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CITY OF SUNNYVALE

WATER POLLUTION CONTROL PLANT

DESIGN STANDARDS

MECHANICAL

July 2014

carollo in association with HDR

CITY OF SUNNYVALE

WATER POLLUTION CONTROL PLANT

DESIGN STANDARDS

MECHANICAL

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1.0 PURPOSE AND CONTENT

This document describes the mechanical engineering design standards to be used for 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. Where deviations from these standards are necessary, the consultant shall secure written approval from the City.

Future designers shall note that the Administration building will be designed to LEED Gold requirements, that consideration shall be given to design WPCP facilities to meet the objectives of ENVISION, but the cost impacts must be considered and discussed with the City; and include PG&E's "Savings By Design" program in the project (if applicable).

Designers shall note that the design shall be sent to the City's Building Department for review and comment at 60, 90 and 100 percent design submittal phases for review.

Designer shall coordinate with other design standards prepared for other disciplines.

The design engineer is responsible for the design. The design standards herein shall be reviewed and confirmed for the appropriateness for individual projects. If the design engineer disagrees with the information contained within the design standards or wishes to propose an alternative, the City shall be notified and the design engineer's recommendation discussed prior to implementation.

2.0 STANDARD DEFINITIONS AND ABBREVIATIONS

ºC	Degrees Celsius
ºF	Degrees Fahrenheit
ABMA	Anti-Fiction Bearing Manufacturers Association
AHU	Air Handling Unit
Air Gap	Vertical, unobstructed distance, between the flood level in a plumbing fixture and the lowest water supply inlet, such as the distance between the rim of the tub and the faucet.
AISI	American Iron and Steel Institute Standards
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers

ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CalOSHA	California Occupational Safety and Health Act
CFM	Cubic Feet per Minute
Circuit Vent	Plumbing drainage system vertical vent which is run from the last two traps on a horizontal drain line to the main vent stack of a building drainage system.
CBC	California Building Code
CEC	California Energy Code
CFC	California Fire Code
CMC	California Mechanical Code
CPC	California Plumbing Code
DI	Ductile Iron
DO	Dissolved Oxygen
DX	Direct Expansion
EPDM	Ethylene Propylene Diene Monomer Rubber
ESP	External Static Pressure
Flow Control Valve	Device designed to reduce water flow to a plumbing fixture. Often used to improve efficiency and reduce operating costs.
FM	Factory Mutual
FPM	Feet Per Minute
GPF	Gallons per flush
HP	Horsepower
HUD	Housing and Urban Development
HVAC	Heating, ventilation and air conditioning
IBC	International Building Code

IFC	International Fire Code
IMC	International Mechanical Code
IPC	International Plumbing Code
Median of Extreme Temperatures	The median of the highest (for summer design) or lowest (for winter design) historical temperatures recorded. This data is used when designing 100% outdoor air systems.
MLSS	Mixed Liquor Suspended Solids
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSA	Outside air
OSHA	Occupational Safety and Health Act
Plumbing Fixture	Mechanism which both receives and discharges wastes and water into a drainage system.
Pressure Head	Pressure in a plumbing system. The unit of measure which is the vertical force exerted by water at a particular depth.
P-Trap	Plumbing device, used to prevent sewer gas from entering a building, by keeping a water seal in the drain.
RAS	Return Activated Sludge
RPM	Revolutions Per Minute
SCADA	Supervisory Control and Data Acquisition
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
Summer design dry bulb temperature:	The historical ambient air temperature during the four month period of June through September. Three percentage values defined in ASHRAE are 1 percent, 2.5 percent and 5 percent. These percentages represent the amount of time the ambient temperature will be above the listed temperature. If no percentage is listed then the design temperature is based on the more conservative 1 percent.
Summer mean coincident wet bulb temperature:	Mean of historic wet bulb temperatures that occur coincident with the summer design dry bulb.

Trap	Curved section of pipe that collects water and blocks the drain so that gasses from the sewer system can not pass through the drain and into the building. All fixtures that have drains connected in a sanitary sewer system must have a "P" trap installed. A toilet is the only plumbing fixture with an "S" trap.
TSP	Total Static Pressure
UL	Underwriters Laboratories Inc.
VAV	Variable Air Volume
Vent Pipe	A pipe that is used to vent a building's plumbing to the outside atmosphere.
VFD	Variable Frequency Drive
Vitreous	Surface material on some plumbing fixtures derived from or consisting of glass, translucent, and low on porosity.
WAS	Waste Activated Sludge
WC	Water column
Winter design dry bulb temperature:	The historical ambient air temperature during the three month period of December through February. Two percentage values defined in ASHRAE are 99 percent and 97.5 percent. These percentages represent the amount of time the ambient temperature will be below the listed temperature. If no percentage is listed then the design temperature is based on the more conservative 99 percent.
WPCP	Water Pollution Control Plant

3.0 CODES AND STANDARDS

The mechanical system shall be designed and built to the following codes and standards. The latest adopted version by the city of the following codes and standards shall be used.

- Applicable City of Sunnyvale and Santa Clara County ordinances
  - County of Santa Clara Building Department http://www.sccgov.org/sites/dso/Building%20Inspection/Pages/Office-of-Building-Inspection.aspx
  - County of Santa Clara Fire Marshall

    http://www.sccgov.org/sites/fmo/Pages/Fire-Marshals-Office.aspx

- County of Santa Clara Building Code Amendments (Based on the 2010 Building Code) http://www.sccgov.org/sites/fmo/docsandapps/firecodeamemdments/Documents/2012%20Code%20Amendments%20Final.pdf
- County of Santa Clara Fire Code Amendments (Based on the 2010 Fire Code) http://www.sccgov.org/sites/fmo/docsandapps/firecodeamemdments/Documents/CFC-CBC-Ordinance-1100.115.pdf

- American Industrial Hygiene Association (AIHA) ANSI/AIHA Standards Z9.5-93, Laboratory Ventilation
- American Iron and Steel Institute Standards (AISI)
- American National Standards Institute (ANSI)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standards 90.1. – Energy Standard for Buildings Except Low Rise Residential
- ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
- ASHRAE, HVAC Applications Handbook
- American Society of Mechanical Engineers, Boiler and Pressure Vessel Code (ASME P&PV)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- Anti-Friction Bearing Manufacturers Association (ABMA)
- California Green Code, CalGreen
- California Building Code, 2013 Edition, with local amendments
- California Electrical Code, 2013 Edition, with local amendments
- California Energy Commission (CEC) Title 24, Energy Efficiency Standards
- California Fire Code, 2013 Edition, with local amendments
- California Mechanical Code, 2013 Edition, with local amendments
- California Plumbing Code, 2013 Edition, with local amendments
- California Energy Code, 2013 Edition, with local amendments
- California Energy Commission (CEC) Title 24, Energy Efficiency Standards

- Factory Mutual
- HUD Standards for Energy Conserving Appliances
- IFC, as amended by the State of California
- Industrial Ventilation: Handbook of Recommended Practice
- National Fire Protection Association (NFPA) Standard 90A, "Installation of Air Conditioning and Ventilation Systems."
- NFPA Codes and Standards
- 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 FRP Duct Construction Manual
- State of California Occupational Safety and Health Act (CalOSHA)
- Underwriters Laboratories Inc.
- U.S. Department of Labor Occupational Safety and Health Act (OSHA)

4.0 PROCEDURES AND GUIDELINES

4.1 Mechanical Equipment

4.1.1 General

1. Each item of driven equipment and each motor weighing more than 50 pounds will be fitted with a minimum of one lifting eye.
2. Ladders, platforms will be provided for accessing elevated equipment for O&M purposes.
3. Adequately sized doors and hatches will be provided in buildings to install and remove equipment.

4.1.2 Bearings

1. Equipment bearings will be oil or grease lubricated ball or roller type to accommodate all radial and axial thrust.
2. Extended vertical and horizontal shafts will have two sets of universal type couplings with steady bearings for each shaft extension.

3. Vertical shafts in discharge columns of pumps will have rubber, resin, or bronze bearings held in place with “spiders.”

4. Oil lubricated bearings will be equipped with either a pressure lubricating system or a separate oil reservoir type system.

5. Grease lubricated bearings (except factory sealed and lubricated bearing) will be fitted with easily accessible grease supply, flush, drain, and relief fittings. Extension tubes will be used when necessary. Grease supply fittings will be standard hydraulic alemite type. No intermediate bearings are allowed. The City standardizes on Chesterton split seals and they shall be specified when applicable.

6. Bearings will be rated in accordance with the latest revisions of ABMA Methods of Evaluation Load Ratings of Ball and Roller Bearings for a minimum L-10 rating life of 100,000 hours as determined using the maximum equipment operating speed. The rating life of bearings (L-10) is the number of hours that 90 percent of a group of bearings will complete or exceed before the first evidence of fatigue develops.

7. Intermediate bearings are not allowed.

4.1.3 V-Belt Assemblies

1. Sheaves and bushings that operate at peripheral speed equal to or less than 5,500 feet per minute (fpm) will be statically balanced.

2. Sheaves and bushings that operate at peripheral speeds greater than 5,500 fpm will be dynamically balanced.

3. Sheaves will be separately mounted on bushings by three pull-up grub or cap tightening screws.

4. Bushings will be key seated to the drive shaft

5. Belts will be selected for not less than 175-percent of rated driver horsepower (hp).

4.1.4 Pump Shaft Seals

1. Mechanical seals will be a nondestructive (nonfretting), split seal. Metal parts will be type 316 or 316L stainless steel. Springs will be Hastelloy C. Rotary faces will be tungsten carbine or silicon carbide. Stationary faces will be ceramic, tungsten carbide, or silicon carbide.

2. Mechanical seals for overhung shaft, constant speed pumps, and split case centrifugal pumps will be self-aligning, single, rotary type. Pump shafts will be furnished with no size reduction through the seal area.

3. Mechanical seals for variable speed, overhung shaft pumps for sludge applications will be double, balanced, self-aligning type. Pump shafts will be furnished with no size reduction through the seal area.

4. Mechanical seal boxes will be drilled and tapped for installation of utility water barrier supply piping. Seals shall be compatible with the use of plant utility water. Oil seals are also allowed and preferred in certain applications.

5. Stuffing boxes for shaft packing will be tapped for installation of seal water supply piping and will hold a minimum of five rows of packing.

6. Lantern rings will be bronze or Teflon, packing will be die-mold rings of non-asbestos material, and glands will be bronze, two-piece split construction.

7. Seal water pressure for packing seals will be approximately 3 to 5 psig higher than the packing seal pressure (as determined by pump manufacturer).

8. Seal water pressure for centrifugal pumps should be minimum 10 psig above suction pressure or as recommended by the manufacturer.

9. Flushing liquid pressure for column pumps or positive displacement pumps should be a minimum 10 psig above the pump discharge pressure.

10. The City standardizes on Chesterton split seals and they shall be specified when applicable.

4.1.5 Couplings

1. For equipment with a driver greater than ½ hp where the driven equipment input shaft is directly coupled to the driver output shaft, a flexible coupling will be provided, which will accommodate angular misalignment, parallel misalignment and end float, and which will cushion shock loads and dampen torsional vibrations.

2. Flexible members will consist of a tire with synthetic tension members bonded together in rubber. Flexible members will be attached to flanges by means of clamping rings and cap screws, and the flanges will be attached to the stub shaft by taperlock bushings.

3. Short vertical shafts should be close coupled.

4. Avoid extended horizontal and vertical shafts whenever possible. If an extended shaft is required, two sets of universal type couplings shall be used. Operating angles for universal couplings shall not exceed three degrees.

5. No intermediate bearings are allowed.

4.1.6 Guards

1. Guards that meet OSHA requirements will be provided for exposed moving parts.

2. Guards will be fabricated of 14-gauge steel, ½-inch mesh expanded metal screen galvanized after fabrication, stainless steel, aluminum or fiberglass.

3. Guards will be modified to meet all equipment manufacturers' specified maintenance requirements (such as preventative or routing maintenance tasks) without disassembly of guards. Lube fittings, for example, will be extended through guards for easy personnel access.

4. Piping, manifolds, heaters, and other surfaces having a surface temperature sufficient to burn human tissue (140° Fahrenheit or greater) will be covered with thermal insulation or guarded. Thermal insulation will be as described elsewhere in this document.

5. Provisions for signage for hazards shall be specified in design documents.

4.1.7 Lubricants

1. Lubricants will be of the type recommended by the equipment manufacturer. Designer shall review manufacturer's recommended lubricants for new equipment and confirm that the lubricants meet the City's preferred lubricants at the plant.

2. Grease lubricated bearings will have grease and relief fittings.

3. Oil lubricated bearings will have constant-level oilers.

4.1.8 Miscellaneous Items

1. Caution signs will be provided for equipment with guarded moving parts that operate automatically or by remote control.

2. Pressure taps will be provided on the suction and discharge side of pumps, blowers, and compressors.

3. All equipment, including valves will be provided with nameplates. Equipment nameplates will have the equipment name and number engraved or stamped on stainless steel material.

4. High points in piping systems shall be provided with air release valves.

5. All low pressure air and hot water piping will be designed for expansion/contraction and supports due to temperature and pressure fluctuations in the piping systems.

4.1.9 Equipment Mounting

1. All supports, anchorage, and mounting of all equipment will be in accordance with the manufacturer's recommendations, the latest codes and the requirements of the Structural/Seismic Design Standards.

2. All floor-mounted equipment will be installed on minimum 4.5-inch reinforced concrete pads plus 1.5 inch grout pad for a total height of 6 inches.

3. Concrete pads shall be a minimum of 4" larger in all directions than the equipment base, and will enclose all conduits, drains, and piping connections.

4. All rotating or moving equipment will be grouted into place on top of the pad.

5. Equipment baseplates for floor mounted equipment will be fabricated steel or cast iron, hot-dipped galvanized after fabrication.

6. Anchor bolts will be designed for lateral forces for both pullout and shear to comply with the seismic area and intensity as defined in the IBC. See Structural Design Standards.

7. Seismic anchorage calculations, stamped by a Structural Engineer registered California, will be required for all equipment weighing more than 400 lbs.

8. Minimum diameter of anchor bolts will be ½ inch. Anchor bolts shall be cast-in type for all new concrete locations. Post-installed adhesive type anchors shall be used in locations of existing concrete.

9. Material for equipment anchor bolts will be Type 316 stainless steel.

10. Pipe connecting to equipment shall be anchored to avoid transfer of stresses from the pipe to the equipment.

4.1.10 Electric Motors

1. All motors will be supplied by the driven equipment supplier.

2. Electric motors less than 0.5 hp used to drive nonprocess-related equipment will be specified as open, drip proof (ODP) or Totally Enclosed (TE), as required by the application, 1.15 service factor, 115 volts, single-phase, with Class B or F insulation.

3. Electric motors less than 0.5 hp used to drive process-related equipment will be specified as totally enclosed, fan-cooled (TEFC), 1.15 service factor, 115 volts, single-phase, with Class B or F insulation.

4. Electric motors 0.5 hp through 200 hp will be specified as TEFC, 1.15 service factor, 460 volts, 3-phase, Class F insulation with a maximum of 90° C temperature rise. Motors 100 hp and larger will be specified with over-temperature protection.

5. Electric motors greater than 200 hp used to drive process-related equipment will be specified as weather-protected II (WPII) enclosures, 1.15 service factor, 460 volts, 3-phase, Class F insulation with a maximum of 90° Celsius temperature rise. Motors will be specified with resistance temperature detectors.

6. All electric motors will be specified with bearings rated for an L-10 life of 100,000 hours.

7. Electric motors specified for use with adjustable frequency drives will be totally enclosed, forced ventilated, with 1.0 service factor, voltage as appropriate, Class F insulation, inverter duty.

8. Electric motors 10 hp and larger will be specified with space heater or as applicable to location.

9. Electric motors shall be rated for the area classification and application to which they are located in, e.g. Class 1, Division 1.

10. Motors shall meet NEMA premium efficiency standards.

11. Refer to Electrical Design Standards.

4.1.11 Vibration Isolation

1. Piping connecting to rotating or reciprocating equipment will be provided with flexible couplings or expansion joints to absorb/limit vibration.
2. Fans, compressors, pumps and other rotating equipment mounted inside curb mounted equipment, or otherwise mounted on the roof, will be mounted on vibration isolating bases.
3. Structural steel bases will be rectangular in shape for all equipment other than centrifugal pump bases, which may be “T” or “L” shaped. Typical application is centrifugal fans.
4. Double-deflection neoprene mountings will have a minimum static deflection of 0.35 inches. All metal surfaces will be neoprene covered and have friction pads on both top and bottom. Typical applications are blowers and floor mounted air handling units (AHU).
5. Steel members used to cradle machines having legs or bases that do not require a complete supplementary base will be sufficiently rigid to prevent strains on the equipment. Typical applications are cooling towers and condensing units.
6. Freestanding, spring-type mountings will have housings and vertical limit stops when used for equipment exposed to the wind or with operating weight different from installed weight. Typical applications are chillers, boilers, and air cooling towers.
7. Freestanding, spring-type mountings without housings will be laterally stable and have neoprene friction pads between the base and support. Typical applications are refrigeration reciprocating compressors and slow speed compressors.
8. Steel hanger mountings will contain steel spring and a 0.3-inch deflection neoprene element in series. Principal application is suspended air handling equipment.
9. Double-deflection sandwich pad mountings will consist of a high density cork layer permanently bonded to top and bottom layers of corrugated oil-resistant synthetic rubber. Typical applications are centrifugal compressors and vacuum pumps.
10. Restraints will meet the seismic requirements as defined in the IBC.

4.1.12 Noise Requirement

1. The maximum permissible noise level for a complete piece of mechanical equipment located within or outside a structure will not exceed 85 dbA at three feet. A complete piece of mechanical equipment is defined as the driver and driven equipment, plus any intermediate couplings, gears, and auxiliaries.
2. Noise reduction measures (such as sound reduction enclosures, acoustical equipment mountings, acoustical wall or ceiling panels, and acoustical insulation on equipment) will be provided where necessary following installed equipment field noise testing.

4.1.13 Equipment Clearances

1. Minimum clearances will be as follows, whichever is more stringent:
   a. Between adjacent items of equipment: 3.5 feet.
   b. Vertical (floor to overhead obstruction): 7'-6" preferred minimum or 7'-2" absolute minimum.
   c. Manufacturer's recommended minimum maintenance clearances plus: 1 foot.
   d. Design engineer shall coordinate with the City.
2. Clearances shall be actual, to most outstanding dimension (i.e., edge of flange), not nominal.
3. Equipment shall be located to maintain the minimum clearances on at least three sides.
   a. Manufacturer and code minimum equipment clearances will be maintained at all times.
4. Provide adequate headroom for removing vertical turbine pumps or provide shafts, tubes, and columns that come in sections.
5. Provide space for installing future equipment, when such equipment is identified.

4.1.14 Gages

1. Pressure gages, vacuum gages, compound gages, and temperature gages (thermometers) shall be provided on equipment and piping to indicate the various conditions of the respective services. No mercury gages are allowed.
2. All gages shall be installed with the face in the vertical position, and in strict accordance with the manufacturer's recommendations. Care shall be taken to minimize the effect of water hammer or vibrations on the gages by installing isolation valves and pulsation dampeners. In extreme cases, the gages may have to be mounted independently using flexible connectors.
3. On cast iron and ductile iron pipe 3" and larger, the gages shall be connected by means of threaded tappings, or bosses, or by threaded saddles. Refer to Table 1 for maximum sizes of tapping for ductile iron pipe.
4. On piping 2 1/2" and smaller, the gages shall be attached to threaded fittings. The recommended tapping sizes for ductile iron are listed in Table 1.
5. On welded steel pipes, 3,000 lb, threaded half-couplings of 1¼ inch size shall be welded into the pipe wall, epoxy lined, and the pipe lining shall be repaired if damaged by welding. Threaded taps can also be used and shall have the same requirements as the ductile iron pipe.
6. All pressure and vacuum gages shall be controlled by separate shut-off valves and fitted with snubbers or pulsation dampeners where connected to piping subject to vibration or pulsation.

Table 1	Tapping Sizes for Ductile Iron Pipe Mechanical Design Standards City of Sunnyvale				
DI Pipe Diameter (inches)	**Maximum Recommended Direct Tap Size by Pressure Class (inches)**				
	150	**200**	**250**	**300**	**350**
3	-	-	-	-	¾
4	-	-	-	-	¾
6	-	-	-	-	1
8	-	-	-	-	1
10	-	-	-	-	1
12	-	-	-	-	1 ¼
14	-	-	1 ¼	1 ½	1 ½
16	-	-	1 ½	2	2
18	-	-	2	2	2
20	-	-	2	2	2
24	-	2	2	2	2

7. Gages attached to systems involving chemical solutions, corrosive fluids, sludge, sewage, digester, or other liquids containing solids, shall be equipped with diaphragm seals.

8. For sewage, sludge, and scum lines in sizes 4-inch through 24-inch, sleeved pressure gages shall be used, which are less subject to plugging than diaphragm seals. The inner sleeve material shall be Buna-N unless another material is needed for chemical protection. Sleeved pressure gages are typically purchased as an entire unit, fully charged and sealed, with the gage.

9. Gages shall be industrial quality type with Type 316 stainless steel internal parts and cases, and a 4-inch-diameter face, minimum.

10. The connection to gages should have minimum ½-inch NPT male threads.

11. The gages shall have an accuracy of ±0.5 percent and read to 150 percent of the working pressure of the system or vessel to which they are connected.

12. Pressure gages shall be installed on the suction and discharge sides of all pumps, blowers, and compressors, on air receiver tanks, surge tanks, each side of pressure reducing valves and wherever required by process equipment.

13. Manual reading thermometers shall be installed on inlet and discharges of all process heating equipment such as boilers, engine jacket water piping, heat exchangers.

4.1.15 Pump Speeds

1. Centrifugal pump speeds should, as a rule, not exceed 1,750 revolutions per minute (rpm) in water and waste pumping applications. Exceptions would be services such as single-stage pumping against very high heads (over 300 feet). Speeds slower than 1,750 rpm are desirable in many cases where non-clog centrifugal, vertical turbine, mixed-flow, and

axial-flow pumps are used, particularly sizes of 100 horsepower (hp) or larger. Speeds of 1,170 rpm, 870 rpm, and lower are not unusual for large-diameter pumps. Slower-speed pumps are usually larger than pumps operated at 1,750 rpm, however, and therefore cost more.

2. If slow-speed (580 rpm and 900 rpm) or medium speed (1,000 rpm and 1,750 rpm) horizontal mixed-flow and axial-flow pumps do not provide the head required, vertical multistage units of the same types should be considered. Two-stage and sometimes three-stage vertical mixed-flow and axial-flow pumps are available.

3. Operating speeds for positive-displacement pumps vary depending on the pump type and fluid being pumped. Generally rotary lobe pumps shall have a maximum speed of 300 rpm and progressive cavity pump shall have a maximum speed of 200 rpm. Check with pump manufacturers for recommended maximum pump speeds for specific services. Another restriction is to limit the maximum speed of progressing-cavity pumps for services other than polymer to 200 rpm.

4.1.16 Pump Alignment

1. Vertical and horizontal centrifugal direct-drive pumps and motors 3 hp and larger will be mounted on single frames. Pumps 3 hp and less will generally be close-coupled and pumps larger than 3 hp will generally have a flexible coupling between the pump and motor shafts. The pump and motor for belt driven pumps will be mounted on a single frame and the motor will be arranged to the side of the pump. Reference HI Standards for requirements.

4.1.17 Pump Curves

1. Provide pump curves for all pumps. For pumps controlled by variable frequency drives (VFDs) provide system performance curves that plot the variable frequency curves against the system curves; various parameters; and operating modes. A typical graph layout should have head on the y-axis, flow on the x-axis with selected parameter (hydraulic efficiency, BHP, system head, speed) plotted along various frequency curves (i.e. 20hz, 30hz, 40hz, 50hz, 60hz). Various operational ranges (i.e., dry, wet, low and high temperature) appropriate to system type should be superimposed onto the graphs along with the system curve.

2. Design to HI standards as applicable.

3. 3Hp and larger pumps shall be frame mounted.

4.1.18 Pump Efficiency

1. Both pump and wire-to-water efficiencies should be evaluated in selecting a manufacturer's pump offering. Pump efficiency is the criteria used to assess pump performance both hydraulically and mechanically. Wire-to-water efficiency is required to assess expected annual operating costs.

2. For pumping systems greater than 50 mgd or pumps greater than 100 Hp, lateral and torsional critical speed analyses should be performed to determine critical speeds for either constant speed or variable speed pumps; especially when floor-mounted pumps are used with extension shafts. The requirements for these analyses will be specified in the pumping specs for the project and shall be performed by the pump manufacturer.
3. The pump should have a head–capacity curve that rises continuously from its BEP to shutoff.

4.2 Wet Well Sizing Criteria for Start/Stop Pumping

1. To prevent excessive pump starts, the wet well volume required must be checked and compared against the available volume (including upstream channel volume). The minimum wet well volume required is calculated by the following formula:

   $V = TQ/4$

   V = Minimum active wet well volume, gal

   Q = Pumping capacity, gpm

   T = Allowable minimum cycle time

2. The above equation is derived based on the relationship that pumps will cycle the most when the influent flow is half the capacity of the pump. Wet wells with constant speed (C/S) pumps should be sized based on the equation above. For variable speed pumps, operational volume should be evaluated considering minimum pump speed and cycle time. Starts per hour for non-submersible pump motors in a dry pit arrangement should be limited to 6 starts per hour for 200 horsepower or less. Larger dry pit motors would be limited to 3-4 starts per hour or less. In no case shall the maximum starts per hour exceed the recommendation of the pump and motor manufacturer.
3. Submersible motors in a submerged application would have more allowable starts per hour due to improved heat transfer. Submersible motors that are 100 horsepower or smaller can have up to 8 starts per hour. Larger submersible motors should be maintained at a maximum of 6 starts per hour. In no case shall the maximum starts per hour exceed the recommendation of the pump and motor manufacturer.

4.3 Equipment Selection

1. Mechanical equipment selection such as pumps, gates, blowers, air compressors, tanks, conveying systems, process equipment, etc. shall be performed by the design engineer on individual projects for the specific application.
2. Table 2 provides a list of mechanical equipment where the WPCP staff has indicated specific preferences for various types of equipment or manufacturers. The design

engineer is responsible for coordinating the WPCP staff on these items and confirming the appropriateness for such equipment for the specific application on the project.

Table 2 WPCP Mechanical Equipment Preferences Mechanical Design Standards City of Sunnyvale

Equipment Type	Service/Application	Acceptable Manufacturer(s)	Notes
Plug Valves	Sludge	Dezurk	-
Butterfly Valves	Sludge	Dezurk	-
PVC Valves	Water	George Fisher or Asahi	-
Brass Valves	Water/Gas	Nibco	-
Solenoid Valves	Air/Water/Gas	Asco	-
Grit Lines	Grit	-	Glass Lined

4.4 Piping, Valves, Gates, and Accessories

1. A piping material schedule outlining the City's preferences and standards for pipe material is included in Appendix A. The design engineer is responsible for reviewing this information and confirming the pipe material used on individual projects is appropriate. If the design engineer disagrees with pipe material listed in the piping material schedule, it should be discussed with the City prior to proceeding. Pipe fittings, joints, coatings, valves, gates and accessories shall be specified by the design engineer to meet the specific requirements as appropriate for each project. See Corrosion Design Standards for other material requirements.

4.4.1 Gates and Actuators

1. Cast Slide Gates
   a. Cast slide gates will be heavy-duty, flat-back frame type meeting the requirements of AWWA C560.
   b. Materials of construction are shown in Table 3.
2. Slide Gates
   a. Slide gates will be stainless steel frame type meeting the requirements of AWWA C561.
   b. Materials of construction are shown in Table 4.
3. Gate Actuators
   a. All automated gates shall have electric actuators.
   b. All gate actuator pedestals shall be mounted directly on concrete slab where possible.
   c. All gate actuators shall be sized for future conditions.

Table 3 Sluice Gate Materials of Construction Mechanical Design Standards City of Sunnyvale	
Component	**Material**
Gate, guide, and frame	ASTM A126, Class B, Ni-resist cast iron
Seating faces	ASTM B103 or B139, bronze
Wall thimbles	ASTM A126, Class B, Ni-resist cast iron
Stems	ASTM A276, stainless steel, Type 316
Wedges, thrust nut, stem couplings	ASTM B584, bronze, CA872
Fasteners and adjusting hardware	ASTM A276, stainless steel, Type 316, or ASTM F593 and F94, stainless steel, Group 1 or Group 2
Yoke	ASTM A126, Class B, cast iron
Flush bottom seal	Neoprene
Flush Bottom retainer	ASTM A276, stainless steel, Type 316 bar

Table 4 Slide Gate Materials of Construction Mechanical Design Standards City of Sunnyvale	
Component	**Material**
Frames rails, yokes, and slides	ASTM A276, Type 316L stainless steel
Fasteners and anchor bolts	ASTM A276, Type 316 stainless steel
Stems	ASTM A276, Type 316 stainless steel
Bottom, top and side seals	ASTM D2000, Buna-N, or Neoprene Rubber or UHMWPE
Stem guides	ASTM A276, Type 316 stainless steel with ASTM D2000, UHMW bushings

4.4.2 Flanges and Pipe Threads

1. Ductile iron or cast iron flanges on equipment and appurtenances will conform in dimensions and drilling to ANSI B 16.1. Pipe threads will conform in dimension and limits of size to ANSI B 1.1, coarse thread series, Class 2 fit.

2. Steel and stainless steel flanges on equipment and appurtenances will conform in dimensions and drilling to ANSI B16.5. Threaded fittings will conform in dimension and limits of size to ANSI B 16.3. Threads will conform to ANSI B 1.2.

3. Threaded flanges will have a standard taper pipe thread conforming to ANSI B1.20.1. Flanges will be flat-faced whenever practical.

4. Flange assembly bolts will be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot-pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads will be Uniform Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

5. Flange pressure ratings will be selected to match the service and test pressure of the piping system where they are installed. Pressure ratings for ductile iron and cast iron

flanges range from 125 psi up to 350 psi. Pressure class ratings for steel and stainless steel pipe range from Class 150 up to Class 2500. The pressure rating of each class is dependent on the temperature of the service.

4.4.3 General Valve and Actuator Requirements

1. All valves, including those that are equipped with power operators or those designed for automatic operation, will be provided with manual operators. Valves with powered operators will also have manual control for periods when there is a loss in power.
2. Unless specifically required to be equipped with other types of operators, all valves with centerlines more than 6'-6" above the floor will be provided with chain wheels and operating chains. Valves 8-inch and larger and valves with chain wheels are provided with geared actuators.
3. Wrench nuts will be provided on all buried valves, on all valves that are to be operated through floor boxes, and where otherwise required.
4. Valves of the same size and service will be provided by a single valve manufacturer. Designers will be responsible for valve selection and consideration of service, size, and pipe material shall be considered for the exact application and valve use.
5. Install manual drain valve on lowest point of every pipeline and on suction and discharge of all pumps.
6. Install automatic or manual drip traps on piping systems containing digester gas.
7. Provide adequate clearances for rising stem valves and gates.
8. Allow ample space for diaphragm-, cylinder-, and motor-operated actuators.
9. Install automatic air release valves on high points of all piping. Pipe drainage to a waste receptor at the floor.
10. All automated valves shall have electric actuators.
11. All actuator pedestals shall be mounted directly on concrete slab where possible.
12. All valve actuators shall be sized for future conditions.

4.4.4 Butterfly Valves

1. Butterfly valves will be of the through shaft design, flanged or lug body.
2. Butterfly valve bodies for all piping services, except digester gas will be cast iron, ASTM A126, Grade B. Butterfly valve bodies for digester gas service will be stainless steel Type 316.
3. Butterfly valve bearings will be reinforced Teflon or chemically inert nylon.
4. Butterfly valve shafts will be stainless steel, ASTM A276, Type 304 or ASTM A582, Type 416. Seat mating surfaces will be stainless steel, ASTM A276, Type 18-8. Seat sealing

surface will be neoprene or Buna-N for systems with service temperatures less than 180 DegF and EPDM for service temperatures from 180 DegF to 250 DegF.

5. Discs for all piping services, except digester gas will be ductile iron, ASTM A536 or cast iron, ASTM A48, Class 40 or ASTM A126, Class B, or stainless steel Type 316, ASTM A276, or aluminum-bronze, ASTM B148. Discs for all digester gas service will be stainless steel Type 316.

6. Butterfly valves will be used for isolating service on water and air service applications greater than 2-inch.

7. AWWA butterfly valves will be used in sewage and sludge service. High performance will be used in digester gas, low pressure air, or ozone.

4.4.5 Ball Valves

1. Ball valves 2 inches and smaller will be threaded, full bore, will have bronze, brass, or stainless steel bodies, balls and stems, and Teflon seats at both ends. Valves will be rated at 300 psi and will be so constructed as to make positive shutoff with flow in either direction.

2. Ball valves larger than 2 inches will be flanged, full bore, will have carbon steel or ductile iron bodies, balls and stems, and Teflon seats at both ends. Valves will be rated at 275 psi and will be so constructed as to make positive shutoff with flow in either direction.

3. Ball valves will be used for isolating service on air and water applications less than or equal to 2-inches, and as isolation on pressure gauges.

4.4.6 Gate Valves

1. Gate valves 3 inches and larger in size will comply with AWWA C500, including hydrostatic testing requirements and be specified as resilient seated type.

2. Gate valves smaller than 3 inches will be subject to system test pressure hydrostatic testing.

3. All exposed gate valves will be rising stem type.

4. All buried or submerged valves will be non-rising stem type.

5. Materials of construction are summarized in Table 5.

4.4.7 Globe Valves

1. Globe and angle valves will have all bronze bodies.

2. Valves will have union bonnets and renewable composition or plug discs.

3. Valves will be re-packable when open.

4. Globe and angle valves will be rated at 200 psig.

5. Globe valves will be used for throttling service on air and water service applications.

Table 5	**Gate Valve Materials Mechanical Design Standards City of Sunnyvale**
Component	**Material**
Body	
≤ 3 inches	Bronze
> 3 inches	Cast iron, ASTM A126, Class B
Wedge	
≤ 3 inches	Bronze
> 3 inches	Cast iron, ASTM A126, Class B
Mounting	Bronze
Stem	Bronze, AWWA C500 (Section 3.12)
Seat Rings	Bronze, Grade A, AWWA C500 (Section 3.8)

4.4.8 Eccentric Plug Valves

1. Eccentric plug valves will be straight-flow, non-lubricated, resilient plug type suitable for drip-tight, bi-directional shutoff.
2. Valve upper and lower journal bearings will be replaceable, sleeve-type, corrosion-resistant, and permanently lubricated.
3. Eccentric plug valves 3 inches and smaller will be threaded. Valves larger than 3 inches will be flanged.
4. Plug valves shall be installed in orientation as recommended by the valve manufacturer.
5. Materials of construction are summarized in Table 6.

Table 6	**Eccentric Plug Valve Materials Mechanical Design Standards City of Sunnyvale**
Component	**Material**
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B; cast iron, ASTM A436 (Ni-resist); or ductile iron, ASTM A536
Plug	Neoprene or Buna-N
Body seats	
< 3 inches	Cast iron, ASTM A126, Class B
≥ 3 inches	Stainless steel, ASTM A276, Type 304 or welded nickel overlay
Packing	Buna-N or TFE

4.4.9 Pressure Regulating Valves

1. Pressure regulating valves for air, water, and gas service will be of the direct acting type.
2. Valves used for water service will have bronze bodies and stainless steel seats. Diaphragms will be Buna-N with nylon inserts.
3. Valves used for air service will have bronze bodies and stainless steel or monel seat rings.
4. Valves used for gas service will have cast iron bodies, and trim will be stainless steel, Type 316 and UL listed.
5. Wye filters will be provide upstream of pressure regulating valves.

4.4.10 Solenoid Valves

1. Solenoid valves will be encapsulated coil, direct operated, suitable for 2-, 3-, or 4-way service.
2. Solenoid valve bodies will be brass or Type 316 stainless steel. Seats will be Teflon or Buna-N.
3. Solenoid valve coils will be the tube, core or shell type.

4.4.11 Control Valves

1. Flow Characteristics and Valve Selection
   a. Control valves are classified by their flow characteristic, which is the relationship between the flow rate through the valve and the valve travel from zero to 100 percent.
   b. For determining the flow characteristic, flows are measured with a constant pressure differential across the valve.
   c. The size required for the valve is calculated after the maximum and minimum flow rates of the system and the pressure drops at each flow rate are determined. When determining valve size, ensure that:
      1) Control valves are sized to pass minimum flow at no less than 20 percent and maximum flow at no greater than 80 percent of the fully open position.
      2) Control valve capacities in terms of sizing coefficients are expressed as Cg, which for liquids is the number of gallons per minute flow through the valve at a differential pressure of 1 pound per square inch (psi).
      3) Control valves are sized based on a vendor-supplied chart or computer-sizing program. Valve will be checked for flashing or cavitating conditions. A valve that is neither oversized nor undersized will provide the best control. Restricted trim is an option for applications where future demands for capacities might be greater than current conditions. If the size of the control valve is different from pipe line size, the transition fittings must be shown on the drawings.

d. Computer programs for sizing valves are available from Fisher Controls Company; Valtek; Keystone International, Inc.; Hammel-Dahl; Dezurik; and other control-valve manufacturers.

2. All control valve actuators for automatic valves shall be electric. Actuator pedestals shall be mounted on concrete when possible. Size actuators for future conditions.

4.4.12 Piping Accessories

1. Strainers
   a. Pipeline strainers for air, gas, and water shall be of the Y-pattern in-line type or basket type.
   b. Air and gas strainers will have monel screens, brass blowoff cocks, and stainless steel bodies. The filter material will be Everdur wool.
   c. Water strainers will have Type 316 stainless steel or monel screens and bronze or carbon steel bodies.
2. Vacuum Breakers
   a. Vacuum breakers will have carbon steel bonnets, springs and bodies with stainless steel stems, discs, and fasteners.
   b. The vacuum breaker valves greater than 2 inches will have grooved-end, mechanical-type (Victaulic) coupling connections and will be rated for a 30-inch mercury vacuum. Vacuum breaker valves 2 inches and less will have threaded connections.
3. Expansion Joints
   a. Provisions for expansion will be provided together with anchors and guides to accommodate pipe movement due to temperature changes. Control rods will be sized for the piping system pressure.
   b. Expansion joints, or flexible type grooved-end, mechanical-type (Victaulic) couplings, where appropriate, will be provided wherever required to relieve thermal stresses in piping systems. Expansion joints will be provided for the engine exhaust (EE) system.
4. Flexible Pipe Connectors
   a. Flexible pipe connections will be installed at the suction and discharge of all pumps and blowers to minimize pipe vibration and allow easier pipe removal at equipment for maintenance. Stainless steel braided flexible tubing will be provided on air compressors.
   b. Where piping passes through walls, takedown couplings will be provided within 3 feet of the wall.
   c. A threaded union or flanged takedown connection will be provided within 2 feet of each threaded end valve. For pipelines 2-½ inches in diameter and larger, a

grooved-end, mechanical-type (Victaulic) coupling or threaded union connection will be provided on each valve end.

d. Piping 2 inches in diameter and larger passing from concrete to earth will be provided with two pipe couplings or flexible joints within 2 feet or one pipe diameter of the structure, whichever is greater. Where required for resistance to pressure, mechanical couplings will be restrained in accordance with AWWA M11 (latest edition), Tables 13-6, 13-7, and 13-7A and Figure 13-17.

4.5 Piping Insulation

4.5.1 General

1. Insulation will be provided for the following piping and related vessels and appurtenances:
    a. Potable water (in condensation sensitive locations)
    b. Domestic hot water
    c. Heat reservoir water
    d. Chilled water
    e. Circulating sludge for outdoor service
    f. Digester gas for outdoor service
    g. Engine exhaust
    h. Low pressure air and compressed air (for personnel protection where pipe is above 140 DegF and where possible human contact may occur)
2. Insulation will include insulating material, aluminum protective jackets, flashing, and other materials as required. Pre-insulated piping will be used for buried heat reservoir piping or where applicable. Insulating jackets or pre-molded wraps will be installed on valves.

4.5.2 Low Temperature Insulation

1. Low temperature pipe is piping carrying air or liquids less than 60 DegF.
2. Low temperature insulation will be of the unicellular elastomeric thermal type, or pre-molded fiberglass with all-purpose jacket.
3. Piping insulation will be tubular for simple installation.
4. Insulation will be applied over clean, dry surfaces with all joints butted firmly together.
5. Low temperature insulation will be for chilled water piping, and potable water piping insulation for thermal and condensation control.
6. Surfaces to be insulated include piping and related vessels and appurtenances.
7. Aluminum jacket will conform to ASTM B209, alloy 5005, temper H16. Sheet metal screws will be 6061-T aluminum, anodized 2024 aluminum or Type 300 or 400 series stainless steel of adequate strength. Aluminum jacket will be for all piping. Shield for the protection of non-rigid insulation at hangers and supports will be 16- gage galvanized steel sheet.

8. Minimum insulation thicknesses are summarized in Table 7.

Table 7	**Minimum Insulation Thickness (Low Temperature) Mechanical Design Standards City of Sunnyvale**
Pipe Size	**Minimum Insulation Thicknesses**
All	1 ½ inches

4.5.3 Medium Temperature Insulation

1. Medium temperature pipe is piping carrying air and liquids between 60 DegF and 300 DegF.
2. Medium temperature insulation will be for hot water piping, circulating sludge piping, and heat reservoir water piping insulation.
3. Hot water piping insulation will be suitable for an operating temperature range of 100°F to 300°F.
4. Insulation includes insulating material, protective jackets, flashing and other materials specified. Surfaces to be insulated include piping and related vessels and appurtenances.
5. Jackets will be similar to the jackets for low temperature insulation.
6. The minimum insulation thicknesses are summarized in Table 8.

Table 8	**Minimum Insulation Thickness (Medium Temperature) Mechanical Design Standards City of Sunnyvale**
Pipe Size, Inches	**Minimum Insulation Thicknesses, Inches**
½ - 2	1
2 ½ - 4	1 ½
6 – 12	2
14 and larger	2 ½

4.5.4 High Temperature Insulation

1. High temperature pipe is piping carrying air and liquids over 300 DegF.
2. High temperature insulation will be for engine and boiler exhaust.
3. Insulation includes insulating material, protective jackets, flashing and other materials specified. Surfaces to be insulated include piping and related vessels and appurtenances.
4. Jackets will be similar to the jackets for low and medium temperature insulation.
5. The minimum insulation thicknesses for high temperature insulation is 2 inches.

4.6 Pipe Supports

1. Piping will be supported using project standard pipe hangers, supports, and structural attachments defined in the general mechanical drawings and specifications.

2. Generally, piping will be supported as indicated in Table 9.

Table 9 Pipe Support
Plan Mechanical Design Standards
City of Sunnyvale

Normal Pipe Size, Inches	Maximum Pipe Span, Feet			
	Steel	Copper	Plastic	Cast Iron
3/8 – ¾	5	5	Continuous	--
1	5	5	5	--
1 ¼	5	5	5	--
1 ½	5	5	5	--
2	10	5	5	--
2 ½	10	10	5	All sizes $\geq$ 2 ½: • 12 feet for pressure pipe • 10 feet for soil pipe
3	10	10	5	
4	10	20	5	
6	15	20	5	
8	15	20	5	
10	15	--	5	
12	15	--	--	
14	15	--	--	
16	15	--	--	
18	15	--	--	
20	15	--	--	
24	15	--	--	

3. Seismic bracing for pipes shall be provided using project standard bracing and structural attachments and shall be defined in the general mechanical drawings and specifications provided by the project designer. Bracing will comply with the seismic area and intensity as defined in the Structural/Seismic Design Standards.

4.7 Miscellaneous Piping Requirements

1. Exposed piping (interior and exterior) and piping in ceiling spaces, pipe trenches, pipe chases, and valve boxes will be identified with plastic legend markers and directional arrows located at each side of the walls, floorings, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

2. Connection of ferrous to nonferrous metal piping will be with a flanged connection or with a dielectric union.

3. Connection of dissimilar metal piping will be with an insulating flange kit or a dielectric union.

4. Buried ferrous piping will be corrosion protected by coating with liquid epoxy conforming to AWWA C210, polyethylene tape coating conforming to AWWA C214, or fusion epoxy as specified in the piping system specification sheets.
5. Piping will be located so that it is not a safety hazard, or a barrier to accessing equipment.
6. In general, lay out the piping within 6 feet of the walls so that it can be supported easily, particularly in spaces with high ceilings.
7. For piping routed adjacent to a wall, provide clearance between the outermost pipe flanges and the wall to facilitate disassembly.
8. So air can be purged from the pipeline while it is being filled with water, install a manual vent valve on the highest point of every pipeline that will be filled with liquid or that will be tested hydrostatically. This should be shown on plans or process and instrumentation drawings.
9. Provide flexible connections for easily assembling and disassembling piping and for connections to equipment. Ensure that adequate thrust restraint is provided at each flexible coupling.
10. When laying out piping, keep the placement of anchor and expansion joints in mind. These must be located on the drawings.
11. Show piping reducers and increasers, which are required to connect piping to equipment and valves, on the drawings. Bushings are not acceptable.
12. If piping reducers are required on the suction side of pumps, they must be eccentric reducers that are flat on top.
13. Pitch service-air and instrument-air mains downward in the direction of flow so both flow and gravity will carry moisture to traps or water legs, which must be placed at frequent intervals.
14. Gas piping must not be concealed or located under building slabs or in crawl spaces.
15. Do not run water lines or ductwork over electrical equipment.
16. Indicate the centerline for all pressure pipes except when two or more pipes rest on a common support.
17. Indicate the invert elevation for all gravity-flow pipes, including gravity-flow pipes through walls, except when two or more pipes rest on a common support.
18. Indicate the bottom-of-line (outside invert) elevation when two or more pipes rest on a common support.
19. Provide adequate space around piping to account for supports and anchors.
20. Velocity in pipelines should be maintained as follows, although higher velocities can be considered as long as the resultant pressure drop through the piping system is accounted for when sizing and selecting equipment:

a. Water: Maximum 6 feet per second.

b. Compressed Air: Maximum 50 feet per second

c. Natural Gas: For buried piping- maximum 65 feet per second, for exposed piping- maximum 330 feet per second.

4.8 Heating, Ventilation, Air Conditioning (HVAC)

4.8.1 Levels of Conditioning

4.8.1.1 Level 1 – Process Areas

Level 1 is for areas where no heating is required to prevent freezing or extreme temperature or where work is done on an intermittent or short-term basis. Process areas contain wastewater treatment operations including pump stations, headworks, solid processing buildings, and blower buildings.

4.8.1.2 Level 2 – Shop Areas

Level 2 provides minimal comfort e.g. 65°F, under all anticipated ambient conditions for occupied process work areas. Testing and Balancing shall be specified in project specifications provided by project designer.

4.8.1.3 Level 3 - Personnel Areas and Electrical RMS and Instrumentation Rooms

Level 3 provides comfort heating and cooling under all anticipated ambient conditions for normally occupied office/laboratory/work areas. Air testing shall be conducted per project specifications provided by project designer.

4.8.1.4 Reuse Systems

In order to conserve energy whenever possible, HVAC systems will be designed to utilize incoming fresh air first in those portions of buildings where operations are of a relatively clean nature, then to reuse the conditioned air by transferring it to other areas or re-circulating a portion back to the main supply unit where allowed by Code.

4.8.2 Climatic Conditions

The HVAC systems will be designed for the following climatic conditions[1]. The weather data can be referenced from the ASHRAE manual.

- For building systems:
  - Heating Design Dry Bulb: 37.8 DegF (ASHRAE 99% value)
  - Cooling Design Dry Bulb: 88.6 DegF (ASHRAE 1.0% value)
  - Cooling Design Mean Coincident Wet Bulb: 66.2 DegF (ASHRAE 1.0% value)

[1] Taken from ASHRAE 2001 Fundamentals Handbook, Climatic Conditions for Moffit Field.

- For 100% outdoor air systems:
  - Winter mean of extremes, 5 year: 29.4 DegF
  - Summer mean of extremes, 5 year: 102.2 DegF

Designer shall refer to the weather data in ASHRAE manual.

4.8.3 Design Parameters

Recommended ventilation rates are as follows:

- Maintenance areas: 6 air changes per hour, partial circulation within the area
- Chemical process areas: 10 air changes per hour, 100 percent outside air (OSA), minimum 1.0 cfm per square foot for Group H occupancies as determined by CEC, CBC, and CMC or to control heat gain (no greater than 10° above ambient)
- Mechanical rooms: When above room temperature setpoint ventilate at 6 air changes per hour, 100 percent OSA, or to control heat gain or as required to maintain space temperature at 10°F above ambient
- Office areas, minimum: Per ASHRAE 62.1, CEC, CBC, and CMC.
- Laboratory areas, minimum: Per Industrial Ventilation Handbook of Recommended Practice and per California Mechanical Code, Table 4-4.
- Washrooms, minimum: 6 air changes per hour or to control air quality, 100 percent exhaust. Fan to be connected to light switch
- Electrical rooms: Maintain 50°F heating, 80°F cooling
- Process areas: To meet NFPA 820 requirements per Table 10 (Refer to NFPA 820 (2012) for Complete Requirements)

The NFPA ventilation rates are intended to provide a measure of fire protection. Higher ventilation rates are sometimes appropriate to control corrosion, improve odor collection, or improve the space for occupancy safety or comfort. Higher ventilation rates, however, result in higher operating costs and higher capital costs, especially if the space is odor controlled.

NFPA guidelines allow recirculation of up to 75 percent of air in an unclassified space as long as the system provides a minimum of 6 air changes per hour, recirculation does not occur during occupancy, or if combustible gas detectors sense a lower explosion limit (LEL) of 10 percent or higher. In these cases, automatic dampers can be opened and closed based on an occupancy sensor and the combustible gas detector signal.

Table 10	Recommended Minimum Ventilation Rates and Inside Design Temperatures Mechanical Design Standards City of Sunnyvale				
Area	**Recommended Minimum Ventilation Rate (AC/HR)**	**Class Division**	**Design Inside Heating, °F**	**Design Inside Cooling, °F**	**Space Pressurization**
Sewage Wet Wells	12	C1/D1	NA	NA	NEG
Drywells	6	C1/D2	55	90-100	NEG
Enclosed Screening Areas	12	C1/D1	50-60	90-100	NEG
Screening Handling Buildings	12-20	Unclassified	50-60	90-100	NEG
Grit Handling Rooms	12-20	Unclassified	50-60	90-100	NEG
Uncovered Grit Tanks	NA	C1/D2[6]	NA	NA	NA
Covered Grit Tanks	12	C1/D1	NA	NA	NEG
Covered Primary Sedimentation Tanks/Channels	6-12	C1/D1	NA	NA	NEG
Uncovered Primary Sedimentation Tanks	NA	C1/D2[8]	NA	NA	NA
Sludge Pumping Gallery	6	Unclassified	50-60	90-100	POS
Blower Rooms	NA	Unclassified[4]	50-60	90-100	
Dewatering and Thickening Facilities	6	Unclassified[4]	50-60	90-100	
Enclosed Digested Sludge	12	C1/D2	NA	NA	NEG
Digester Control Rooms	6	Unclassified[3]	50-60	90-100	
Boiler/Engine Rooms	6	Unclassified[4]	50-60	90-100	
Shop Areas	6	NA	68	85	
Electrical Rooms	Per ASHRAE 62.1[5]	Unclassified	55	80	
Personnel Areas	Per ASHRAE 62.1[5]	NA	68	75	

Notes:

(1) The area within a 10 ft radius of valves, drip traps, sediment traps, etc. are C1/D2.

(2) The areas within a 3 ft radius of fans, dampers, pressurized unwelded ductwork, etc. are C1/D2.

Table 10 Recommended Minimum Ventilation Rates and Inside Design Temperatures Mechanical Design Standards City of Sunnyvale					
Area	**Recommended Minimum Ventilation Rate (AC/HR)**	**Class Division**	**Design Inside Heating, °F**	**Design Inside Cooling, °F**	**Space Pressurization**
(3) No digester gas processing equipment inside the digester control room. Gas utilization equipment such as boilers and engines are not considered gas processing equipment and are allowable.					
(4) Ventilation rate determined from internal heat gain or air change rate, whichever is higher. Because of high internal heat gain and whether the blowers and piping are insulated or not blower rooms will normally have a high air change rate. Dewatering facilities are normally odor controlled if biosolids are exposed to the space. Ventilation and odor control of solids and centrate chutes and tanks shall also be provided if applicable. The IFC requires a minim 1 cfm per sf for chemical handling facilities.					
(5) To control heat gain. Minimum ventilation rates to be per ASHRAE 62.1. Air Conditioning.					
(6) Within a 10 foot envelop around equipment and open channel.					
(7) If less than 6 air changes per hour, space becomes C1/D2.					
(8) Within 18” of top of tank and extending 18” beyond exterior wall.					

4.8.3.1 Ventilation Considerations

4.8.3.1.1 Supply and Exhaust Fans

NFPA 820, in general, requires that process areas be ventilated with both supply and exhaust fans. Exceptions are wet wells, which use only exhaust fans that create a space with negative pressure and helps contain potentially hazardous gases and odors.

4.8.3.1.2 Ventilation Supply and Exhaust Locations

Design the supply and exhaust ductwork to properly distribute and collect the ventilation air.

In general, supply and exhaust points should be at opposite ends of the space. Exhaust collection points should be near potential odor or hazardous gas generation points.

For spaces with the potential for hydrogen sulfide (H_2S) and methane to be present, the exhaust ductwork pickup points must be low and high as H_2S is heavier than air and methane is lighter.

4.8.3.1.3 Space Pressurization

Clean spaces should be designed to be at a positive pressure relative to potentially odorous or hazardous spaces. Clean spaces include laboratories electrical rooms, office areas, equipment rooms without gas handling equipment, or equipment rooms not exposed to wastewater or biosolids. Positive pressure is achieved by supplying more air than exhausting.

All classified spaces are required under NFPA 820 to have a negative pressure of 0.1 inch WC. For exhaust only systems, design the intake system for a 0.1 inch WC pressure drop. For systems using supply and exhaust fans, design the exhaust system with slightly greater airflow than the supply airflow. Indicate the desired space positive or negative pressure on the drawings.

All HVAC systems require balancing (refer to specification Section 15990 CBC). The air balancing contractor will adjust dampers and motor speeds to achieve the specified space pressures. The system design must include adequate head pressure and the duct system must have sufficient manual and automatic dampers to allow for balancing.

In laboratory spaces where exhaust hoods and glove boxes are started and stopped depending on need, the supply system will be a variable air volume (VAV) system. Fan speed and, therefore, air flowrate will be controlled from a pressure transducer(s) located in the laboratory space. The VAV shall be designed so that the electrical VFD and VAV work together to provide adequate positive space pressure and air volume for heating and cooling. The blower building shall be designed so as to maintain adequate air pressure during blower operation.

4.8.3.1.4 Odor Control

See Odor Control Design Standards.

4.8.3.1.5 Transfer Air

To reduce energy consumption ventilation air is sometimes transferred from one space to another. However, NFPA 820 does not allow the transfer of ventilation air between classified and unclassified spaces. For unclassified buildings such as a dewatering facility, consider transferring air from low odor spaces to higher odor potential spaces. This will reduce the overall amount of unconditioned air in the area and, therefore, the heating and cooling energy usage.

4.8.3.1.6 Emergency Power

Ventilation systems for all classified spaces will be connected to the emergency power per NFPA 820.

NFPA 820 requires flow alarms for all continuous ventilation systems in classified spaces (except administrative office areas). In classified spaces, NFPA 820 also requires combustible gas detectors.

4.8.3.1.7 Blower Rooms

Air intakes and filters for blower rooms will account for process air to the blowers. Where high speed turbine blowers are installed, cooling air is exhausted to the space and the heat load must be accounted for when determining ventilation requirements for the space. An intake gravity hood or wall louver with a backdraft damper will be installed to protect the room from high negative pressure in the event of an air handler failure.

4.8.3.2 Calculations

HVAC systems require that detailed calculations be performed to correctly size the system to meet the space heating and cooling load requirements. The ASHRAE handbooks provide methods for determining heating and cooling loads, duct sizing and pressure loss, and pipe sizing and pressure loss. The quality of air filters shall be agreed upon by plant maintenance.

4.8.3.2.1 Cooling and Heating Loads

Heating and cooling loads will be calculated using ASHRAE's TRACE 700 or other load calculation programs approved by the Plant. Energy efficiency goals will be as defined in the California Energy Efficiency Standards (T-24). Heating and cooling systems will be designed as required to achieve defined temperature, humidity and ventilation requirements.

Process areas can have large equipment heat gains. The amount of heat gain is determined from the equipment efficiency at design load. Some process equipment, such as blowers and centrifuges, and uninsulated hot air or water piping will also add heat gain because the equipment or piping surfaces are hot. The heat gain totals from this type of equipment will be requested from the manufacturer. Pumps generally do not provide any heat gain other than from the motor.

Hot air piping that is less than eight feet above the floor will be insulated for safety. Heat gains from the insulated hot piping shall be factored into heat gain calculations. ASHRAE recommendations will be followed for calculating heat gain to the space from un-insulated piping.

Equipment heat gain, lighting and/or people loads are not included when sizing the heating system.

The outside air heating load must be considered when sizing the heating system.

4.8.3.2.2 Safety Factors

California's Energy Code allows a 10 percent safety factor and a 30 percent startup factor for the heating system load. The cooling system is allowed a 10 percent safety and 10 percent startup factor. These factors are recommended to be applied to the heating and cooling loads. Generally, the startup factor applies only to occupied spaces.

4.8.3.2.3 Static Pressure Drop

Detailed static pressure loss calculations will include intake louvers, filters, coils, duct, air supply devices, and building pressurization requirements. The duct systems will be sized based on the equal friction method using a value of 0.1 inch WC per 100 feet of duct. The SMACNA Duct System Design loss coefficients and velocity pressure are used to determine the duct fittings pressure drops. Filter pressure loss will be assumed to be the pressure drop at which the manufactures recommends the filter to be changed. A 10 percent safety factor will be added to the fan static pressure.

4.8.3.2.4 Water Pressure Drop

Water pressure loss will be calculated for all HVAC-related water systems. A 10 percent safety factor will be added to the pump head selection.

4.8.3.3 Air Flow Schematics and HVAC Control Drawings

Once the space airflows have been determined, either from air change rates or the heating/cooling loads, air flow schematics and HVAC control drawings and control point schedules will be prepared. The schematics will include:

- Each ventilated space as a box with a title
- Air flow (CFM) into the space
- All ventilation equipment including fans and intakes or relief vents
- All heating or cooling devices
- All control dampers

Control drawings and point schedules form the basis for the direct digital control system programming. Together, the sequence of operation, the control diagram and point schedule show all control and monitoring points, and define the level of control.

4.8.3.4 Equipment Selection

HVAC equipment includes fans, pumps, heating systems, cooling systems, and filtration systems. Proper selection of the type and size of equipment is necessary for a functional design.

4.8.3.4.1 Heating and Cooling Systems

Several different types of heating and cooling systems(s) are available. The appropriate system type must be determined for each application. Heating for new administration building and maintenance building will be from the hot water loop.

1. Heating Systems: New heating systems that will be used at the City of Sunnyvale will include natural gas fired equipment (makeup air units, gas unit heaters, hot water systems).
2. Cooling Systems: New cooling systems will include packaged direct expansion (DX) air conditioning units split system DX air conditioning units, chilled water air conditioning units, or adsorption chillers. A central chilled water system is preferred at the plant in order to provide a chilled water loop to air conditioned areas using chilled water.

a. Ventilation Only Cooling: Those spaces where the indoor temperature can exceed the outdoor design temperature will be supplied with ventilation only air. The ventilation rate will be that required to maintain the space at 10°F above the ambient temperature or as dictated by NFPA 820, whichever is greater. Exceptions include where requested by the client and where necessary for the electrical equipment. The space temperature limitations for the electrical equipment will be coordinated with the electrical designer. For rooms with high internal heat gains, mechanical cooling will be considered to reduce the ventilation rate.

4.8.3.4.2 Fans and Pumps

Efficiency and stable operation will be considered when selecting HVAC fans and pumps. Fans in air handling units are specified either by external static pressure (ESP) or total static pressure (TSP). TSP is preferred, but the coil, filter, inlet, etc. pressure drops must also be specified. ESP only includes the ductwork, terminal device, and building pressurization static pressure. Most fan catalogs provide guidance for fan selection and usually two or three fan sizes will meet the necessary flow and static pressure. The fan wheel diameter and rpm will be included in the equipment schedule to insure the proper sized equipment is submitted. Submit fan and pump curves with the fan and pump selection calculations.

4.8.3.4.3 Filters

All HVAC systems that utilize cooling or heating coils must include filters. If the system has an air handing unit, it should include a filter section. Process building supply air from rooftop or wall fans is not usually filtered. Carbon filters will be provided on every air handler serving clean rooms and electrical/control rooms, in addition to normal filtration. Face velocity across the filters will be a maximum of 500 feet per minute. Laboratories shall have MERV 14 rated filters. Filtration efficiency for all other areas will be as recommended in ASHRAE 55.2.

Filters shall not be located above ceilings in clean rooms. They shall be located above hallways or other adjacent spaces to prevent debris from falling in the room. A hose bibb shall be provided at all washable filter locations.

4.8.3.5 Equipment Location

4.8.3.5.1 Considerations

HVAC equipment such as air handling units can be located inside or outside (rooftop or grade). An inside location is more protective of the equipment, usually easier for maintenance, and is less unsightly but it often creates a larger, more costly building. An inside location is recommended, in general, but not always available due to process space requirements. Client input will be requested early in the design. If HVAC equipment is to be located on the roof, consider the equipment access needs and client preference - often an access ladder is inadequate necessitating access stairs.

Air handling units can also be suspended from the roof and in finished areas located above the drop ceilings. Consider access carefully for these designs, especially when the units include heating and cooling coils. Access to filters should be considered when locating units in ceiling spaces and between joists or trusses. Split system air conditioners shall provide matching manufacturers for the condensing unit and air handler. Pressure gages shall be mounted on the air handler so that there are no visible exterior tubes.

Exhaust fans can be roof or wall mounted. Upblast roof fans are recommended. Exhaust fans can also be located inside the space and a wall exhaust louver utilized – usually at higher construction cost

4.8.3.5.2 Ventilation Intake and Exhaust Location

Locate the intake and exhaust ventilation points to avoid short-circuiting or cross contamination. The prevailing winds in Sunnyvale are from the southwest, so intakes should be located to avoid these winds wherever possible. Locate potentially hazardous exhaust discharges, for example from laboratory fume hoods or from classified spaces, to prevent entrainment reentrance of the contaminated air into the building.

Ventilation systems with the primary purpose of cooling a space should exhaust from a high point.

Intake louvers should be sized for 0.10 inch WC or less pressure drop. The intake velocity is to be below the louver’s rain carryover velocity. Louver intake velocity should be no more than 500 fpm through the free area, although this varies with the louver type and manufacturer.

Do not locate exhaust ventilation points such that they will exhaust directly on to walkways. Provide wall or roof vent caps for exhaust air from restrooms.

4.8.3.5.3 Access

Provide adequate clearance, usually a minimum of four feet, around each piece of equipment and adequate space to remove coils, shafts, etc. Follow the manufactures equipment dimensions for appropriate clearances. Products from at least two manufactures should be considered during the layout period to help prevent space problems during construction. 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.

Temperature control panels shall not be mounted directly on the equipment. They shall be located on a nearby wall or close to the equipment while still maintaining manufacturer clearance requirements.

Provide access doors in ductwork for dampers, instruments, inspection, and cleaning. Provide adequate clearance around the ductwork that requires cleaning.

4.8.3.5.4 Electrical Equipment Location and Clearance

Electrical equipment requires specific clearances in front of MCCs and switchgear – usually 42 inches for 480V systems.

HVAC equipment and ductwork shall not be located over electrical panels. The National Electrical Code has specific requirements and exceptions that must be observed.

Do not route water piping above electrical equipment.

4.8.3.5.5 Piping and Equipment Layout

1. General
    a. Piping layouts will maintain adequate clearance heights. The minimum clearance of 7.5 feet is for head clearance, and that this is 7.5 feet to the lowest part of the pipe support or insulation.
    b. Flexible connections will be provided at all interfaces with rotating or vibrating equipment.
2. Drainage of Piping and Equipment
    a. Drains will be provided at all low points to facilitate equipment maintenance.
    b. Provide adequate isolation valves to prevent draining large sections of pipe. Slope pipe to facilitate drainage.
    c. Drains for boiler condensate lines shall be acid resistant.
3. Seismic Supports
    a. Seismic supports for pipes, ducts and equipment will be seismically braced per SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, current edition. They will require more space than normal pipe supports.
    b. Seismic supports shall meet the requirements of the CBC and the SMACNA Seismic Restraint Manual. See Structural/Seismic Design Standards.
4. Thermal Pipe Expansion
    a. Hot and cold piping systems expand and contract. Provide sufficient pipe flexibility through use of pipe turns when possible.
    b. For long straight runs, provide expansion joints or expansion loops with appropriate anchors and pipe guides to accommodate calculated pipe expansion.
    c. Coordinate forces generated by pipe expansion and the resulting forces imposed by the supports on the building with the structural design team.
5. Unions and Flanged Connections
    a. Provide a means to facilitate pipe disassembly at valves and equipment.
    b. Unions shall be used for pipe less than 4 inches in diameter.
    c. Flanged connections shall be used for pipe 4 inches in diameter and larger.

6. Existing System Modifications, Tie-Ins
    a. When connecting to existing systems consider the impact on the existing operation.
    b. Verify capacity of existing system to supply new and existing loads and flows.
    c. Provide valves for shutdown and isolation of the existing system while the new connection is made.
    d. Provide a bypass or temporary system as required to maintain service to the plant.
    e. All plans for connection to existing systems, including required modifications to plant operations and shutdowns must be reviewed and approved by the Plant during design.
7. Future and Redundant Equipment
    a. The need for redundant equipment will be discussed with the Owner early in the design.
    b. Space will be provided for systems designed for future expansion.

4.8.3.6 Energy Efficiency Codes

Designer shall comply with the energy efficiency requirements of the 2013 CEC (Title 24) for new HVAC systems and modifications to the existing HVAC systems.

4.8.3.7 Noise

New mechanical equipment will be designed for a noise criteria rating of NC-35 to NC-40 to limit noise in office and laboratory spaces.

Noise levels for plant HVAC systems will be designed to limit the noise levels to 75 dBA at the property line per City of Sunnyvale commercial noise ordinances.

All HVAC equipment will be new equipment selected and designed to meet the noise standards.

4.8.4 Fans and Air Handling Units

4.8.4.1 Equipment Redundancy

HVAC system serving critical electrical, control, and server rooms will be provided with redundant equipment. Redundant units will be sized for 50% of the total capacity of the system. Therefore both units would operate at the same time. The units can also be set up as lead-lag so if temperature can be maintained in the space with only one unit operating, the second unit can remain off. If temperature cannot be maintained with one unit, the second unit would operate. This arrangement would help to minimize cycling of the units during lower cooling demand periods.

Redundant ventilation fans will also be provided for areas where an NFPA 820 classification has to be maintained based on airflow requirements. Each fan would have 100-percent redundancy.

4.8.4.2 Centrifugal Fans

Centrifugal fans, or utility sets, requiring a static pressure of two inches or more, or fans with motors larger than 3 hp will have backward inclined airfoil, or backward inclined blades for high efficiency.

Forward curved blades will only be used on small fans or when low first cost is of primary concern.

All fans will be provided with belt guards and vibration isolators.

4.8.4.3 Propeller Wall Fans

Propeller wall fans will be V-belt driven whenever possible.

Propeller fans will be provided with drive-side guards and wall-mounting sleeves.

4.8.4.4 Roof Exhaust Fans

Roof exhaust fans will be specified with manufacturer-supplied mounting curbs.

In general, backdraft or gravity dampers are not required for continuously operating fans.

Fans requiring guaranteed closure will be provided with motorized dampers.

Exhaust fans equipped with ducting will be the centrifugal-wheel type.

4.8.4.5 In-Line Centrifugal Fans

In-line centrifugal fans will be used where appropriate. In-line fans will be provided with vibration isolators and flexible-duct connections at each end.

4.8.4.6 Cabinet Fans

Small cabinet fans provided with ducting through the wall or roof may be used instead of roof exhaust fans where a small capacity fan is appropriate.

Ceiling fans will be considered for low noise applications.

Differential pressure switches and motorized dampers will not be used with small cabinet fans and ceiling fans.

4.8.4.7 Air Handling Units

Air handling units (AHU) will be packaged single zone, multi-zone, variable air volume (VAV), split systems, or mini-split systems that can supply heating, cooling, ventilation, humidity control, and air filtration as required. Air handling unit fans will be belt-driven and will be of the backward inclined or backward inclined airfoil type. Air handling unit cabinets will be weatherproof when used for rooftop installation with hinged access doors. Whenever possible, air conditioning units should be located indoors or if outdoors, coated for exterior (salt air) environment. All coils should be with coatings recommended by the manufacturer for the environment.

4.8.5 Air Filtration Equipment

Flat type or V-type filters will be used with a face velocity below 500 fpm.

Clean pressure drop will be about 0.2 inch with a dirty pressure drop of about 0.5 inch. Air handling units will be provided with a differential pressure gauge across the filters.

All filters are to have a MERV rating of 11 or greater.

All exterior filters and those that have a possibility of high moisture will be constructed with a plastic frame.

Special attention will be given to filters serving outdoor air intakes.

Outdoor air intakes will be fitted with moisture separators or a duct configuration to prevent rain water intrusion or contact with the filter surfaces.

4.8.6 Ductwork

4.8.6.1 Materials

Galvanized steel ductwork will be used for all interior ducting in dry areas. Fasteners for galvanized ductwork will be galvanized steel. Ductwork will be fabricated according to Industrial SMACNA standards. These standards will be included in the project specifications.

Aluminum or FRP ductwork will be used for all process areas where moisture may be present. Fasteners for aluminum duct will be stainless steel. Fabricate aluminum ductwork in accordance with SMACNA Thermoset FRP Duct Construction Manual. Fabricate FRP ductwork in accordance with SMACNA Thermoset FRP Duct Construction Manual.

Stainless steel ducting will be used with laboratory equipment such as fume hoods, and for all exposed exterior ducting. Stainless steel ducting will be Type 316 stainless steel and will generally be round. All fasteners used with stainless steel ducting will be Type 316 stainless steel. Stainless steel ductwork will be fabricated according to SMACNA Thermoset FRP Duct Construction Manual for low pressure or medium-pressure applications.

Fiberglass reinforced plastic (FRP) ductwork will be used for all odor control. Ductwork will be fabricated according to SMACNA Thermoset FRP Duct Construction Manual. Dampers for odor control systems shall be FRP.

4.8.6.2 Duct Sizing and Velocity Ranges

- The computation of the total system pressure, (static plus velocity pressure will be based on the equal friction method as defined in SMACNA. Size ductwork with an airflow below

10,000 cfm for a maximum pressure drop of 0.08" per 100 feet. Size ductwork with an airflow above 10,000 cfm per the velocity criteria below:

- Rectangular
  - Main ducts: 1,500 to 2,000 fpm
  - Branch ducts; 800 to 1,600 fpm
- Round
  - Main ducts: 1,800 to 2,500 fpm
  - Branch ducts: 1,000 to 1,800 fpm

4.8.6.3 Insulation

Thermal insulation will be provided on supply, transfer, or return ducting that carries heated or cooled air. Thermal insulation will also be provided where condensation may occur, particularly when ductwork is installed above dropped ceilings. This insulation may be external insulation, where damage from traffic is unlikely or internal insulation. Duct liner may be used for internal duct insulation. Use encapsulated duct liner to prevent erosion of the fibers into the airstream and the propagation of mold. Thermal duct insulation will generally be fiberglass.

Duct liner will be used for acoustical insulation in noise sensitive locations such as offices, control rooms and laboratories where required to comply with the specified noise requirements.

4.8.6.4 Duct Dimensions and Design

Rectangular and round metal ductwork will have whole number dimensions expressed in inches. Manufacturer's standard duct sizes and fittings shall be used whenever possible with round FRP ducting. Rectangular ducts will be designed with the smallest possible aspect ratio; aspect ratios greater than 4:1 will be avoided. ASHRAE and SMACNA standards and recommendations will be used for all duct designs. Rectangular metal duct will be used where space limits the duct dimensions, otherwise round metal duct will be used. Exhaust and return intakes in areas where gasses are heavier than air will be extended to within 6 inches of the finished floor. Where gasses are lighter than air, the exhaust and return intakes shall be within 6" of the high points of the ceiling, and extend into any pockets.

4.8.6.5 Duct Accessories

Radius elbows with the minimum internal radius of 1/2 the duct width will be used where space allows. If square elbows are required because of space constraints, they will have turning vanes. Turning vanes will be of the same material as the duct and will be the single-walled type.

Access doors will be provided adjacent to all pieces of duct-mounted equipment or instrumentation.

Fire dampers will be UL listed for closing against an operating air stream, (UL555), with UL listed fusible links; 160°F to 165°F standard. Fire dampers will also be according to NFPA requirements. Fire damper shall carry the same fire rating as the wall fire rating per CBC.

Combination fire and smoke dampers will be installed where required by the CMC and will be UL listed. Fire damper will have fusible link 160°F to 165°F and motor operated smoke damper.

Extractors are allowed to divert, equalize and control airflow from the main ducts into branch ducts, grilles and diffusers, however they should not be required with a well designed duct system. The extractor vanes will be provided with either a worm-drive mechanism or a square shaft with a ceiling-mounted operator knob. Extractor construction will be similar to turning vane construction.

Flexible duct connectors will be used for vibration isolation of the air moving equipment from the duct system. Flexible duct connectors will be with metal-attached or prefabricated metal-edged fabrics where canvas, neoprene-coated glass fabric, or other materials, are rolled into the metal.

Splitter dampers will be used to divert and control airflow from a main duct to two branch ducts of opposite directions. Splitter dampers will be of the same material as the duct.

4.8.6.6 Grilles, Registers, and Diffusers

Grilles, registers, and diffusers will be sized in accordance with the manufacturer's recommendations for noise level, air velocity, and throw. Grilles, registers, and diffusers will be of the same material as the duct. Diffusers will have multi-directional blades. Supply grilles will have two sets of adjustable blades. Return and exhaust grilles will be egg crate type.

4.8.6.7 Drum Louvers and Ball Turret Louvers

Drum louvers and ball turret louvers will be considered for air distribution systems when concise directional air throws or air throws in excess of approximately 20 feet are required.

4.8.6.8 Condensate Drains

Chilled water and DX cooling coils will create condensate and must be collected at low points and drained to the plumbing system through an air gap. Condensate pumps will be required where it is impossible to drain condensate by gravity. Provide secondary drain pans under air conditioning units.

4.8.7 Control Dampers

Mixing dampers will be of the opposed-blade, right-angle type. Actuators will be motorized, modulating type with position feedback.

Shut-off dampers will be parallel blade type with 2 position actuators and end switches.

Volume dampers used for balancing will be butterfly type in ducts less than equal to 12 inches and opposed blade type in ducts greater than 12 inches. Balancing dampers will be provided at all supply and return duct branch takeoffs. Locations of all dampers will be clearly identified on the design drawings. Hinged maintenance access panels will be provided before and after all damper, turning vane and duct mounted control locations for inspection, cleaning, and maintenance. If the access panels are concealed behind a fixed ceiling or wall, coordinate access panels with the architect.

Dampers in odor control systems will be butterfly type.

4.8.8 Controls and Smoke Detection

4.8.8.1 Controls

The HVAC control systems for the new facilities will have direct digital control (DDC). The DDC systems for each building or area will be stand-alone and will have local controls and local and remote monitoring. There will only be remote monitoring of HVAC equipment run/fail, smoke detection, dirty filter detection, and temperature from the SCADA system. No remote control of HVAC equipment will be provided.

4.8.8.2 Smoke Detection

HVAC systems greater than 2,000 cfm require automatic shutoff upon the detection of smoke. CMC provides exceptions to this requirement. The smoke detector shall be installed in the main supply duct. If the building has a fire detection or alarm system the smoke detector(s) are to be supervised by such systems. For areas without a fire alarm system, the smoke detection will be monitored by the SCADA system. Follow NFPA 820 requirements for process structures.

4.8.9 Louvers

Intake and exhaust louvers will be provided with bird screens and insect screens. Together with the louver blades, these screens produce a 0.10 to 0.25 inch pressure drop when clean. Louvers will be sized for a free area velocity of 500 to 750 fpm. Location and finish of louvers will be coordinated with the project architect. Do not select intake louvers with a velocity above the limit of moisture penetration.

4.8.10 Heating Water and Cooling Water Coils

Cooling coils will be sized with a maximum air velocity of 500 feet per minute. Heating coils with a maximum air velocity of 900 feet per minute. Coils will be copper tube with aluminum fins. Provide protective coatings in areas with high H2S concentrations. Temperature control valves provided on piping to coils will be sized based on a differential pressure of 2 psig and may be either two- or three- way type. Heating and cooling water piping will be sized to maintain a maximum velocity of 6 feet per second.

4.8.11 Unit Heaters

Unit heaters will be gas-fired. Unit heaters will be controlled with wall-mounted thermostats.

Gas-fired unit heaters will have flues routed to the outside. Combustion air will be provided through louvers or fans and will be calculated according to the CMC.

Unit heaters in electrically classified areas will be electric or hot water and properly rated to operate safely in the atmosphere.

4.8.12 Piping and Valves

HVAC system piping for above grade service will be black steel for hot or chilled water and natural gas, and Type L copper for refrigerant piping. Use pre-manufactured insulated piping systems for below-grade service for hot and chilled water. Use HDPE for below-grade gas piping.

EDPM is required for valve seats on all hot water systems.

4.9 Plumbing

4.9.1 Water Heater

1. Water heaters will be tank type, glass lined and fully automatic with insulation and burner meeting the requirements of the California Energy Code.
2. Hot water heaters will be natural gas-fired with ASME pressure-temperature relief valves.
3. Heaters will be UL listed and meet or exceed the requirements of ANSI/ASHRAE/IES 90A, the Efficiency Standards for Energy Conserving Appliances set forth by HUD, and the CEC.
4. Heater mounting and sizing will be determined by the design engineer.

4.9.2 Water Closets and Accessories

1. Water closets will be wall-hung siphon jet type.
2. Seats will be solid plastic, open-front, with stainless steel check hinges.
3. Flush valves will be chromium-plated water saver type with screwdriver stops and vacuum breakers.
4. Water closets will be low volume flush 1.28 pgf.

4.9.3 Urinals

1. Urinals will be wall-hung washout type.
2. Urinal flush valves will be chromium-plated water saver type with screwdriver stop.
3. Urinals will be low flush 0.5 gpf.

4.9.4 Lavatories

1. Countertop lavatories shall be oval, self-rimming basin with front overflows.

2. Faucets will be single lever type or electronic no-touch type. Water saver style with 0.5 gpm flow, and pop-up drain.
3. Install wall hung lavatories using a carrier bolted to the floor and concealed in the wall.
4. Install wall hung sink using a carrier bolted to the floor and concealed in the wall.

4.9.5 Service Sinks

1. Service sinks will be 22 inches by 18 inches, acid-resisting, enameled cast iron with stainless steel rim guards, and will be wall-hanger types.
2. Service sinks will be served with hot and cold water.

4.9.6 Roof Drains

1. Roof drains and overflow drains will be cast iron body, low profile types with outlets sized per the CPC to serve the expected rainfall. Drains will be provided with a rough bronze dome and underdeck clamp. Overflow drain pipes will be routed with the rain leaders and discharge at grade in a conspicuous location.

4.9.7 Floor and Process Drains

1. Floor drains will have cast iron bodies with round nickel-bronze adjustable strainers.
2. Floor drains in finished areas will have nickel plated grates with square holes and heavy duty cast iron grates in unfinished areas.
3. Floor sinks will have Sani-coated exteriors, acid-resisting interiors, and will be 8 inches deep with nickel-bronze rims and grates.
4. Floor drains, floor sinks and process drains connected to the sanitary system will be provided with traps.
5. Floor drains in areas where the trap can dry out will be supplied with trap primers.
6. Process drains will not be provided with traps where they are isolated from the sanitary sewer by a sump or running trap in the drain line.

4.9.8 Hub Drains (Bellups)

1. Hub drains will be provided at all equipment where an indirect drain is required, such as seal water, condensate, air release valves, tank and equipment drains.
2. Hub drains will be provided with a trap when connected to the sanitary system.

4.9.9 Emergency Eyewash and Shower

1. Emergency eyewash and shower units will be the conventional stay-open ball valve type. Outdoor units or units exposed to the elements will be the freezeproof type.
2. All units will be supplied with tepid potable water at a minimum temperature of 60°F per ANSI Standard Z358.1.

3. Provide an anti-scald valve for outdoor showers that may be exposed to direct sunlight.
4. All units will include flow-activated local beacon and alarm.

4.9.10 Backflow Preventers

1. Backflow preventers will be provided as required in the CPC.
2. Reduced pressure backflow preventers will be provided on all water supplies to boilers, emergency showers and eyewashes, pump seal water systems, and other process equipment where there is a possibility of cross contamination of potable water.
3. Double check type backflow preventers will be provided for any potable water supply used for fire protection at structures.

4.9.11 Hose Bibbs

1. Hose bibbs for ¾ inches and smaller applications will be boiler drain type with attached vacuum breakers.
2. Hose bibbs greater than ¾ inches will be configured with angle globe valves.
3. Each hose bibb location will also have a hose rack

4.9.12 Yard Hydrants

1. Yard hydrants will be 1½ inches and non-freeze type.
2. Post type yard hydrants will be Wade W-8610 or equal.
3. Wall hydrants will be Wade-8600 or equal.

4.9.13 Piping Systems

4.9.13.1 Drain, Waste, and Vent Piping

1. Drain, waste, and vent piping will be classified as either sanitary drainage or chemical drainage by area use as follows:
    a. Chemical Drainage
        1) Laboratory areas
    b. Sanitary Drainage
        1) Personnel areas
        2) Maintenance areas
        3) Process areas
2. Piping and fitting requirements will be defined in the specifications for specific piping systems.

4.9.13.2 Pipe Elevations

1. Indicate the centerline for all pressure pipes.

2. Indicate the invert elevation for all gravity-flow pipes, including gravity-flow pipes through walls.

4.9.14 Plumbing Calculations

1. Cold and hot water, and waste and vent pipe sizing will be in accordance with the CPC.

4.9.15 Natural Gas Systems

1. Natural gas supply piping to new facilities will be provided with a pressure regulating valve.
2. The pressure regulating valve will be sized to reduce the pressure to 13-inch water column (W.C.) prior to entering the inside of the facility.
3. All piping downstream of the regulatory valve will be sized per the CPC.
4. All piping serving fixtures will be provided with isolation plug valves.
5. Isolation plug valves inside finished areas will be installed inside walls and will be provided with access doors.

4.9.16 Fire Protection

4.9.16.1 Codes

The following codes will be used for the design and installation of fire protection systems.

- International Fire code, 2012 edition, amended by the State of California, California Fire Code, 2013
- National Fire Protection Association (NFPA), 2012:
  - NFPA 13, Installation of Sprinkler Systems
  - NFPA 13A, Sprinkler Systems, Care and Maintenance
  - NFPA 14, Standpipe and Hose Systems
  - NFPA 70, National Electric Code
  - NFPA 72A, Local Protective Signaling System
  - NFPA 72E, Automatic Fire Detectors

4.9.16.2 Design Criteria

1. The project architect will perform a building code review to determine the need for fire sprinkler systems. If it is determined that fire sprinkler systems are required, the areas will be designated a fire hazard classification per NFPA 13. The following are the classifications defined in NFPA 13:
   a. Light Hazard Occupancies. Occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

b. Ordinary Hazard (Group 1). Occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 12 feet, and fires with moderate rates of heat release are expected.

c. Ordinary Hazard (Group 2). Occupancies or portions of other occupancies where quantity and combustibility of contents is moderate to high, stockpiles of combustibles do not exceed 12 feet, and fires with moderate to high rates of heat release are expected.

d. Extra Hazard Occupancies. Occupancies or portions of other occupancies where quantity and combustibility of contents is very high and flammable and combustible liquids, dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release.

   1) Extra Hazard (Group 1). Occupancies with little or no flammable or combustible liquids.

   2) Extra Hazard (Group 2). Occupancies with moderate to substantial amounts of flammable or combustible liquids or where shielding of combustibles is extensive.

2. In general, office areas and areas where light duty work is performed are classified as light hazard. Process areas at wastewater facilities are generally classified as Ordinary Hazard-Group 2. Process areas that handle chemicals and other hazardous materials are classified as Extra Hazard-Group 1.

3. A meeting will be held with the Fire Marshall to confirm the fire hazard classifications.

4.9.16.3 Design

1. Final design and installation is performed by a licensed fire sprinkler contractor during construction based on a performance spec provided as part of the project design.

2. Preliminary flow and pressure calculated during design will be used to size the main riser pipes at each of the facilities and to determine if the available water supply and pressure of the treatment plant is adequate to serve the sprinkler systems without the use of booster pumps.

3. Three types of fire suppression systems are used as follows:

   a. Wet pipe system consisting of a riser with valving and trim to allow water contained inside the piping system to discharge out of a sprinkler head(s) unfusing from a fire. Most of the facilities will be provided with this type of system.

   b. “Gas” fire suppression systems will be specified for electrical and control areas that are critical to the operation of the treatment plant. The dry chemical systems consist of cylinders with special valves, nozzles, and controls to operate and discharge the dry chemical in the case of a fire.

   c. Pre-action systems are “dry pipe” systems which are similar to wet pipe systems except that there is no water in the piping system. Water is held back from the system by a closed pre-action valve. This valve will only open if a sprinkler head unfuses with a loss of air pressure in the piping and/or the fire detection system detects a fire. This type of system prevents discharge of water into the space upon accidental damage to a sprinkler head or false alarms from the fire detection system. This type of system will be provided in control rooms where discharge of water into the space could cause major equipment damage, but not impact critical operations. This dry pipe fire protection system will also be provided for outdoor areas such as covered chemical storage areas.

5.0 REFERENCES

Where required for resistance to pressure, mechanical couplings will be restrained in accordance with AWWA M11 (latest edition), Tables 13-6, 13-7, and 13-7A and Figure 13-7.

APPENDIX A – PIPING MATERIAL SCHEDULE

WPCP Approved Pipe Materials Table
Master Plan Mechanical Design Standards
City of Sunnyvale

Pipe System	Pipe Abbreviation	Pipe Size							
		< 3”		3” – 12”		14” – 36”		> 36”	
		Buried	Exposed	Buried	Exposed	Buried	Exposed	Buried	Exposed
Aluminum Sulphate (Alum)	AL	PVC	PVC, CPVC	PVC	PVC, CPVC	--	--	--	--
Applied Water (Filter Influent)	AP	--	--	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, Steel, RCP	DIP, Steel, RCP
Backwash Air	BA	Steel	Steel	Steel	Steel	--	--	--	--
Chlorine Gas	CL	Steel	Steel	Steel	Steel	--	--	--	--
Chlorine Gas under Vacuum	CLV	PVC	PVC	PVC	PVC	--	--	--	--
Circulated Sludge	CS	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Digester Gas	DG	--	SST	HDPE	SST	HDPE	SST	--	--
Digested Sludge	DS	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Equipment Drain	ED	--	--	HDPE, PVC, DIP	HDPE, PVC, DIP	HDPE, PVC, DIP	HDPE, PVC, DIP	HDPE, PVC	HDPE, PVC
Ferric Chloride	FC	PVC, CPVC	CPVC	PVC, CPVC	CPVC	--	--	--	--
Filtered Water	FW	PVC, DIP	Copper, PVC, DIP	PVC, DIP	PVC, DIP	--	--	--	--
Final Effluent	FE	--	--	--	--	DIP, RCP, Steel	DIP, RCP, Steel	DIP, RCP, Steel	DIP, RCP, Steel
Fixed Growth Reactor Effluent	FGRE	--	--	--	--	DIP, RCP, Steel	DIP, RCP, Steel	DIP, RCP, Steel	DIP, RCP, Steel
Fire Water	FW	Steel	Steel, Copper	Steel, DIP, PVC	Steel, DIP	Steel, DIP, PVC	Steel, DIP	--	--
Foundation Drain	FOD	--	--	PE	--	PE	--	--	--
Grit	GR	--	--	DIP	DIP	--	--	--	--
Hot Water Supply and return	HWS/HWR	Steel	Steel	Steel	Steel	--	--	--	--
Instrument Air	IA	--	SST	--	--	--	--	--	--
Liquid Gas Flare	LGF	HDPE	Steel	HDPE	Steel	--	--	--	--
Low Pressure Air	LPA	Steel	SST	Steel	SST	Steel	SST	Steel	SST

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		< 3”		3” – 12”		14” – 36”		> 36”	
		Buried	Exposed	Buried	Exposed	Buried	Exposed	Buried	Exposed
Mixed Gas	MG	HDPE	Steel	HDPE	Steel	--	--	--	--
Natural Gas	NG	HDPE	Steel	HDPE	Steel	--	--	--	--
Overflow, Outfall	OF	--	--	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP
Polymer	POLY	PVC	PVC	PVC	PVC	--	--	--	--
Potable Water[2]	PW	PVC, DIP	Copper, PVC, DIP	PVC, DIP	PVC, DIP	PVC, DIP	--	--	--
Pumped Drain	PD	Steel	Steel	DIP, Steel	DIP, Steel	DIP, Steel	DIP, Steel	--	--
Primary Effluent	PE	--	--	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, Steel, RCP	DIP, Steel, RCP
Primary Scum	PSC	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Return Activated Sludge	RAS	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Raw Sludge	RS	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Roof Drain	RD	CI, PVC	CI, PVC	CI, PVC	CI, PVC	--	--	--	--
Roof Overflow	RO	CI, PVC	CI, PVC	CI, PVC	CI, PVC	--	--	--	--
Service Air	SA	Steel	Steel	Steel	Steel	--	--	--	--
Sanitary Drain	SD	PVC	CI, PVC	PVC	CI, PVC	HDPE, PVC	--	HDPE, PVC	--
Sanitary Forcemain	SFM	--	DIP	DIP	DIP	DIP	DIP	--	--
Secondary Effluent	SE	--	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, Steel, RCP	DIP, Steel, RCP
Secondary Scum	SSC	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Sodium Hypochlorite	SH	PVC	PVC, CPVC	PVC	PVC, CPVC	--	--	--	--
Supernatant	SN	--	DIP	DIP	DIP	DIP	DIP	--	--
Sanitary Sewer[2]	SS	HDPE, PVC, CI	HDPE, PVC, CI	HDPE, PVC, CI	HDPE, PVC, CI	HDPE, PVC	HDPE, PVC	HDPE, PVC	HDPE, PVC
Storm Drain[2]	STD	--	--	--	--	RCP, PVC	--	RCP, PVC	--
Tank Drain	TD	--	--	--	--	HDPE, PVC	--	HDPE, PVC	--

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Pipe System	Pipe Abbreviation	Pipe Size							
		< 3"		3" – 12"		14" – 36"		> 36"	
		Buried	Exposed	Buried	Exposed	Buried	Exposed	Buried	Exposed
Utility Water[2]	UW	PVC	Copper, PVC	PVC, DIP	PVC, DIP	--	--	--	--
Vent	V	PVC	CI, PVC	PVC	--	HDPE, PVC	--	HDPE, PVC	--
Waste Activated Sludge	WAS	--	--	Steel, DIP	Steel, DIP	Steel, DIP	Steel, DIP	--	--
Waste Water	WW	--	--	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP	DIP, RCP

(1) "—" denotes a material application that is atypical and does not fit under the standard pipe materials table. Pipe materials for these applications to be determined during detailed design.

(2) Pipe materials from City of Sunnyvale Standards

(3) The design engineer shall review the information included and confirm the pipe materials listed are appropriate for individual projects. If the design engineer disagrees with the information contained within the table or wishes to propose an alternative, the City should be notified and the design engineer's recommendation discussed prior to implementation.

(4) See Corrosion Design Standards for pipe linings and coatings.

(5) Abbreviations: CI- Cast Iron, DIP- Ductile Iron Pipe, HDPE-High Density Polyethylene, RCP- Reinforced Concrete Pipe, SST- Stainless Steel.