlined in the manufacturers operation and maintenance manuals.
b. Establish that the biotower media is within proper operating range for, but not necessarily limited to, pH, moisture, nutrient level, bacterial speciation and enumeration and biomass. If any of these parameters are not within the optimum range, as determined by published guidelines and media performance data, the Biotower System supplier shall undertake the necessary steps to establish these conditions.
c. Establish the effect of increased residence time in the biotower. If increased residence time is effective in meeting the removal requirements, Biotower System supplier shall add any additional media required to return the removal efficiency of the biotower to the specified performance criteria.
d. Examine the differential pressure drop across the biotower bed to determine if this is within the acceptable design criteria. If the media has become fouled, under specified operating conditions, resulting in increasing back pressure, the Biotower System supplier shall take corrective action, which may include replacement of part or all of the media to reduce the media differential pressure to the specified optimum operating range.
e. If a claim is made under this performance guarantee and is subsequently demonstrated by Biotower System supplier that the Biotower System has not been operated in accordance with the specified design criteria and the instructions provided in the manufacturers operating and maintenance manuals the Biotower System shall assist the Owner in re-establishing the specified operating conditions. In this case, any corrective procedures and capital expenditures required to re-establish performance criteria will be at the cost of the Owner.

C. Biotower Media Warranty:

1. The biotower media shall be provided with a 10-year warranty.
2. The warranty period shall begin on the date of final completion.
3. This warranty shall be issued to the Contractor and transferred to the Owner 2 years from the date of final completion for the remainder of the warranty period.
4. In Addition:
   a. The media shall not shrink or compact by more than 10 percent of the original bed depth, as indicated in differential pressure drops exceeding maximum limits stated herein at design airflow rates.

b. The media shall not degrade or decompose during the 10 year warranty period.
c. If the media does shrink or compact by more than 10 percent of the original bed depth or if the media is found, upon examination by the media supplier, to have degraded or decomposed or to be defective in material or workmanship or both the media supplier shall at his sole discretion either (a) add new media or (b) repair or replace any part of the defective media or (c) replace the entire media bed at no cost to the Owner.

5. This Warranty shall be Contingent on the Following Conditions:
a. The Owner must ensure that the biotower system is operated and maintained in accordance with specified design criteria and in accordance with the instructions provided in the manufacturer's operation and maintenance manuals.
b. The Owner must seek written authorization from media supplier prior to undertaking any service, modifications or the addition of any substance(s) to the media.

1.09 SPARE PARTS AND SPECIAL TOOLS

A. Delivery: In accordance with Section 01600, Material and Equipment.

B. For Each System: Furnish, tag, and box for shipment and storage the following spare parts and materials:

Item	Quantity
Water Cabinet Strainer Elements	One complete set per cabinet
Nozzle assembly for irrigation water distribution	One assembly
Nutrient Solution	One year supply

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.

B. All components of the System shall be provided by a single Manufacturer who shall have sole-source responsibility for the equipment elements detailed herein.

C. Materials, equipment, components, and accessories specified in this Section shall be products of:

1. BIOWAY America Inc.
2. US Filter/RJ Environmental.
3. "Substitute" as allowed by Division 1, General Requirements.

D. Any "Substitute" manufacturer, as allowed by Division 1, General Requirements, shall submit the following information, in addition to the requirements of Paragraph Submittals. A list of at least 5 existing biological treatment installations as required by Paragraph Quality Assurance, Item A.4, of these Specifications. Installations shall have contact time equal or greater to that listed in these Specifications and shall have equal or better odor and hydrogen sulfide removal. Odor removal performance will be demonstrated by submission of test results by a certified Commercial Odor Laboratory using methods consistent with those specified in Paragraph Service Conditions, Item A.

2.02 SERVICE CONDITIONS

A. The biotower systems shall be designed to remove odorous constituents from process air stream under the following operating conditions:

Process Parameter	Value
Duty	Continuous
Location	Outdoors
Inlet Air Temperature	40 to 110 degrees F
Lift Station No. 6 Four Air Flowrate	700 acfm
Lift Station No. 7 Four Air Flowrate	700 acfm
Lift Station No. 50 Four Air Flowrate	1,500 acfm
Average Inlet RH	60 to 100%
Type of Contaminant	H_2S and Reduced Sulfur Organic compounds and other odors typically found at WWTPs
H_2S at Inlet	Average 100 ppmv Peak 200 ppmv
Reduced Sulfur Organics at Inlet	Average 1 - 3 ppmv Peak 5 ppmv

Process Parameter	Value
Removal Required	H_2S: For inlet concentrations $\geq$ 10 ppmv, 99% removal For inlet concentrations < 10 ppmv, outlet H_2S concentration $\leq$ 100 ppbv Odor Removal: For inlet odor DT[1] concentrations $\geq$ 5,000 OU, 90% removal; For inlet odor DT concentration < 5,000 OU, outlet DT concentration < 500 OU.

[1]Odor DT concentrations to be determined in accordance with ASTM E679 with a 20 liter/minute odor panel presentation rate.

B. Each Biotower System Design Shall Conform to the Following Parameters:

Design Parameter	Value
Empty Bed Residence Time	Minimum 20 sec
Manufacturer	BIOWAY America Inc. US Filter
Number/Type of Biotower Modules:	
Lift Station No. 6	One (1) ZeroChem 2200-2 Reactor vessel; One (1) Zabocs BTF
Lift Station No. 7	One (1) ZeroChem 2200-2 Reactor vessel; One (1) Zabocs BTF
Lift Station No. 50	One (1) ZeroChem 2200-4 Reactor vessel; One (1) Zabocs BTF
Water Supply (irrigation):	
Lift Station No. 6	10 gpm at 45 psi (measured at inlet to water cabinet)
Lift Station No. 7	10 gpm at 45 psi (measured at inlet to water cabinet)
Lift Station No. 50	25 gpm at 45 psi (measured at inlet to water cabinet)
Water Quality (irrigation)	COD: < 100 mg/L BOD: < 30 mg/L N_{tot}: 2 – 20 mg/L, as N P_{tot}: 1 - 5mg mg/L, as P Chlorine: <5ppm (total active Cl) TSS: < 10 mg/L Salts < 2,000 ppm
Electrical	480V ac

Design Parameter	Value
Air Pressure Drop:	
Lift Station No. 6	Maximum: 2 inches WG at 700 cfm
Lift Station No. 7	Maximum: 2 inches WG at 700 cfm
Lift Station No. 50	Maximum: 2 inches WG at 1,500 cfm

1. Provide supplemental nutrients as required to meet these parameters

2.03 SYSTEM COMPONENTS

A. Biotower Reactor:

1. General:
   a. Free standing tower including media and top spray media bed irrigation system.
   b. Designed to support the required number of media layers and treatment stages.
   c. Inspection windows, man-ways, drains, etc., provided as needed for inspection and access to internals of the biotower and drainage of the biotower.
   d. No exposed metal allowed inside the air plenum.
2. Vessel Construction:
   a. General:
      1) Vessel of dual-laminate construction, consisting of Filament-Wound FRP body.
      2) Filament-Wound Tanks: Construct according to ASTM D3299, Grade 1.
      3) Closed Top Tanks: Head knuckle radius minimum 1.5 inches.
      4) Flat Bottom Tanks:
         a) Bottom Knuckle Radius of Minimum 2 inches.
         b) Extend reinforcement of the knuckle-radius area up to the vertical wall a minimum of 8 inches on tanks up to 4 foot diameter and 12 inches for tanks over 4 foot diameter.
   b. Resin:
      1) Suitable for intended service.
      2) Use the same resin throughout the structural layer.
      3) Add ultraviolet absorbers to surfacing resin to improve weather resistance.
      4) No dyes, pigments, or colorants except in exterior gel coat.
      5) Vessel exterior color to be selected by Owner, from color charts provided by supplier.
      6) No fillers or thixotropic agents.

c. Curing Systems:
   1) Use resin manufacturer's currently recommended cure system.
   2) Apply a white color coat after inspection of the laminate has been completed.
   3) Cure all products to a minimum of 90 percent of the minimum Barcol hardness specified by resin manufacturer.
   4) Measure Barcol hardness according to a ASTM D2583.
   5) Post-cure the tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature.
   6) Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.

d. Reinforcement:
   1) Veil: Electrically conductive material, carbon fiber veil, 12 to 16 mils thick, with a finish and a binder compatible with the lay-up resin.
   2) Corrosion Barrier: resin-rich interior surface of nominal 100 to 120 mils using chopped strand mat backing the veil. Use no additive in the corrosion barrier.
   3) Chopped Strand Mat: Type E glass, minimum 1-1/2 ounces per square foot, with silane finish and styrene soluble binder.
   4) Continuous Roving Used in Chopper Gun for Spray-Up: Type E glass.
   5) Woven Roving: Type E glass, nominal 24 ounces per square yard, 4 by 5 weave, with silane type finish.
   6) Continuous Roving Used for Filament Winding: Type E glass with silane type finish, with a nominal yield of at least 110 strand yards per pound.

e. Laminate:
   1) Laminate shall consist of an inner surface (corrosion barrier), an interior layer, an exterior (structural) layer and an exterior finish.
   2) Meet requirements of the mechanical properties and visual acceptance criteria in ASTM D2563, Level I.
   3) Reinforce inner surface with a resin-rich surfacing veil of 10 to 20 mils thick.
   4) The resin content of the inner surface shall be a minimum of 80 percent by weight.
   5) Construct interior layer of resin reinforced with at least two plies of chopped strand mat. Thickness of interior layer shall be at least 100 mils.

6) Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.
7) The exterior or structural layer shall be filament wound. Filament winding shall be with continuous strand roving to provide a glass content of 50 to 80 percent.

f. Packing Support:
1) Slotted beam, gas injection type.
2) Free Area: Minimum of 95 percent of the cross-sectional area of the tower.
3) Quantity: Sufficient to hold packing plus entrained irrigation liquid.
4) Opening size shall not allow passage of packing media.

g. Marking: Identify each tank with the fabricator's name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, minimum thickness, vessel number, vessel name, and date of manufacture.

3. Synthetic Media:
a. Composed of high porosity, chemically resistant polyurethane, polyethylene or polyvinyl chloride.
b. Media shall not shrink or swell with varying moisture content.
c. Treatment layers must be constructed in a manner to minimize the potential for short circuiting of the air being treated.
d. Sufficient media to provide contact time listed herein.
e. Organic materials shall not be acceptable.

4. Irrigation System:
a. Each reactor shall be configured with at least one fluid injection spray nozzle for each treatment stage.
b. The spray nozzle(s) shall be located above the treatment stage and disperse the fluid evenly over the entire treatment layer.

5. Water Cabinet:
a. Type 316 stainless steel or FRP, NEMA 4X construction.
b. Containing valves, strainer, flow meter, and plumbing required for irrigation of synthetic media.
c. Remotely mounted from reactor vessel exterior.
d. Electric resistance space heater, with thermostat, for condensation control.
e. Field connection to external water supply.
f. Instrumentation to Include:
1) Water supply totalizers.
2) Irrigation motorized valves, normally-closed.
3) Pressure reducing valve.
4) Water pressure indicators.
5) Isolation ball valves.
6) Y-strainer for water supply.

7) Media pressure differential gauges.
8) Water flow meters.
9) Chemical metering pump.

B. Recirculation Tank:

1. Purpose: Effluent collection sump (drain tank) for permanent or temporary installation during startup phase only.
2. Constructed from HDPE or FRP.
3. Minimum Storage Capacity: 350 gallons.
4. After startup has been completed, the odor control system supplier will configure the odor control system for normal operation. For temporary recirculation systems, one recirculation kit, including but not limited to the recirculation tank, pump, controller, hoses and any other ancillary equipment, will be cleaned and turned over to the Owner. For permanent recirculation systems, one complete system will be provided for each site.

C. Recirculation Pump:

1. Purpose: Irrigation water recirculation pump for temporary or permanent installation during startup phase.
2. Construction:
   a. Vertical multistage centrifugal pump, with inline suction and discharge connections or horizontal mag. drive.
   b. Cast iron base and head or polypropylene.
   c. Impellers, diffusers, intermediate chambers and outer liner, Type 316 stainless steel.
   d. Motor suitable for the full range of the published performance curve.
   e. Each impeller fitted with a Teflon® seal ring.
   f. Type 316L stainless steel shaft.
3. Performance Characteristics:
   a. Continuing rising curve from minimum head to shut off condition.
   b. Water flow and head pressure as required for specified irrigation water supply performance and field installed configuration.
4. Mechanical Seal:
   a. Suitable for the full pressure and temperature range of the pump.
   b. Fitted with graphite rotating face and Silicon Carbide stationary face.
5. Pedestal Bearing:
   a. The motor pedestal shall be fitted with an oversize thrust bearing.
   b. Tungsten Carbide intermediary bearing(s).

c. The thrust bearing must be connected to the adapter and shaft coupling in such a manner as to eliminate pump axial loads from the motor, allowing standard NEMA design motors to be used.
d. The thrust bearing will also remove the necessity for adjustments of any other moving part during the pump life cycle.

6. Connections:
   a. Pump assembled in a vertical shaft configuration with the suction and discharge connections being in-line at the bottom.
   b. Suction and discharge connections shall have same size flanges drilled for ANSI 250 rating.
7. Electric Motor:
   a. In accordance with Section 16220, Low Voltage AC Induction Motors.
   b. Enclosure: TEFC.
   c. Power Supply: 480V, 3-phase.
   d. Horsepower: as required for specified irrigation water supply performance and system configuration.
8. Manufacturers:
   a. Armstrong.
   b. NOCCHI.
   c. March Pump (mag. drive).

D. Nutrient Metering Pump:

1. To be installed within each Water Panel (FP-X-1-1).
2. Simplex, motor-driven, reciprocating, mechanically actuated diaphragm type or solenoid type.
3. Integral motor, oil-lubricated gear reducer, and a cam-spring drive mounted in aluminum housing.
4. Ceramic balls and PTFE seats.
5. Head and Fittings: PVC.
6. Fixed stroke frequency, adjustable stroke length.
7. PVDF injection check valve, foot valve, ceramic weight, and factory tubing.
8. Flow Range: 0.125 to 0.4 gph.
9. Maximum Injection Pressure: 110 psi.
10. Manufacturer and Product: LMI, Series P0; Wallace and Tiernan, Premia 75.

E. Control Panel:

1. Houses electronic and electric components required to monitor and control operation of system.
2. Panel factory fabricated for field installation on support frame.
3. Refer Article, Instrumentation and Controls, for additional requirements.

F. Odorous Air Blowers: Refer to Section 11583, Odor Control Blowers.

G. Odorous Air Ductwork and Accessories: Refer to Section 15815, Fiberglass Reinforced Plastic (FRP) Ductwork and Accessories.

H. Piping and Accessories:

1. For piping, refer to Section 15200, Process Piping-General.
2. For valves, refer to Section 15202, Process Valves and Operators.

I. Miscellaneous Components:

1. Instrumentation Manufacturer and Products: Biotower Supplier's preference, except as noted below.
2. Pressure Gauges: Ashcroft; Duragauge Model 1279, furnished with snubber.
3. Pressure Seal, Diaphragm:
   a. Ametek or Ashcroft.
   b. Materials suitable for application.
4. Motorized Valves:
   a. As specified in Section 15202, Process Valves and Operators, Type V940.
   b. Valves shall be rated for Class 1, Division 2, Group D unless mounted more than 3 feet away from biotower.
5. Nutrient Tank:
   a. UV resistant plastic material, minimum 2-1/2 gallons capacity.
   b. Full tank of liquid nutrients, composition as required to treat Site water to provide water quality in accordance with Article Service Conditions.
   c. Supplier to provide a 12 month supply of nutrients at no additional cost to Owner.

J. H_2S Monitoring (one system):

1. Manufacturer and Product: Detection Instruments Low Range Sampling System (LRSS-2).
   a. One 0-200 ppm Odalog, one low range Odalog.
   b. Calibration kit.
   c. Operations software.
   d. User’s manual.
   e. Sampling tubing.
   f. Communication cables/linking hardware.

2.04 INSTRUMENTATION AND CONTROLS

A. General:

1. Control system shall comply with requirements of Section 13390, Package Control Systems.
2. Provide field panels, electrical components and wiring for a complete, functional system.
3. Provide all items not specifically specified which are required to implement the specified functions and the functions required for proper system operation.

B. Field Panels:

1. Provide field panels and instruments with external interfaces as shown on the Instrumentation and Control Drawings.
2. Construct the field panels in accordance with Section 13390, Package Control Systems.
3. Panel shall contain the local control and monitoring for the odor control system components. This includes, but is not limited to, valves, pumps, analyzers, and flow meters.
4. The system supplier shall provide the panel complete with PLC, operator interface, and all input/output hardware. PLC shall be Modicon TSX Micro or Nano Series. Modicon Momentum will not be accepted.
5. Provide the Following Field Panel(s):

Panel No.	Name	NEMA Rating	Enclosure Materials
FP-6-1-2	Lift Station No. 6 Biotower Control Panel	4X	Type 316 stainless steel or FRP
FP-7-1-2	Lift Station No. 7 Biotower Control Panel	4X	Type 316 stainless steel or FRP
FP-50-1-2	Lift Station No. 50 Biotower Control Panel	4X	Type 316 stainless steel or FRP
FP-6-1-1	Lift Station No. 6 Biotower Water Cabinet	4X	Type 316 stainless steel or FRP
FP-7-1-1	Lift Station No. 7 Biotower Water Cabinet	4X	Type 316 stainless steel or FRP
FP-50-1-1	Lift Station No. 50 Biotower Water Cabinet	4X	Type 316 stainless steel or FRP

6. Operator Controls and Indicators:
   a. As a minimum, the following operator interface functions and displays shall be provided on the panel exterior:
      1) Control Panels FP-X-1-2: GENERAL ALARM indicating light.

2) Water Panels FP-X-1-1: None

b. As a minimum, the following operator interface functions and displays shall be provided on the panel interior:

1) Field Panels FP-X-1-2:

a) GENERAL ALARM indicating light.
b) ALARM RESET pushbutton.
c) LAMP TEST pushbutton.
d) Main power ON/OFF selector switch.
e) Master HAND/AUTO selector switch.
f) Irrigation Valve OPEN indicating light.
g) Irrigation Valve OPEN/CLOSE/AUTO selector switch.
h) Odorous Air Blower HAND/OFF selector switch.
i) User Interface Module, for PLC.
j) User Interface with PLC:

(1) Provide the following minimum user adjustable control parameters.
(2) Reactor Irrigation CYCLE FREQ, Minutes (time between successive irrigation cycle start signals).
(3) Reactor Irrigation CYCLE TIME, Seconds (duration of irrigation cycle).

k) Provide the following minimum user control commands:

(1) RESET irrigation water flow total.
(2) RESET Alarm history.
(3) RESTART Irrigation Cycle.

7. External Interfaces:

a. As a minimum, the following functions shall be provided:

1) Field Panel FP-X-1-2:

a) Discrete Outputs:

(1) COMMON FAIL ALARM for the odor control system.
(2) Blower failure.
(3) Blower ON status.

8. Functional Requirements:

a. As a minimum, the following functions shall be provided:

1) Field Panel FP-X-1-2:

a) A COMMON ALARM output shall be provided on any of the following conditions:

(1) Low irrigation water flow (irrigation valve open but water flow low).
(2) High irrigation water flow (irrigation valve open but water flow high).

(3) Unexpected water flow (irrigation valves closed but water flow recorded).

b) Irrigation Water Motorized Valve Control:
   (1) CLOSE motorized valve when the respective selector switch is in the CLOSE position or the selector switch is in the AUTO position and the automatic scheme calls for the valve to close.
   (2) OPEN motorized valve when the respective selector switch is in the OPEN position or the selector switch is in the AUTO position and the automatic scheme calls for the valve to open.
   (3) Any OPEN valve will activate VALVE OPEN indicating light.

c) Odorous Air Blower:
   (1) START blower when the respective selector switch is in the HAND position.
   (2) STOP blower when the respective selector switch is in the OFF position.

d) Reactor Irrigation Cycle:
   (1) Command Irrigation Valve OPEN.
   (2) START Irrigation cycle timer.
   (3) Command Irrigation Valve CLOSED after CYCLE TIME duration.

e) System Manual Operation:
   (1) Master HAND/AUTO selector switch in the HAND position.
   (2) SUSPEND automatic cycle timers.
   (3) CLOSE irrigation valves.
   (4) No automatic operation of irrigation valves.
   (5) Manual operation of control components via selector switches in control panel.

f) System Automatic Operation:
   (1) Master HAND/AUTO selector switch in the AUTO position.
   (2) Reactor Irrigation Cycle:
      (a) START irrigation cycle frequency timer.
      (b) Initiate Reactor Irrigation Cycle.
   (3) Repeat Reactor Irrigation Cycle when irrigation cycle frequency timer reaches CYCLE FREQ set point.

g) Trend Display:
   (1) Irrigation water consumption, current day.
   (2) Irrigation water consumption, previous day.

(3) Irrigation water consumption, total to date, since last reset.
(4) Alarm history.

2) Field Panel FP-X-1-1: Control via FP-X-1-2.
a) Include thermostatically controlled heater.
b) Include nutrient pump with AC motor and manual stroke adjustment. Pump to be duty cycled in FP-X-1-2 by cycling of power.
c) Include flow monitor on nutrient pump discharge. Pulses to be transmitted to FP-X-1-2 to detect pump failures.
d) Include water spray control valve. Valve to be opened and closed via cycling of power from FP-X-1-2.
e) Include flow transducer on discharge of water line. Pulses to be transmitted to FP-X-1-2 for control and monitoring functions.
f) Provide manual valves and piping as schematically represented on P&ID.

9. Power Supply:
a. Field Panel FP-X-1-2: 480V, 60-Hz.
b. Field Panel FP-X-1-1: All power provided by FP-X-1-2.

2.05 ACCESSORIES

A. Anchor Bolts: Sized by equipment manufacturer and as specified in Section 05500, Metal Fabrications and Castings.

B. Lifting Lugs: Equipment weighing over 100 pounds.

C. Equipment Identification Plate and Equipment Tags: Provide in accordance with Section 01600, Material and Equipment.

2.06 FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09900, Painting and Protective Coatings, System No. 4. Color shall match the color of the connected process piping as defined on the Piping Schedule in Section 15200, Process Piping-General.

2.07 SOURCE QUALITY CONTROL

A. Factory Test: Perform manufacturer's standard test on equipment.

B. Motor Test: See Section 16220, Low Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 GENERAL

A. Packaged Equipment: When any system is provided as prepackaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.02 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Anchor Bolts: Accurately place using templates furnished by fabricator and as specified in Section 05500, Metal Fabrications and Castings.

3.03 FIELD FINISHING AND CORROSION PROTECTION

A. Field touchup in accordance with Section 09900, Painting and Protective Coatings, or as determined by manufacturer.

3.04 FIELD QUALITY CONTROL

A. Provide Field Quality Control Tests in Accordance with Section 01810, Equipment Testing and Facility Startup.

B. Functional Tests:

1. Conduct on each piece of equipment in the system.
2. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
3. Blower Vibration Test: Refer to Section 11583, Odor Control Blowers.
4. Ductwork Pressure Testing:
   a. Conduct pneumatic tests on all ductwork at the pressures listed.
   b. Test procedures shall be as specified in Section 15815, Fiberglass Reinforced Plastic (FRP) Ductwork.
5. Air Balancing:
   a. Provide for services of an independent air balancing and testing firm to balance the odorous air into Biotower System as shown in the Contract Documents and as required in Section 15950, Foul Air Collection System Testing, Adjusting, and Balancing.
   b. Test and balance biotower odor control system in operation.

6. Biotower System:
    a. Test all system components for proper adjustment and operation in both the manual and automatic operating modes.
    b. Irrigation System:
        1) Allow the biotower to operate for a 48-hour period with control system in the AUTO mode.
        2) Monitor proper irrigation system operation; make adjustments as necessary.
    c. Provide certification of functional acceptance prior to commencing performance testing.

C. System Startup:

1. Performed by Manufacturer.
2. Startup will commence following a visual inspection and check out of the System by the Manufacturer's technical representative
3. Specialized materials to be used during the startup such as inoculums, shall be furnished by the Manufacturer.
4. The reactor vessel media will be irrigated with water drawn from and returned to the recirculation tank. This mode of operation, designed to acclimate the biomass, will last for approximately the first 3 weeks of system operation.
5. Total system acclimation will be accomplished within 6 weeks of system startup.

D. Performance Testing:

1. General:
    a. To demonstrate that the Biotower System furnished hereunder is installed and performs in accordance with the provisions of these Specifications, the Manufacturer shall conduct a performance test on each odor control system in accordance with an approved testing protocol.
    b. The performance test shall not commence until a Performance Testing Plan has been submitted and approved, and the functional testing has been completed.
    c. The Contractor shall demonstrate that all required interfaces with the plant control system are properly transmitted and received by the control system.
    d. The Manufacturer shall provide, install, and maintain, if required, all temporary metering or analytical equipment necessary to measure the various performance parameters.
    e. The Manufacturer shall provide for all sampling and laboratory analysis. Laboratory analysis shall be done by an independent testing laboratory and paid for by the Manufacturer.

f. Before the performance test begins, the Engineer and the Manufacturer shall meet and agree upon the procedures and guarantee points to be used. Such agreements shall be included in the written Performance Testing Plan submittal.
g. The Manufacturer shall inform the Engineer at least 14 days prior to the start of any performance testing. The Engineer shall have the right to observe, sample, and make any parallel determinations during the performance test.
h. Within 30 days after the conclusion of the test period, the Manufacturer shall submit a Performance Test Report, including all laboratory and field test data, stating the conclusions of the test with regard to the performance criteria.

2. Performance Tests: Conduct performance test on Biotower System under actual or approved simulated operating conditions as described in this Section.
   a. Test only after supplier-approved acclimation period for biotower. Acclimation is not to exceed 6 weeks.
   b. Test using actual H_2S loading conditions.
   c. Collect inlet and outlet Tedlar bag odor samples for analysis by ASTM Standard of Practice E679. Odor Panel presentation rate to be 20 liter/min.
3. Test Conditions:
   a. The performance test shall be conducted while the sources being controlled are fully operational and at loadings acceptable to Engineer. The biotower shall have been fully functional and receiving odorous air from these facilities for a minimum of 4 consecutive weeks prior to commencing the testing.
   b. All testing, adjusting, and balancing of the fan shall have been completed and approved.
   c. The test shall be conducted over an 8-hour period with sampling and data measurements being evenly distributed over that time period.
   d. The actual sample day shall be chosen for low wind speeds and no rain or snow.
4. Sampling and Data Measurement: During the test period, as a minimum, the following data and measurements shall be taken at the frequency indicated:
   a. Overall System Airflow Rate: Every hour.
   b. Biotower Inlet Pressure in Inches of WC: Recorded hourly.

c. Hydrogen sulfide concentrations (ppbv/ppmv) at the inlet to the biotower system: Every hour.
   1) H_2S measurements to be performed by hand-held instrument previously approved by Engineer, (e.g., Jerome 631X).
   2) Inlet H_2S concentrations during each sampling period will first be screened using gas-phase H_2S adsorbent tubes, (e.g., GAS-TEC).
   3) For inlet concentrations exceeding Jerome 631X operating ranges, e.g., 50 ppmv, inlet concentrations used in determining overall removal will be obtained from instrumentation with operating range matching screening results; eg. INTERSCAN 1170 with range 1-199 ppmv.
   4) For adsorbent tube results indicating inlet H_2S concentrations below 50 ppmv, Jerome 631X readings will be taken and used in determining removal efficiencies.

d. Hydrogen sulfide (ppbv) concentrations at the outlet of each modular unit: Every hour. Individual hourly performance results will then be calculated by:
   1) Percent Removal = (Inlet - Outlet)/ Inlet. Note: Percent Removal is only applicable when the biotower inlet sample's concentrations for hydrogen sulfide are greater than 10 ppmv. For concentrations less than 10 ppmv hydrogen sulfide, all average biotower outlet samples must be less than 100 ppbv to meet performance verification requirements. Individual hourly removal rates will be averaged to determine system average removal rates for hydrogen sulfide.

e. Odor Concentrations at the Outlet of the Biotower:
   1) Biotower exhaust sampling will be performed before inlet sampling to minimize risk of sample carryover.
   2) Two samples to be collected; one at the beginning of the 4-hour time mark, the second at the beginning of the 8-hour time mark.
   3) Odor removal rates to be calculated using same methodology described for hydrogen sulfide.
   4) For average inlet odor concentrations < 5,000 OU, system-average exhaust odor concentrations must not exceed 500 OU.

f. Odor Concentrations at the Inlet to the Biotower: Two samples to be collected; one at the beginning of the 4-hour time mark, the second at the beginning of the 8-hour time mark.

g. A photographic record of the sampling technique and bed sampling location will be completed for each type of sampling.

h. Sampling Log: A sampling log shall be maintained that will include:
   1) Date, time, location, sampler, and results of each sample.
   2) A description of each photograph taken.
   3) Weather conditions for the sampling day.
   4) A qualitative description of the operation of the wastewater and wastewater treatment processes.
   5) A description of any deviations from the sampling plan.

i. System Pressure Drop: Pressure differential measurements shall demonstrate that differential pressure (pressure drop) across each biotower; do not exceed pressure limits specified. Measurements will be recorded hourly for each biotower.

j. Hydrogen Sulfide Sampling and Analysis:
   1) Hydrogen sulfide sampling shall be completed using a Jerome Model 631 X Analyzer or approved equal with a detection limit of 1 ppbv.
   2) The analyzer shall be operated in compliance with the manufacturer's instructions.
   3) A copy of the instructions shall be submitted with the final report.
   4) The results of the hydrogen sulfide sampling shall be recorded in the sampling log.

k. Odor Sampling and Analysis:
   1) Biotower inlet and exhaust outlet shall be sampled and analyzed for Detection Threshold odor concentration, intensity and hedonic tone.
   2) Samples shall be collected in Tedlar bags, using the sampling procedure described in EPA Method 18 with either a vacuum chamber or vacuum pump.
   3) Odor panel shall be performed in accordance with ASTM E679 and odor intensity in accordance with ASTM E544.
   4) Hedonic tone shall also be reported.
   5) Odor panelist presentation rates of 20 liters per minute shall be used.
   6) Bag samples to be collected and analyzed within a 24 hour period.

5. Retesting: In the event the biotower fails to meet the performance requirements, the Manufacturer shall immediately make the necessary modifications, adjustments, and/or facility expansions to meet these requirements. The steps taken by the Manufacturer shall include, as necessary, design and construction of additional biotower capacity, upgrades to the air distribution system, and replacement of the media, all at no additional cost to the Owner.

a. Additional performance tests will be conducted by Manufacturer until the performance requirements are met, at no additional cost to the Owner.
b. If after two retests the performance requirements are still not met, the Owner will have the option, at the Owner's sole discretion, to accept the system as is or obtain a replacement at the expense of the Manufacturer.
c. The maximum time between each retest will be 30 days.

6. Demonstration of Performance: Promptly after the performance test is satisfactorily completed, the Owner will give written notice of the final acceptance of the biotower to the Manufacturer.
7. During the guarantee period following an acceptable system performance test, the Owner may, at his cost, inspect or retest the system for conformance to these specifications. The Manufacturer will be notified of these tests, and he may witness the test and inspections. If the system fails to meet the performance requirements, the guarantee provisions of these Specifications shall apply.

3.05 MANUFACTURERS' SERVICES

A. Provide manufacturer's services in accordance with Section 01640, Manufacturers' Services, and as follows.

B. Manufacturer's Representative: Present at Project Site or classroom designated by Owner, for minimum person-days listed below for each system, travel time excluded:

1. 3 person-days for installation assistance and inspection.
2. 2 person-days for Functional Testing, and Manufacturer's Certificate of Proper Installation.
3. 2 person-days for assistance in completing the Operational Readiness Test (ORT).
4. 1 person-day for Prestartup Classroom and Onsite Training.
5. 2 person-days for Startup and Performance Testing.

C. Manufacturer's representative shall make separate trips to the Project Site to complete the above services. The minimum number of trips required is three.

D. See Section 01810, Equipment Testing and Facility Startup.

END OF SECTION