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CITY OF SUNNYVALE

WATER POLLUTION CONTROL PLANT

DESIGN STANDARDS

ODOR CONTROL

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carollo in association with HDR

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ODOR CONTROL

1.0 PURPOSE AND CONTENT

This document describes the odor control design standards to be used for the improvement projects at the City of Sunnyvale's (City) Water Pollution Control Plant (WPCP). These standards will be used for preliminary and final design of the WPCP improvements.

2.0 STANDARD DEFINITIONS AND ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BAAQMD	Bay Area Air Quality Management District
CFM	Cubic Feet per Minute
CBC	California Building Code
CEQA	California Environmental Quality Act
CFC	California Fire Code
CHSC	California Health and Safety Code
City	City of Sunnyvale
CMC	California Mechanical Code
CPC	California Plumbing Code
FM	Factory Mutual
FRP	Fiberglass Reinforced Plastic
FPM	Feet Per Minute
HP	Horsepower
HVAC	Heating, ventilation and air conditioning
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association

OSHA	Occupational Safety and Health Act
RPM	Revolutions Per Minute
SCADA	Supervisory Control and Date Acquisition
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
TSP	Total Static Pressure
UL	Underwriters Laboratories Inc.
VFD	Variable Frequency Drive
WC	Water Column
WPCP	Water Pollution Control Plant

3.0 CODES AND STANDARDS

The odor control systems shall be designed and built to the following codes and standards. The latest adopted version of these codes and standards shall be used:

- Applicable City of Sunnyvale and Santa Clara County ordinances and codes
- American National Standards Institute (ANSI)
- ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
- ASHRAE, HVAC Applications Handbook
- Bay Area Air Quality Management District Air Quality Guidelines
- California Environmental Quality Act
- California Health and Safety Code
- Industrial Ventilation: Handbook of Recommended Practice
- International Building Code (IBC) as amended by the State of California
- International Mechanical Code (IMC) as amended by the State of California
- International Plumbing Code (IPC) as amended by the State of California
- NFPA Standard 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities

- Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) Duct - Construction Standards – Metal and Flexible
- SMACNA – Thermostat fiberglass reinforced plastic (FRP) Duct Construction Manual
- State of California Occupational Safety and Health Act (CalOSHA)
- U.S. Department of Labor Occupational Safety and Health Act (OSHA)

4.0 GUIDELINES AND PROCEDURES

There are no national regulatory requirements/standards on odor emissions. Individual state and local requirements typically have jurisdiction. In this case, California is regulated under the California Environmental Quality Act and the California Health and Safety Code Section 41700 which states “A person shall not discharge from any source whatsoever such quantities of air contaminants or other material which cause injury, determent, nuisance, or annoyance to any considerable number of people.”(1) The regulation does not state how a violation should be determined or provide enforcement criteria.

Sunnyvale is located in Santa Clara County and is also within the jurisdiction of the Bay Area Air Quality Management District (BAAQMD). The BAAQMD considers an odor source with five or more confirmed complaints per year, averaged over three years, to have a significant impact. Although the WPCP currently has no air or liquid treatment systems specifically intended to control odors, City staff report that the WPCP has not received odor complaints. Therefore, the WPCP is not considered to be a significant odor source and odor control decisions are not driven by regulatory compliance, but rather by the desire to be a good neighbor and protect the environment.

With the WPCP Master Plan and primary treatment facility design, the City wishes to be proactive and make provisions for odor control including preparation of these odor control design standards.

4.1 Related Design Standards

Refer to the Mechanical Design Standards for information on Heating, Ventilation and Air conditioning equipment, pumps, piping and ducting requirements.

Refer to the Instrumentation and Control Design Standards for information on instrumentation and controls.

4.2 Odor Control Equipment

Odor control equipment includes exhaust fans, ductwork and bioscrubber odor control systems. Proper selection of the type and size of equipment is necessary for a functional design.

4.2.1 ***Equipment Location Considerations***

Odor control equipment can be located either indoors or outdoors although freeze protection may be required if located outdoors. An inside location is more protective of the equipment and is less unsightly, but it can create a larger, more costly building especially since the bioscrubbers are typically quite tall. An outdoor location is recommended for the bioscrubbers in this case. The odor control fans should also be located outside and at ground level.

Since the bioscrubbers can be quite tall, special access must be provided for elevated instruments, spray nozzles and other equipment that cannot be accessed at ground level. Provision of access ladders and platforms should be evaluated during the design process. Where provision of access ladders and platforms cannot be accommodated due to space constraints, added cost, or other reasons, at a minimum, provide space adjacent to the bioscrubbers for man-lifts that can be used to access the elevated portions of the scrubbers.

Exhaust fans are typically mounted at ground level. If located outdoors, acoustic sound enclosures may need to be provided to meet noise guidelines listed in Section 4.3.4.

4.2.2 ***Makeup Air Intake***

Locate the makeup air intakes as near the source of the odor as possible but also located to provide good cross-flow and avoid short-circuiting. A minimum negative pressure of 0.1” WC shall be maintained throughout the enclosed space. Multiple intake points may be required to prevent fugitive emissions. Makeup air intake louvers should be sized for 0.25 inch WC or less pressure drop. The intake velocity should be no more than 700 fpm, although this varies with the louver type and manufacturer.

4.2.3 ***Access***

Provide adequate clearance, a minimum of four feet, around each piece of odor control equipment including the odor control fans, bioscrubbers and control panels. There shall be adequate space to remove fan wheels, shafts, bioscrubber media, etc. Follow the manufacturer’s equipment dimensions for appropriate clearances. Products from at least two odor control system manufacturers should be considered during the layout process to be assured that there will be adequate space on the site to properly operate and service the equipment. List these manufacturers in the equipment specifications.

For all outdoor installations, the equipment shall be equipped with water tight access panels or hatches that are hinged for opening.

Provide access doors in ductwork for dampers, instruments, inspection, and cleaning.

Provide adequate clearance around the ductwork that requires cleaning.

The odor control system area shall be free from trip hazards such as water piping, drain piping and electrical conduit. Utilities routed to the odor control equipment shall be placed below the slab to the greatest extent possible.

4.2.4 ***Noise***

Noise levels for outdoor exhaust fans will be designed to limit the noise levels to 75 dBA at fence lines around the plant site per City of Sunnyvale commercial noise ordinances. If necessary, acoustic sound enclosures shall be provided for the fans to meet or exceed noise limits. The sound enclosures shall be manufactured in a way that provides convenient access to grease fittings and easily removable to allow complete access to fan motor, housing and belts. It shall also include a separate ventilation fan to remove heat from the enclosure.

4.2.5 ***Exhaust Fans***

4.2.5.1 Fan Materials

All parts that come in contact with the air stream shall be FRP or FRP encapsulated. The fan shall be constructed in strict accordance with ASTM D-4167 standard specification for FRP fans and blowers to ensure structural integrity. Fan shall be statically and dynamically balanced at design operating speed prior to shipment.

All parts of the fan that may come in contact with the air being handled shall be made of nonferrous material for spark resistance.

4.2.5.2 Fan Accessories

Required fan accessories are:

- Constant V-belt drive.
- Inspection port.
- Positive screw adjustment.
- Threaded drain w/plug.
- All-vinyl ester construction for parts in contact with air stream.
- Flanged and drilled inlet and outlet.
- Wafer-type outlet damper.
- Flanged flexible connector on damper outlet.
- Weather cover.

- Belt guard.

4.2.6 ***Ductwork***

4.2.6.1 Service Conditions

All ductwork shall be designed for a minimum working pressure of 14-inch WC Positive and 14-inch WC Negative pressure. Duct shall have a safety factor of 10 to 1 for pressure and 5 to 1 for vacuum.

4.2.6.2 Duct Sizing and Velocity Ranges

The computation of total system pressure (static pressure plus velocity pressure) will be based on the equal friction method as defined in SMACNA. All odor control ducts shall be sized for the following air velocities:

- 6" – 8" ducts: 1,000 to 1,800 fpm.
- 10" – 42" ducts: 1,800 to 2,500 fpm.
- >48" ducts: 2000 to 3,000 fpm.

4.2.6.3 Materials

Ductwork shall be designed and fabricated for odor control service to carry warm, moisture-laden air with hydrogen sulfide, mercaptans and other organic and inorganic compounds typically associated with wastewater treatment as well as the possibility of greases, and petroleum products.

Acceptable below grade duct materials include FRP and high density polyethylene (HDPE).

Above grade duct material shall be FRP.

FRP ductwork shall meet the following requirements.

4.2.6.3.1 FRP Duct Design

Wall thickness for internal positive pressure should be determined by ASTM 22310 using duct manufacturers Certified ASTM 2992 Hydrostatic Design Basis (HDB) test results. A full copy of the HDB testing should be submitted with the wall thickness calculations.

Duct wall thicknesses shall meet or exceed thicknesses listed in Table 1. Duct wall may need to be thicker to meet pressure and vacuum design requirements.

Table 1 FRP Duct Minimum Wall Thicknesses Odor Control Design Standards City of Sunnyvale	
Duct Inside Diameter (Inches)	**Minimum Wall Thickness (inches)**
<18	0.25
20-36	0.375
42-54	0.50
60-72	0.625

4.2.6.3.2 FRP Duct Material

The interior liner in contact with the contaminated exhaust airstream shall be a minimum of 100 mils thick and constructed of materials resistant to hydrogen sulfide and sulfuric acid. The corrosion liner shall be laid-up as a separate corrosion barrier from the intermediate structural layers.

The internal liner shall be formed with a 10 mil C-glass veil for superior corrosion resistance. Two layers of 1.5 ounce per square foot chopped strand mat and spray-up chopped borosilicate glass shall make up the balance of the internal liner to achieve 100 mil total thickness.

The corrosion liner shall gel completely prior to continuing with the structural layer.

Resin used for the internal corrosion-resistant liner shall be Reichhold Dion Ver 9300 FR, Ashland Hetron FR 992, Dow Dera Kane 510-A or equal. Resin-to-glass ratios shall be 90 percent resin, 10 percent glass.

The resin shall carry a flame spread rating of 25 or less, and smoke contribution rating of Unrated (in excess of 1000) with the addition of 3 percent antimony trioxide. Design engineer shall check local codes for possible additional smoke rating requirements.

The intermediate layer of duct wall thickness shall be fabricated by either filament wound techniques on circular ducts to the dimensional thickness and strength as required by NBS PS 15-69 standards. Hand lay-up techniques may be used for fittings and rectangular ducts.

Resin for the intermediate structural layer shall be Reichhold VER 9300 FR Ashland Hetron FR992, Dow Dera Kane 510-A or equal. Resin to glass ratios shall be 66 percent resin, 33 percent glass. The resin shall carry a flame spread rating of 25 or less, and smoke contribution rating of Unrated (in excess of 1000) with the addition of 3 percent antimony trioxide.

The exposed external surface of all FRP ductwork installed whether indoors, on grade or on the roof, shall provide protection against ultraviolet degradation and weather erosion. The duct shall carry a flame spread rating of 25 or less and a smoke contribution rating of Unrated (in excess of 1000).

All ductwork shall be identified by a finished appearance.

External duct protection shall be provided by an ultraviolet stabilizer added to the final coat of resin that also incorporates parafinated wax curing elements and color pigment.

4.2.6.3.3 FRP Fittings

All fittings shall be hand lay-up construction fabricated from the same resin and have the same strength as FRP ductwork.

All fitting dimensions shall be in accordance with NBS PS 15-69.

The internal diameter of all fittings shall be equal to the adjacent duct.

The tolerance on angles of all fittings shall be ±1 degree up to and including 24-inch diameter and ± 1/2 degree for 30-inch diameter and above. Nozzles for water fittings shall be in compliance with ANSI, 150lb.

Increasers/reducer lengths shall be at least five times the difference in diameter.

4.2.6.3.4 FRP Elbows

The centerline radius of all elbows shall be 1-1/2 times the diameter, unless noted otherwise on the drawings.

Elbows 24-inch diameter and smaller shall be smooth radius. Elbows 30-inch and larger shall be mitered. Provide a minimum of two mitered joints (3-piece) for all elbows above 45 degrees.

4.2.6.3.5 FRP Flanges

Provide flanged connections to flexible connectors, expansion joints, vessels, demisters, fans, silencers and other locations as shown on the drawings.

Flanges shall be hand lay-up construction. Dimensions shall be in accordance with NBS PS 5-69.

Flanges shall be drilled in accordance with PS 15-69, Table 2. Bolt holes shall straddle the centerline of the duct. Backs of flange face shall be flat so that washer seats fully on bolt face and flange backing.

Gaskets shall be EPDM, full face and minimum 1/8-inch thickness.

All bolts, nuts and washers shall be Type 316 stainless steel.

4.2.6.3.6 FRP Joints

Provide all butt and wrap joints in accordance with ASTM D 3982, PS 15-69 and manufacturer's drawings.

Field weld kits shall be supplied by the duct manufacturer. All necessary fiberglass and reinforcing material shall be supplied pre-cut and individually packaged for each joint. Bulk Glass rolls will not be acceptable.

All resin, catalyst and putty shall be supplied in quantities to complete all field joints plus 20 percent extra for waste.

4.2.6.4 Accessories

4.2.6.4.1 Expansion Joints

Expansion joints/flexible connectors shall be installed at the following locations:

- Where ducts of different materials are joined together.
- Where ducts join up with fans.
- Every 100 feet of above grade straight duct.
- Where required for assembly and field fit-up.
- Other locations as determined by the design engineer.

The expansion joints shall be made of virgin PVC and shall not harden. Series 300 stainless steel adjustable clamps shall be used to fasten the expansion joint to the duct. Joint shall slide over the ends of the two sections of duct. A 1-1/2-inch gap shall be left between the duct ends.

Expansion joints are not to be used to connect to fan inlets/outlets. Flanged flexible connectors are to be used there.

4.2.6.4.2 Butterfly Dampers (Volume Control Dampers)

All round FRP dampers shall be the butterfly type. FRP fabrication shall meet the corrosion requirements specified in this Section for FRP duct work.

Leakage shall not exceed 2 cfm/sq. ft at 30 inches W.C.

Frame and blade: Premium vinyl ester resin. Blade shall fully encapsulate shaft. Blades that bolt to a single side of the shaft will NOT be accepted.

Shaft: Solid Type 316 stainless steel for all dampers.

Bearings and bushings: Teflon.

Pins and all hardware: Type 316 stainless steel.

Shaft seals: EPDM.

Provide all round isolation dampers with a blade stop consisting of FRP angles with full circumference EPDM seals.

All dampers shall have flanged ends. Contractor to provide connecting bolts, nuts and washers.

All dampers 14-inch or larger shall be provided with gear operators with an epoxy coating. Dampers below 14-inch shall be supplied with hand quadrant actuators fabricated of Type 316 stainless steel with a locking quadrant Indicator. All balancing dampers shall have a fully adjustable slot with an extra hole drilled in the handle for contractor to "drill and pin-in place" once system is balanced so handle cannot vibrate loose. Drawing may indicate motorized actuators; if so that shall take precedence. Any dampers over 8-feet AFF shall be furnished with chain wheel gear operators.

All Isolation dampers provided shall bear the AMCA seal. Dampers are to have been tested in an AMCA laboratory for performance (pressure drop) and leakage.

4.2.6.5 Duct Hangers and Supports

All duct supports, interior and exterior, shall meet the requirements of the Mechanical Design Standards, except that hangers and supports for fiberglass duct shall be located at maximum spans as shown in ASTM D 3982, Table 1.

Duct supports located on the exterior of a building shall be designed to include the weight of the duct and to withstand all applicable combinations of wind and seismic loading in accordance with the State Building Code. Exterior supports shall be located as shown on the Drawings and shall be of the "saddle type" support as per the standard detail shown on the Drawings. The locations of duct supports shown on the Drawings are approximate, and the CONTRACTOR shall be required to confirm the support requirements and locations.

4.2.7 ***Bioscrubbers***

Bioscrubber odor treatment systems shall meet the following requirements.

4.2.7.1 Process Description

The odor control system shall remove hydrogen sulfide, organic reduced sulfur compounds (RSCs) and other odorous compounds from the foul air stream using a bioscrubber operating in a counter-current fashion. Co-current systems shall not be allowed.

The foul air shall enter the system at the bottom of each reactor and flow upward through each of the media layers. The media bed shall be irrigated from above using suitable

reclaimed plant effluent or potable water . The water then trickles through the media and is collected in a sump at the bottom of the reactor where it is either recirculated or overflows to drain. The drain water from the system will pass from the sump in the bottom of the reactor vessel and be piped to drain. The drain water will have a low pH, therefore the drain piping will be made of PVC or other corrosion resistant material.

The hydrogen sulfide is oxidized by the autotrophic bacteria resident in the lower media layer(s). As the foul air passes through the upper media layer(s), the resident heterotrophic bacteria will oxidize other organic odorous compounds. The airstream is then released to the atmosphere via the exhaust stack at the top of the reactor.

The bioscrubber shall remove at least 99% of the inlet H2S, or have an outlet H2S concentration so less than 0.5 ppm, whichever is higher.

4.2.7.2 Bioscrubber Vessel

The bioscrubber vessel shall be free standing and of vertical “tower” configuration operating in a counter-current manner. Each vessel shall consist of one (1) or more modules containing plastic, structured media and one (1) top piece. Each module shall be constructed from FRP and be designed with adequate strength to support the number of required modules. Each FRP module shall contain, as a minimum, a 100 mil vinyl ester resin corrosion barrier. The structural layer shall consist of isophthalic resin with chop strand and continuous glass. The exterior top coat shall be isophthalic resin with UV resistant pigment (minimum service life of 10 years).

The reactor vessels shall be provided with 316 stainless steel hold down lugs to account for all anticipated loads to comply with local wind code requirements.

4.2.7.3 Media

The media shall be high porosity, chemically resistant, engineered, plastic, synthetic porous material made from polyvinyl chloride, polyethylene or polyurethane, or equal. Organic media, carbon derived lava rock or lava rock media shall not be allowed. The media characteristics (available surface area, density, and pressure drop) shall be structured or randomly dumped and uniform throughout the media bed.

The media shall have a minimum available specific surface area of 230 ft^2/ft^3 and a void opening of more than 96 percent. Pressure drop shall not exceed 0.17-inch w.g. per foot of media depth.

The media shall be guaranteed not to clog or require cleaning, scrubbing, backwashing, acid-washing or replacement for a period of ten (10) years.

Media shall resist compaction or swelling due to varying moisture levels and shall not degrade when subjected to low pH (i.e., pH < 2) conditions.

The media shall minimize the potential for short circuiting and encourage a uniform water and air flow pattern over the entire media cross sectional area.

The media manufacturer shall provide evidence that the airflow through the media at a 24-inch height from the bottom of the media is homogeneous at the average airflow rate.

Sufficient media shall be provided to ensure the performance requirements are met.

4.2.7.4 Irrigation System

Each reactor shall be configured with at least one (1) irrigation point which shall distribute the irrigation water evenly over the entire upper surface of the media layer. Each spray nozzle shall be tested by the manufacturer and a certificate of conformity supplied with the shop drawings to show that the nozzle has been tested and meets the specified standards for uniform distribution.

The irrigation system shall be supplied with the following components as a minimum:

- A nutrient addition system to provide the macro and micronutrients required by the bacteria for optimal metabolism of the odorous compounds being treated.
- Automatic control valve controlled by system PLC.
- Recirculation flow meter and transmitter.
- Nutrient feed flow meter and transmitter.

4.2.7.5 Electrical Control Panel (ECP)

Electrical controls shall be housed in a NEMA 4X panel constructed of Type 316 stainless steel. The ECP shall house the necessary electronic components for the control and monitoring of the irrigation system.

The ECP shall be mounted at the minimum distance from the foul air stream required by NFPA 820. The panel shall also be in compliance with electrical, instrumentation and controls design standards.

4.2.7.6 Water Control Panel (WCP)

The WCP shall be constructed of Type 316 stainless steel and 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 allow for a single connection to either a potable water source or suitable final effluent plant water source and house the pump and controls for the nutrient addition system.

The WCP shall also contain a flexible spray hose with a hand trigger to allow for convenient rinsing of the strainer, filling of the nutrient barrel, and general convenience. A dedicated ball valve shall be provided in front of the spray hose to allow for the operation of the water panel while simultaneously allowing for bioscrubber operation.

4.2.7.7 Nutrient Tank

Bioscrubber nutrients shall be stored in a medium density polyethylene tank with cover, drain, and coupling for nutrient suction piping connection.

5.0 REFERENCES

1. Bay Area Air Quality Management District – California Environmental Quality Act – Air Quality Guidelines.

2. Curren, Jane, “Characterization of Odor Nuisance”, University of California at Los Angeles, 2012.