WATER AGENCIES' STANDARDS

Design Guidelines for Water and Sewer Facilities

SECTION 10.1
SEWAGE PUMP (LIFT) STATION DESIGN

10.1.1 PURPOSE

The purpose of this section is to provide basic flow capacity, hydraulic design, and equipment/material requirements for sewer pump (lift) station design.

10.1.2 GENERAL

It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document. The Engineer of Work may not deviate from the criteria presented in this section without prior written approval of the Agency's Engineer.

10.1.3 STANDARD TERMS AND DEFINITIONS

Wherever technical terms occur in these guidelines or in related documents, the intent and meaning shall be interpreted as described in Standard Terms and Definitions.

A. Codes and Standards: Codes and standards to be used in the design of pumping stations include the following:

ANSI	American National Standards Institute
AWWA	American Water Works Association
HI	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
UBC	Uniform Building Code
UL	Underwriters Laboratory, Inc.
WAS	Water Agencies' Standard

10.1.4 PUMP STATION PLANNING CRITERIA

If at all possible, the use of sewer pump (lift) stations shall be avoided. However, in cases where constraints such as topography and environmentally sensitive habitat dictate, a pump station maybe necessary. Each agency may have ordinances and regulations on the implementation of sewage lift stations. The respective agencies shall be contacted prior to the planning phase of the project to inquire about the feasibility of utilizing a lift station for a given area. In all cases, an agencies rules and ordinances will supersede this design guideline.

A. Small Tributary: In cases where only a small tributary area is to be served by a pump station, the facility may be allowed under one of the following conditions;

1. An annuity is provided for 100% of the operating and maintenance costs associated of the lift station.

2. The lift station remains private, but a maintenance agreement is executed with the agency for the operation and maintenance of the facility.

3. Each individual parcel has it's own private individual sewage pump and forcemain. Each parcel shall have a separate private forcemain located in a private easement out of the public right of way and transition to gravity flow prior to entering a public easement or right of way.

B. Pump Station Design Capacity: The Pump Station Design Capacity shall be calculated as follows:

1. Pump Station Design Capacity (PSDC): Pump station shall be designed to pump the calculated ultimate peak hour sewer flow rates with inflow and infiltration (I&I) in accordance with Section 4.2, "Sewer Planning" from the upstream tributary area.

2. Pump Station Reserve Capacity Factor (PSRCF): This is a safety factor that takes into account that the service pumps will generally not be operating at their fully intended capacity due to mechanical wear and the subsequent loss of efficiency, and increases in force main friction loss due to the deposition of solids and grit. The reserve capacity factor for emergency overflow storage volume shall be one (1.0) for a two (2) hour, six (6) hour, or greater as directed by the agency. Overflow volume is typically determined on the ability of the agency to respond to a lift station failure. Remote locations, areas with difficult accessibility, and environmentally sensitive areas normally require greater storage volume than those in suburban areas. Where this storage is not provided in design, then a reserve capacity factor greater than 1.0 shall be used and an appropriate factor shall be evaluated for approval on a case-by-case basis by the District Engineer overseeing the preparation of the planning study. The six (6) hour or greater storage requirement is a special station requirement in areas where maximum protection from spillage is needed due to sensitive habitats and water ways.

3. Pump Station Design Capacity = (Peak Hour Flow Rate plus I&I) x (PSRCF)

C. Forcemain: Each pipeline is to be evaluated individually for the need and location of blow off assemblies and air valve locations as specified in Section 6.4 "Pressure Systems (Force Mains)".

10.1.5 PUMP AND SYSTEM CALCULATIONS

A. Constant versus Variable Speed Pumps: Constant speed pumps may be used where pump station design capacity is less than or equal to 3 MGD or 2000 GPM. Variable speed pumps shall be used where pump station design capacity is greater than 3 MGD capacity as directed by the District Engineer.

B. Variable Speed Pumps: (Special Station Requirement): If required by the District Engineer, the preliminary design report for the facility shall prepare alternative analysis that calculates the pumping operation/cycling of constant speed versus variable speed pumps to determine if variable speed is the best apparent alternative for the facility. This shall include an evaluation of operation cycling that will occur during periods of minimum inflow rate vs. periods of maximum inflow rate. Also, the relative life-cycle cost comparison of constant versus variable speed pumps for pumping stations shall include the cost of all structure(s), mechanical and electrical equipment that would be affected by the pump selection. The Agency shall thereafter direct the Design Engineer to incorporate constant or variable speed pumps in its design.

C. Uniform Sizing and Number of Service and Standby Pumps: All installed pumps shall generally be of the same size. The minimum number of pumps per station shall be two. In stations with two pumps, each pump shall be capable of pumping the design flow (“Duty”) with the second pump acting as a full standby (“Standby”). In stations with more than two pumps, an identical “standby pump” of the same size and capacity as the other service pumps shall be installed. The “Duty” and “Standby” pumps shall alternate their sequence of operation. The “Standby” pump shall be programmed to start if the “Duty” pump fails to start at the beginning of a cycle.

D. Calculation of Hydraulic Losses: Procedures to be used for calculating dynamic losses shall be based on the following equations:

$$P_1 = (z_2 - z_1) + h_f + \Sigma h_m + P_2$$

Minor loss for each fitting: $h_m = K*Q^2/(386*D^4)$

Friction loss for pipe (Hazen-Williams)$_1$: $h_f = (10.5*L*(Q/C)^{1.85})*D^{-4.87}$

1 – Pump Station Design, RL Sanks © 1998

Where: P_1 = Head seen at pump (ft)
P_2= 0 (ft) for atmospheric conditions
z_2 = Elevation at point of discharge (ft)
z_1= Elevation of water level (ft)
(Assume minimum water level in wetwell)
Q= Gallons per minute (gpm)
L = Length of pipe (L)
D = Diameter (inches)
h_f = Head due to friction losses (ft)
Σh_m=Summation of minor losses (ft)
K = Headloss coefficient per fitting vendor
C = Hazen-Williams Friction Coefficient

C Factors

Material	**C**
PVC Pipe=	130_1
Epoxy lined and coated ductile iron pipe=	130_1

1 - Plastic and lined pipes typically have a friction factor around 140, however, forcemains for wastewater become coated with grease and reduce the friction factor.

Allowable Pipe Velocities: Allowable pipe velocities are defined in Section 6.4 “Pressure Systems (Force Mains)”.

E. Pump and System Curves: Calculations and curves shall be developed for each station, as described in the following paragraphs. However, where a lift station with an existing flow meter will be rehabilitated (or a timed wet well drawdown can be accomplished to determine a flow rate), a system curve shall be obtained from a field test by varying the flow of the existing pumps and measuring the dynamic pressure and flow rate at multiple readings.

1. Calculation of System Curves: Station system curves shall include static lift and all dynamic losses from the station suction piping to the point of discharge. Dynamic losses and plotted system curves (total dynamic head) shall be calculated on the basis of Hazen and Williams C values of 120, 130, and 140.

2. Selection of Candidate Manufacturer's Pump Curves: For each of the above calculated C values, select a pump curve from a manufacturer's catalogue (pre-approved manufacturer's equipment) that meets the required design operating point(s). Each pump curve shall be accomplished by the same model pump, with only the diameter of the impeller varying (note: refer to comments below on purpose of pump curve plots).

3. "Flat" Pump Curves: Avoid pumps with "flat" pump curves where a small change in total dynamic head (TDH) will result in a large change in pump flow.

4. Plotted System and Pump Curve Information on Design Drawings: For each of the C value condition, provide a plot of the calculated system curve on the associate selected pump curve.

5. Multiple Pump Operation Curves: Where multiple pump operation is designed (i.e. multiple pumps will operate in series or parallel), provide combined pump curves from multiple pump operation required to meet pumping capacity requirements. Should variable speed pumps be selected, pump curve plots over the full range of variable speed pumping, and for multiple variable speed pumps in operation shall be provided.

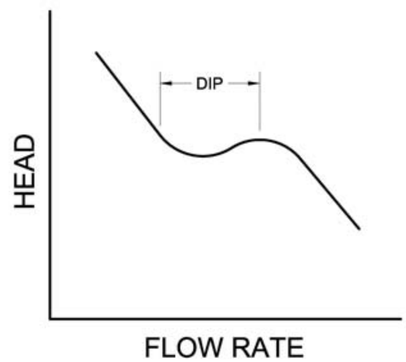
6. Other Information and Pump Curves: The plots of associated system and candidate manufacturers' pump curves required as design submittals shall include the following information: Head versus Q, NPSHR versus Q, Hp versus Q, and efficiency versus Q for the candidate pumps at the required operating speed(s). These curves also shall have the manufacturer's allowable operating regions (ANSI/HI 9.6.3, "Centrifugal/Vertical Operating Region") plotted on them to demonstrate that all specified continuous duty operating points are within the candidate manufacturers' recommended pump operating regions. The selected motor shall be non-overloading throughout the maximum speed curves. The Design Engineer shall require the Contractor to submit the information described above and to demonstrate that his proposed pumps meet the same requirements and those described below:

    a. Pump Selection: The selected pump must provide for stable operation at all operating points falling between the boundary conditions established by the worst (i.e. lowest static lift and lowest pipeline C value) and best (i.e., highest static lift and highest pipeline C value) set assumptions used for development of the station system curves. These boundary conditions must be within the limits of the pump manufacturers' allowable operating region (ANSI/HI 9.6.3, Centrifugal/Vertical Operating Region).

    b. The selected pumps shall operate without damaging cavitation or vibration over the entire design range of flow and head conditions (operating points) including those produced by multiple pump operation and/or variable speed.

    c. Pump NPSHR shall be checked vs. the NPSHA to assure the pump design requirements of Section 10.1.5 (F) are met.

    d. Unless otherwise noted or specified, pump Head/Q curves shall slope in one continuous curve within the specified operating conditions. No points of reverse slope inflection capable of causing unstable operation will be permitted within the specified zone of continuous duty operation. Pumps with Head/Q curves with a dip (as shown below and as described in paragraph 9.6.3.3.12 of ANSI/HI 9.6.3, Centrifugal/Vertical Operating Region) are specifically prohibited if these characteristics will cause unstable operation within the specified range of operating conditions and where startup/shutdown conditions entail operation against a slow opening/closing valve.



e. Pumps shall be designed in accordance with applicable portions of ANSI/HI 1.1-1.6 (Centrifugal Nomenclature, Centrifugal Applications, Centrifugal Operations, Centrifugal Tests), 2.1-2.6 (Vertical Nomenclature, Vertical Applications, Vertical Operations, Vertical Tests), and 9.1-9.6 (General Guidelines, Pump Intake Design Standard). The pumps shall be specifically designed to pump raw wastewater and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified.

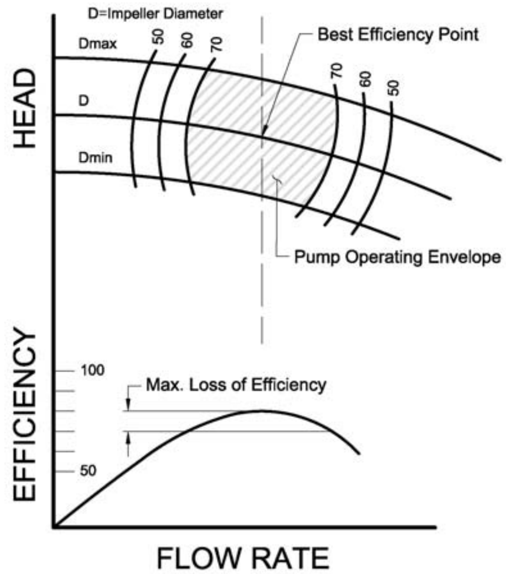
7. Design Pump Rating and Requirements: The specified pump shall be rated to deliver the station design capacity at the worst combination of static head and pipeline C value, and also selected to operate in the manufacturer's Preferred Operating Region (ANSI/HI 9.6.3, Centrifugal and Vertical Pumps - Allowable Operating Region) at the Head/Q curve intersection with the system curve established by the best combination of static lift and pipeline C value.

   The rated condition and all other continuous duty operating conditions specified for full speed operation in the detailed specification section shall fall within the manufacturers Preferred Operating Region as defined in ANSI.HI 9.6.3, "Centrifugal and Vertical Pumps - Allowable Operating Region". The Preferred Operating Region shall be not less than that specified in paragraph 2.1.12 of API 610. Proposed pumps shall be selected to allow not less than a five percent increase in head, as specified in paragraph 2.1.4 of API 620. Variable speed operation to achieve this objective shall not be considered. Pump selections proposing maximum diameter impellers for the proposed pump model and casing size shall not be accepted. The impeller diameter should be selected that is approximately 85% of the maximum trim.

8. Impeller Information for Plotted System and Pump Curves: The purpose of providing separate plotting of the above associated system and pump curves on the design drawings it to show that for the above various C values, the candidate manufacturer's pump can be made to operate at the required design points. This will be accomplished by only varying (replacing) the impeller diameter. This is to assure that the pump station pumps can be configured and designed to operate through the "C" value changes that typically occur during extended service of the facility (i.e., grease coating and corrosion occurring inside the pipe reducing the C factor value over the service life. The pump and impeller combination should be sized so that the impeller is not at the smallest diameter allowable for the pump. This will

provide the ability to trim the impeller if necessary to accommodate lower heads and flows if necessary.

9. Specification of Design Pumps: Based on the above calculations, the candidate manufacturers' design pump to be listed in project specifications and supplied during construction shall be specified so the installed impeller shall be the correct size to operate with the C=130 curve. The pump impeller shall be sized based on the minimum acceptable efficiency allowed by the agency and setting the upper and lower limits on the allowable impeller diameters as shown in the figure below. In no case, shall the maximum or minimum diameter impeller available by the vendor for a particular model be selected.



F. NPSHA Calculation: Net positive suction head available (NPSHA) shall be calculated for all pumps other than column pumps. NPSHA shall be calculated on the basis of the static suction head in feet of water in the wet well, minus the elevation of the center of the pump, minus the vapor pressure of water (in feet) at 85°F at sea level, minus the calculated losses to the pump connection, and minus 5 feet for a factor of safety.

$$NPSHA=H_{bar}+h_s-H_{vap}-h_{fs}-\Sigma h_m-h_{vol}-FS$$

1 – Pump Station Design, RL Sanks © 1998

H_{bar} = Barometric Pressure at Elevation above Sea Level

Elevation Above Sea Level (ft)	Atmospheric Pressure (ft)
0	33.9
1000	32.7
2000	31.6
3000	30.4

h_s = Distance between eye of impeller and water surface (if water surface is below impeller, then the value is negative)

H_{vap} = Vapor Pressure of water column at 85^o = 2.55-feet

h_{fs} = Friction loss in pipe between suction intake and pump (ft).

Σh_m= Sum of minor pipe friction losses (ft).

h_{vol} = Partial pressure of dissolved gasses. Assume 2-feet.

FS = Safety factor. Assume 5-feet.

Pump specifications shall include NPSHA values for all anticipated operating conditions. NPSHA shall always be more than net positive suction head required (NPSHR) by the selected pump(s). The margin ratio NPSHA/NPSHR for the selected pump(s) shall be not less than that specified by in ANSI/HI 9.6.1, “Centrifugal and Vertical Pumps - NPSH Margin,” at specified operation conditions, and the margin ratio shall be calculated using the following methodology:

Specify pumps to be selected for NPSHR (Net Positive Suction Head Required) characteristics using the suction energy methodology set forth in ANSI 1.6, “Centrifugal Tests”, or 2.6, “Vertical Tests,” as applicable for the proposed pump. The Design Engineer shall require the Contractor to document the method used to determine the NPSHR for the proposed pump in its pump submittal material.

The specifications shall require the Contractor to use suction energy rules in selecting proposed pumps and to apply the selection criteria as set forth in the individual paragraphs below. Percentages stated below shall apply to pump capacity on the selected pump’s head/capacity curve at the speed required to achieve the specified operating condition.

The Contractor shall submit the manufacturer’s suction energy calculations justifying the proposed pump selection.

1. A minimum NPSHA/NPSHR margin ratio of 1.3 shall apply at any operating condition within 85 percent of best efficiency capacity. The minimum acceptable NPSHA/NPSHR margin ratio at any other location on the pump’s head/capacity curve shall be 1.8.

2. Notwithstanding item i above, the manufacturer shall use the methodology in ANSI/HI 9.6.1, “Centrifugal and Vertical Pumps - NPSH Margin,” to determine the proposed pumps suction energy. In determining the proposed pumps suction energy, the inlet nozzle size shall be increased by two nozzle sizes to account for impeller design consideration. In employing the suction energy method, the minimum NPSHA/NPSHR ratio shall be not less than that recommended in ANSI/HI 9.6.1, “Centrifugal and Vertical Pumps - NPSH Margin,” or item i above, whichever is greater. For submersible or wet pit pumps, suction nozzle size shall be the impeller eye diameter for the proposed pump.

3. If the proposed pump’s energy, as determined in item ii falls into the “high” region in Figure 3 of ANSI/HI 9.6.1, “Centrifugal and Vertical Pumps - NPSH Margin,” the minimum acceptable NPSHA/NPSHR margin ratio shall be 1.5 and 2.0 respectively.

G. Mass Elastic Systems and Critical Speed Calculations

Each pumping unit, consisting of pump, intermediate shafting, couplings, motor, supports and all attached appurtenances shall have no dangerous critical or resonant frequencies or multiples of resonant frequencies within 20 percent above and 15 percent below the speed (range) required by the pump to meet the indicated operating conditions. A dangerous critical speed shall be defined as one which produces a torsional stress exceeding 3500 psi. The Design Engineer shall require the pump manufacturer, through the Contractor, to be responsible for the analysis of critical speeds and the complete mass elastic system, which shall be analyzed and certified by a registered professional engineer regularly engaged in this type of work. Analysis shall be at least equal to the industry standard technique developed by Dunkerly and Holzer.

H. Wet Well Calculations

1. Flow Data Table: Provide a table of flow data on the design drawings for the sewer line discharging into the wet well up to 500 feet upstream, as shown in the following table:

Pipe Section (MH# to MH#)	Peak Q	"N"	d/D

2. Wet Well Inlet: The wet well inlet sewer invert shall be above the normal high water operating level. The wet well inlet sewer shall be designed to minimize turbulence, odor generation, and shall be located above the high water level with no free fall discharge into the wet well under any operating condition. The wet well inlet shall be designed in accordance with ANSI/HI 9.8, "Pump Intake Design Standard for Solid-Bearing Liquids".

3. Wet Well Operating Volume: The wet well operating volume and pump(s) sequencing start/stop call levels shall be configured to meet minimum inflow conditions through peak wet weather inflow conditions. The total wet well operating volume is the volume between the first pump on start level in the wet well to all pumps on start level. For periods of very low inflow, the volume to be pumped by the first pump call shall be as small as possible to allow regular pumping down of the wet well volume to prevent septic action from taking place. However, the wet well must be large enough to provide at least 5 minutes pump running time at minimum flow to prevent overheating of electric motor and controls.

   Where variable speed pumps are installed (i.e. to provide the required variation in pumping rate for minimum inflow through peak wet weather inflow conditions), the pump(s) start/stop call levels in the wet well shall be configured to satisfy the above requirements over the entire range of design pumping rates and pump sequencing.

4. Minimum Inflow Calculation: In the sizing of a pump station wet well, determination of minimum flow is also important to control cycling of constant speed pumps. Wet well should be large enough to provide at least 5 minutes of pump running time to prevent overheating of the motor, but not too large in order to prevent septic conditions in the wet well. The following table shall be used to determine minimum flow (note: typically 20 to 30% of the average daily flow dependent on population flow (Source: WPCF Manual of Practice No. 9).

Ratio of Minimum to Average Flow

Average Flow, MGD	Min. Flow Factor
Less than 1	0.20
2	0.24
3	0.26
4	0.27
5	0.28
7	0.30
10	0.32

$Q_{\text{Minimum Inflow}}$ = (Minimum Flow Factor) X (Average Dry Weather Flow)

5. First Pump Call Level in the Wet Well Operating Volume: The minimum wet well operating volume (i.e. first pump call operating volume based on start and stop levels) shall be equal to the following:

   First Pump Call Wet Well Operating Volume = [(PSDC) – ($Q_{\text{Minimum Inflow}}$)] x 5 minutes

6. Wet Well Operating and Alarm Levels: The wet well low and high operating watering levels and alarm levels shall be indicated on the design drawings. The pump automatic shut-off level shall be located above the pump volume level to ensure sufficient net positive suction head per Section 10.1.5 (F). Minimum submergence of the pump suction bells (this defines the low flow level) shall not be less than that determined in accordance with Section 9.8.7 of the Hydraulic Institute Pump Intake Design Standard. The automatic low level shut-off feature shall be inoperable during cleaning cycles of self-cleaning trench type wet wells.

7. Emergency Storage Volume: Separate from the wet well operating volume, the Design Engineer shall provide an emergency storage volume sufficient to accommodate storage of a two-hour pumping volume at peak wet weather flow. The total pump station sewage storage volume (i.e., volume of the wet well above the pump “off” level to the lowest sewage spill point) can be accomplished by the following measure singly or in combination (listed in order of preference): additional storage in the wet well above the operating volume, separate overflow tank and storage in the inlet line to the spill level.

   This “emergency repair holding time” will allow operating personnel at least two (2) hours to respond to a station failure alarm and/or to shut off all pumps to perform emergency repairs to correct a failure condition. In addition, this storage is also available to be utilized for flow equalization during large storm events should peak wet weather inflow exceed the pump station design capacity.

8. Influent Line Storage: The wet well influent sewer shall not be designed to accommodate storage except as required for “emergency repair holding time” as described in the previous paragraph (note: this causes grease buildup problems in the inlet line). This storage shall be utilized where it is not practical to provide two-hour emergency storage in the wet well and/or separate overflow storage tank.

9. Spill Location Indication: Influent sewer and pump station spill locations shall be indicated on the design drawings (lowest upstream elevation or wet well cover elevation where backup spill will occur). Mean sea level (MSL) elevation shall be included for information for spill location.

I. A Six-Hour or Greater Emergency Storage (Special Station Requirement)

1. Closed Tanks: In areas where maximum protection from spillage must be provided, such as areas where a station sewage spill would flow into a water supply reservoir or other sensitive areas as determined by the District Engineer, a six-hour (or greater if determined by the respective agency) emergency overflow storage (at peak wet weather inflow rate) shall be provided. The emergency storage can be an underground structure or a separate tank that is normally empty but can drain by gravity back into the wet well.

2. This storage is also available to be utilized for flow equalization during large storm events should peak wet weather inflows exceed the pump station design capacity.

3. Ponds: In isolated areas, an open-air basin or a pond maybe provided as an emergency storage in lieu of underground concrete structure; however, the basin shall be lined with an impermeable flexible barrier protected by a layer of concrete. Provisions shall be made for draining the emergency storage basin back into the wet well.

J. Force Main

1. Capacity of Discharge Sewer: During pump station design, the Design Engineer shall verify that there is sufficient capacity to handle the increased sewer flow in the gravity sewer into which the force main discharges. This calculation shall route the design discharge of the facility through the discharge sewers to the point at which the pump station component is reduced to 10% of the total flow.

2. Force Main Retention Time: The following calculations shall be used to determine maximum retention time within the force main. This information shall be utilized with other hydraulic factors (i.e. maximum wet well detention time, downstream gravity sewer discharge conditions) to determine if chemical addition for odor control is required.

- Force Main Volume = Length x Area
- Minimum Pump Run Time (PRT) = 5 minutes = (First Pump Call Wet Well Operating Volume)/[(Pump Station Design Capacity) – ($Q_{Minimum\ inflow}$)]
- Number of Cycles = Force Main Volume/[(Pump Station Design Capacity x PRT]
- Maximum Wet Well Filling Time = (First Pump Call Wet Well Volume)/($Q_{minimum\ inflow}$)
- 1 Cycle Period = Maximum Wet Well filling Time + PRT
- Maximum Retention Time = (Number of Cycles) x (1 Cycle Period)

10.1.6 PUMPS

A. Vertical Non-clog Pumps

1. Vertical non-clog pumps driven by extended drive shafts are the standard type of pump to be provided in sewer pump station, and shall have the following features.

2. General Construction: Pumps shall have ductile iron impeller; stainless steel wear ring on the pump volute and on the impeller; a Type 316 stainless steel shaft and Type 400 shaft sleeve; mechanical seals (refer below); powder epoxy coat on impeller, interior of bowl and water passages; and Type 316 stainless steel fasteners securing the impeller and in all wetted areas and casing bolts. Pumps shall have volute and suction inlet hands holes/inspection plates.

3. Maximum Size Solid Passing through Impeller: All pump shall be sized to pass a three inch (3”) spherical solid.

4. Mechanical Seals: Pumps shall have a single cartridge type mechanical seal cooled by product water routed from the backhead area into the stuffing box through a machined clearance. Pump/impeller shall be designed to provide positive pressure above atmospheric to the stuffing box area to allow seal flush line to function. Stationary portion of the seals shall have stainless steel construction. Rotating faces of the seal shall be of silicon carbide against carbon. Seal shall be manufactured by AES Engineering C.U.R.C. Type, or Chesterton 155, no exceptions (note: this mechanical seal specified is a standard single cartridge type with standardized dimensions). The seals shall be constructed to allow rebuilding of the seal utilizing repair parts.

5. Compound Pressure Gauge Installation: Provide a combination vacuum and pressure gauge on the suction side and a pressure gauge on the discharge side of each pump. Gauge assemblies shall include the following and mount off of the piping to reduce vibration: Type 316 stainless steel nipple into piping; 1-inch stainless steel isolation ball valve; high-pressure rate flexible hose; 1-inch stainless steel ball valve; air release fitting; diaphragm seal and pulsation dampener; pressure gauge with safety flow-out relief (diaphragm seal and gauge filled with glycerin for isolating valve from sewage).

6. Pump Bases: Pump concrete support bases shall be monolithically constructed with the dry well floor concrete pour. Edges of the pump concrete bases shall be chamfered (1-inch minimum).

7. Stainless Steel Anchor Bolts for Pump Bases: Anchor bolts shall be cast in place only, and constructed with stainless steel class 316. Wedge type or chemical type anchor bolts are not allowed for rotating equipment, and shall be specifically prohibited.

8. Pump Drain Lines: Provide a two inch (2”) valved and capped drain connection on the suction elbow of each pump, including an isolation valve. Provide with a quick cam type coupling. Provide a flexible hose to be stored in the station that will connect to the coupling, and be used to drain to the sump.

B. Motors

1. Motors for Extended Shaft Pumps: The motors specified in this subsection are the standard type to be provided in sewer pump stations, and shall have the following features.

2. Sewer Lift stations with a peak hour collection system inflow rate of less than 694 gpm (1 MGD) shall be equipped with pumps that have 1800 rpm motors. Lift stations larger than 1 MGD shall be equipped with pumps that have 1200 rpm motors or less, provided that high pump efficiencies are achieved.

3. Motor Horsepower Selection: The motor shall be sized with sufficient rated name plate horsepower to meet the requirements described in the previous sections and provide design pumping capacity at varying friction values that may occur over the service life of the force main.

4. Motor Features: Specify totally enclosed fan cooled (TEFC) motors to resist water penetration. Motors shall be of a high efficiency type. Specify resistance type motor heaters with automatic disconnect upon motor start to reduce corrosion and a manual on/off breaker switch. Motor windings are to be all copper and epoxy encapsulated (aluminum windings or components are not acceptable). Motor controls are to include high-temperature safety switches installed in the motors. Motors shall be rated for a minimum of 10 starts per hour and NEMA motor design letter shall be “B”. Starting code letter/locked rotor KVA/hp rating shall be “F” or better. Motor winding

insulation shall be epoxy and have a class "F" rating. The motor temperature shall not exceed class "B" temperature limits as measured by resistance method when the motor is operated at full load at 1.15 safety factor continuous in maximum ambient temperature of 50°C. Motors shall have a Factory Mutual approval. Motor nameplate horsepower must exceed maximum required by pump under all possible operating conditions. Bearing temperature rise at rate load shall not exceed 60°C. For efficiency, the motors specified for constant speed application shall be rated premium efficiency and operate in the range within 90% to 95% of its rate power. Avoid greatly oversizing motors since both efficiency and power factors drop in motors running below their full load rating. Specify a 1.15 service factor (SF) for constant speed motors and 1.2 service factor for variable speed motors. Provide a motor stand as required to allow access to the motor coupling for maintenance.

5. Soft Start Motor Starters: All motors shall have programmable solid state soft start starters, Allen Badley or approved equal. Provide by-pass magnetic contractor, which shall be used for by-passing the solid state starter when full speed is reach in order to extend the life of the solid state starters, or for emergency across the line starting in the event of soft start failure.

C. Extended Drive Shafts

1. General: Drive shafts shall be fitted with universal joins (U-joints) to assist in disassembly or removal from the station. Shaft length typically shall not exceed ten feet (10'). Intermediate motor installations shall be located above two-hour overflow storage level. Generally, based on typical manufacturer recommendation, the intermediate shaft shall be furnished as a single unit with couplings and shaft offset between two (2) and twelve (12) degrees.

2. U-Joint Greasing Access: Motor support bases (including installations with inertial flywheels) shall have sufficient height and clearances above the floor to allow ease of access to U-joints for greasing. At intermediate levels, provide catwalks (with safety ladders) for ease of access to the U-joints for maintenance. Drive shaft safety guard shall have secured access doors for this purpose.

3. Safety Guard: Install a safety guard around the entire length of the drive shaft and latched access doors at the U-Joints. The guard shall be designed with sufficient strength to enclose a swinging, broken, rotating drive shaft. The guard shall be installed in sections to allow removal of the pump after removal of the lower shaft guard section.

4. Intermediate Level Motors (Special Station Requirement): In stations requiring long drive shafts (30 ft and longer), the motors shall be installed at an intermediate floor level to reduce the drive shaft length. This intermediate floor level shall be above the wet well emergency overflow level.

D. Equipment Clearances

1. Minimum equipment clearance shall be as follows:

Between adjacent items of equipment (pumps, motors, piping, equipment, appurtenances and station walls: 3'-6" or manufacturers recommended minimum maintenance clearances plus 1', whichever is more stringent.

Vertical (floor to overhead obstruction): 7'6"

Clearance shall be actual, to most outstanding dimension (i.e., edge of flange), not nominal. Equipment shall be located to provide the above clearances on at least three sides.

E. Spare Parts to be Furnished

1. For all lift stations, furnish the following spare parts and spares:

A. Provide a complete set of mechanical seals, bearings, gasket set, wear rings, fasteners, and spare impeller for each of the service, standby and spare pumps to be provided.

F. Large Pump Stations (Special Station Requirement)

1. Classification: With special approval by the District Engineer, the following maybe required for large installations (capacity greater than 3 mgd):

2. Mechanical Seals for Variable Speed Pumps (Special Station Requirement): Seals on variable speed pumps shall be designed to operate properly over the range of pump speeds.

3. Split Mechanical Seals (Special Station Requirement): Where large pumps cannot be easily removed for replacement of seals, provide split seals for ease of replacement.

4. Air-Gap Seal Water Pressurization System (Special Station Requirement): Cooling mechanical seals with pressurized potable water fed from air-gap tanks requires special approval from the District Engineer. At the water seal connection at each pump provide inlet/outlet isolation valves, head-loss gauge, and flow-rate gauge. The seal water shall have a constant pressure of 10 psi minimum above the operating pressure inside the pump casing. The pump controls shall cause the pump to stop running upon loss of seal water. The tanks shall have a make-up water supply line.

5. Air-Gap Tank Installation (Special Station Requirement): The air-gap tanks and pumps shall be located at the station grade level. Provision shall be made for periodic drainage of air-gap tanks to prevent scale buildup and contamination. Per Health Codes requirements, the system requires reduced pressure backflow protection devices supplying the air-gap tanks located at grade level to allow operation of the system during maintenance and/or testing. All piping downstream of the air-gap tanks must be above ground and visible in the station to prevent the possibility of illegal connections. Provide two seal water regenerative turbine type pumps (one connecting to each tank) with automatic start of the second pump as backup if the on-line pump fails. Provide a pre-charged type diaphragm hydro-pneumatic tank on the common pump discharge line. A telemetry alarm shall indicate a loss of seal water pressure and shut down the pump on preset low pressure of the seal water. The system shall have 50 micron filters equipped with differential pressure gauges (to detect clogging of the filters) and the seal water return line to the air-gap tank.

G. Pump Station Equipment Retrofit Projects (Special Station Requirement)

1. Retrofitting Equipment in Existing Pump Stations: The following types of equipment are not allowed for the design of new facilities due to higher maintenance requirements, and other operation concerns. Where existing facilities with this type of equipment are retrofitted, the following equipment shall be incorporated:

2. Closed-Couple Motors (Special Station Requirement): This type of installation is typically not allowed due to the potential of flooding damage in the pump room. Where this type of pump is required (i.e., application in retrofit projects), the following features shall be provided: utilize totally encapsulated motors capable of operation in submerged conditions and NEMA 6P submerged rated power and control wiring. Utility standard motor frame size dimensionality for ease of replacement with standard motors shall be required.

3. Dry Pit Submersible Pump Installation (Special Station Requirement): Where this type of pump may be required (i.e. application in pump station retrofit projects, or coastal pump station flooding concerns), the following features shall be provided: moisture sensing probes (detect seal failure and send warning only, does not lock out pumps); over temperature detectors; positive oil circulating cooling of motor or product water cooling of the motor; stainless steel motor and pump shafting; ductile iron impeller; powder coat epoxy bowl and impeller; silicon carbide mechanical seals; bearing retaining rings on the shaft; stainless steel wear rings; and volute hand hole access plate on the pump for cleaning. The pump motor shall be rated for a minimum of 10 starts per hour, and also for continuous running in a dry well installation without drainage. The pump shall have a class “F” rated insulation. The pump shall have a Factory Mutual or UL explosion-proof rating. All power and control cables to the pump below the motor control center (MCC) level shall be NEMA 6P rated so that the pumps will continue to run if the pump room is flooded. Cable shall be routed to the MCC level, supported with Kellum cable grips. Locate all junction box connections for the pump power cable above the pump room where flooding can potentially occur, and also for ease of disconnection/reconnection of the cable. Motor cooling jacket shall be equipped with pressurized flushing connection.

4. Wet Well Submersible Pump Installation (Special Station Requirement): Where this type of pump may be required (i.e. application in pump station retrofit projects), the following features shall be provided: Generally provide the features described as above for dry pit submersible pump applications. Also, pumps shall have a Factory Mutual, or UL explosion-proof rating. Install a 3-inch bleed hole on the discharge line of the pump at the 90° elbow fitting prior to penetration through the wet well for removal of air (when the wet well has been drained). Provide Type 316 stainless steel cable and guide rails for installing the pump. Submersible pumps for wet well installations are prohibited except when otherwise directed by the City. This wet well installation is for dewatering pumps only and shall not be allowed for wastewater pumping application.

10.1.7 PIPING AND APPURTENANCES

A. Isolation Valves

1. The valve types recommended for raw wastewater applications found in lift stations are summarized in the following table:

Recommended Isolation Valves For Sewer Lift Stations

Valve Type	Rating
Ball	Excellent
Cone	Excellent
Plug Valve - Eccentric	Excellent
Gate Valve - Sluice	Good
Pinch	Good
Plug Valve - Lubricated	Good
Plug Valve - Non-Lubricated	Good
Gate Valve - Knife	Fair to Good
Gate Valve - Resilient Seat	Fair to Good
Gate Valve - Solid Wedge	Fair to Good
Angle	Do Not Use
Butterfly	Do Not Use
Gate Valve - Double Disk	Do Not Use

2. Dry Well Isolation Valves: Dry well isolation valves inside the station shall be cone, eccentric plug or ball valves made for wastewater applications.

3. Dry Well Valve Operators: Valves shall operate with hand wheels, and have geared operators for ease of tuning.

4. Valve Accessibility: All valves in the dry well shall be accessible from the floor, 6 feet above floor maximum.

5. Elevated Valve Access: Elevated valves mounted more than 6 feet above the floor shall be accessible from the stairwell; special platforms, landings, or catwalks shall be installed as required for access. A ladder with safety climb equipment and harness shall be provided on all platforms and catwalks.

6. Suction Valve Extensions: Suction valves shall be fitted with extensions to the grade level (or the floor above if below grade station). Suction valves shall be fitted with hand wheels in the dry well, and hand wheels (or recessed and covered valve keys are required) at the level above. The extension shall be equipped with two (2) U-joint type fittings at the valve to allow ease of rotation in the event of minor out of alignment of the extension installation.

7. Buried Valves: For buried applications, provide fusion-bonded epoxy coated cone, eccentric plug or ball valves made for wastewater applications with watertight bonnets and buried service gear operators. Provide valve extension to the ground level for operating the valve. Locate valves within the station fenced-in area, if possible. Isolation valves outside the station on the inlet and force main shall be located as shallow as possible.

8. Wet Well Isolation Valve: Locate a pressure isolation sluice gate on the wet well inlet sewer with the following features: stainless steel frame with stainless steel guide inserts, slide and stem; rising stem type (provide stem plastic cover tube to protect from dirt); actuation by square nut or wheel stand accessed from top of wet well. Apply fusion epoxy coat on all ferrous items.

9. Underground Valves in Vaults (Special Station Requirement): Where difficult soil and/or site conditions exist such that buried valves may not be easily accessible for emergency repairs, locate valves in a vault for easy access to valve bonnet pickings, gear operators and/or pressure greasing fittings. This would include force main isolation valves and emergency pump connection valves (refer to Force Main section).

B. Check Valves

1. General Features External Spring Level Check Valves: Specify external spring lever check valves. Wherever possible, install the check valve in a horizontal position to prevent pipe clogging from sedimentation. Valves for vertical installation must be approved. The valve shall have an access plate for cleaning debris from the check assembly. Install a sufficiently strong spring valve to close the valve before return water will cause a "slamming valve" (design to close when the flow of the liquid in the force main halts prior to the back surge wave). The valve flapper shaft and all fasteners in contact with the pumped liquid shall be Type 326 stainless steel.

2. Specific Valve Feature: Specify a low head-loss type check valve, approved for sewer applications. This type of valve will typically require less than a 25° swing for full port opening and have a "no slam" closing characteristic due to the minimal check movement. A full port opening through the valve is typically provided using a wide valve body. Specify a Golden Anderson Quiet Closing valve, no equals.

3. Air/Cushion Valve (Special Station Requirement): Where large discharge heads or flows may cause water hammer, install air/oil cushion type timed closing valves. These valves should be designed to close when the flow of liquid in the force main halts prior to the back surge wave, with a slow close during the final 10 percent of valve closing.

4. Proximity Switch: Install a proximity type limit switch on the check valve. Limit switch shall indicate valve open/closed condition, and interlock with pump controls per standard schematic. Switch and wiring shall be NEMA 6P for protection from water (Note: This switch, indicating a check valve failure to open condition, shall operate with a time delay control relay initiated by pump call to stop the pump motor and prevent motor damage, and signal a pump fail alarm should the sensor not be actuated within the set time delay. It shall also prevent a pump start if the check valve is leaking backflow and potentially spinning the pump in a reverse direction).

C. Piping and Fittings

1. Ductile Iron Pipe: Sewage suction and discharge piping and fittings installed in the wet well and the dry well shall be fusion bonded epoxy lined and coated ductile iron (DI).

2. Threaded-On Ductile Iron Flanges: Threaded-on ductile iron flanges shall be made up with epoxy on the threads for sealing for corrosion protection.

3. Make-Up Length Piping: Provide flanged by plain end pipe fittings and restrained tie rod coupling section for make up length fittings.

4. Pipe Disassembly Lengths: Discharge piping shall be fitted and connected so that there are no lengths of pipe that cannot be disassembled and removed from the station utilizing the station overhead crane rail hoist.

5. Approved Pipe Joints: All pipe joints must be restrained. The following types of joints are acceptable: flanged, and dresser type coupling restrained by tie rods. Threaded on type DI pipe flanges are allowable. For this type, the Design Engineer shall specify assembly per AWWA standards.

6. Non-Approved Couplings Fittings: The following fittings are not allowable and shall not be used in design: rubber bellows-type couplings and flange coupling adaptors (i.e. pipe restraint with set screws).

7. Victaulic Coupling (Special Station Requirement): These fittings are not generally allowed. However, for retrofit projects and where piping space is critical, grooved pipe couplings may be utilized with proper bracing against lateral and rotational movement.

8. Restrained Couplings for Ease of Piping Alignment: On suction and discharge piping connected to each pump and on the discharge manifold horizontal and vertical runs, install two dismantling joints or flexible sleeve couplings with tie rod thrust restraint to absorb piping misalignment and prevent stress in the pump and piping and for ease of piping removal.

9. Piping Supports and Bracing: Piping supports shall be provided under the suction and discharge lines. Piping supports shall be designed to support the piping runs both vertically and horizontally. Bracing shall be provided to resist the maximum expected pressure transient forces. Typically, the end of the manifold will be braced to the adjacent wall for this purpose.

10. Seismic zone 4 Design: All Piping supports shall be designed to meet Seismic Zone 4 requirements.

11. Base Elbows: Base elbow fittings shall be installed on pedestals at vertical bends. The vertical piping run shall be braced horizontally and vertically to the wall, so that base elbows are not required to resist any horizontal or vertical thrust loads.

12. Manifold Configurations: For manifolds, utilize wye fittings rather than tee type fittings. Connect discharge piping from individual pumps horizontally into the side of the manifold (Note: to minimize deposition of solids at check valves).

13. Manifold to Force Main(s) Piping Configuration: Design dual force mains that can be operated independently. Within the dry well pump room, the manifold shall wye into two separate force mains. Each shall be provided with an isolation valve downstream of the wye (note: this configuration allows operation of any pumps through either force main, while the other force main is isolated from maintenance/repair.

D. Force Main Drain Lines

1. Force Main Drain Lines to Wet Well: Within the pump room, provide a drain line with isolation valve from each discharge force main, and discharge to the wet well (note: this configuration will allow draining back the entire force main while the other is operating in the even of a force main break).

2. Force Main Drain Lines (Special Station Requirement): For large pump stations (greater than 3 MGD) or station with critical flooding concerns (i.e., existing electrical equipment located in below-grade pump room not permitted for new pump station or retrofits), the drainage from the force mains(s) and any sump pump installation in the dry well shall be discharged to the sewer manhole immediately upstream of the wet well provided the wet well contains an inlet gate. The gate shall be closed to prevent further flooding and to allow repair work on any pump room leakage.

E. Small Appurtenance Pipe Fittings

1. Small Appurtenance Piping: Two-inch diameter or less piping appurtenances connected to Station DI piping (ie air release valve connections, seal water drain lines, or seal piping drain lines shall be Type 316 stainless steel. Galvanized steel shall not be permitted. Install corrosion isolation nylon brushings when mounting dissimilar metal pipe fittings such as bronze air release gauge cocks on manifold piping.

F. Stainless Steel Bolting

1. Dry Well Fasteners: All dry well pump and pipe fasteners shall be Type 416 stainless steel.

2. Wet Well and Buried Fittings Fasteners: All wet well fasteners and anchor bolts, and all fasteners for buried fittings shall be Type 326 stainless steel.

G. Air Release Valves

1. Installation Locations: Locate air release valves on the discharge piping of the following:

2. Flooded Suction Pumps: Provide auto air vacuum release to remove air after servicing prior to putting pump back in service.

3. Air Release Valves: Install two sewage application combination type air release and vacuum valves (note: two for redundant operation to allow removal for maintenance) on discharge manifolds located at the piping penetration from the dry well. Valves are typically 2-inch size. Provide an independent connection with isolation valve for each valve to the discharge manifold. Brace the valves to the station wall. This installation shall be accessible by a catwalk platform for maintenance. Specify sewage application combination type air release valves as approved by Agency.

4. Stainless Steel Pipe Fittings: As specified above, for each air valve assembly or gauge cock, the pipe nipple connection to the manifold and all other piping in the assembly shall be Type 316 stainless steel. Provide a corporation stop type isolation valve and pipe union on the assembly to allow maintenance and removal for each air release valve.

5. Air Valve Drain Piping: Air release valve discharge piping shall be piped to the station drain sump.

6. Self-priming Pumps (Special Station Requirement): For retrofit projects where these types of pumps are in existence (note: this type of pump is not approved for new station designs), install sewage type air release valves on the discharge side of the pump (discharges periodic air in line due to cavitations or on start up). The internal check valve in the pump holds vacuum in the suction line. Route the discharge hose into the wet well so that the discharge is always submerged to prevent loss of vacuum in the fowl if the check valve seat clogs from debris. Piping from the air release valve to the sump shall be 1-inch Type 316 stainless steel.

7. Submersible Pumps (Special Station Requirement): Locate the following equipment in a discharge valve vault: sewage-type air relief valve, discharge check valve and isolation valve. Also, 2-inch drilled hole with pipe gooseneck maybe installed on the discharge piping vertical ell penetration in the wet well for manual continuous air release.

H. Schedule of Pipe Materials

1. Schedule on Mechanical Drawings: Include data schedule on the mechanical drawings with the following information for each pipe valve, and appurtenance to be provided: item number, size, type, quantity, remarks, and specification reference.

I. Lining and Coating

1. Ferrous Valves, Pipes, Fittings, Appurtenance Lining and Coating: All ferrous wastewater valves, pipe and fittings in the dry well, wet well, and buries shall be fusion-bond epoxy line and coated inside and outside per AWWA C213.

J. Comminutor

1. Comminutors may be required on a case by case basis. The design engineer shall request input from the respective agency as to their requirements for a comminutor installed at the lift station and whether ragging problems have traditionally been an issue. When feasible, the design shall install the comminutor in a manhole upstream of the wetwell to assist in operations and maintenance. The peak hour and I&I flow capacity and headloss through the comminutor shall be calculated based on the manufacturer's recommendations and Section 4.2, "Sewer Planning". If a channel type comminutor is installed, the height of the channel shall be designed according to the manufacturer's recommendations to avoid bypass of the grinders. If directed by the Agency, multiple comminutors or a bypass channel with a bar screen may be required to facilitate the removal and maintenance of one comminutor being out of service.

10.1.8 ELECTRICAL CONTROLS AND INSTRUMENTATION

A. General

1. Electrical controls and instrumentation have been standardized by the individual water agencies. The Design Engineer shall obtain a copy of these standards from the respective water agency, and shall incorporate them in the design after making modifications to meet project specific requirements.

B. Power Switchgear and Distribution

1. Lockout Safety

   a. Provide removable disconnects in the incoming main panel to ensure open circuits for safety while working on switch gear.

   b. Provide circuit breakers with a "lockout/tagout" safety switch handle to provide a switch disconnect of power for use during maintenance operations on machinery.

   c. Install an emergency stop switch at each pump (mounted on the wall or on a pedestal) for electrical safety during maintenance operations. Install the NEMA 6P rated lockout safety switches (Gianni or equal).

2. Circuit Breakers: Use of motor circuit protectors for magnetic starters shall be limited to motors rated below 150 HP. The use of motor circuit protectors (MCPs – fully magnetic circuit breakers) on larger motors such as 150 HP and above can cause MCP trip during start-up and the setting cannot be adjusted beyond 13 time FLA (per NEC). Use thermal magnetic circuit

breakers for motors larger than 150 HP. Additionally, when solid state starters are used, the circuit breakers should be thermal magnetic type.

3. Switchgear Rating Coordination

   a. The circuit breakers shall be designed so that the main circuit breakers will not trip when a supplied breaker is overloaded.

   b. Design Engineer shall perform a short circuit fault performance study to determine levels of fault current throughout the facility. Calculation procedure and methods shall be in accordance with IEEE Red Book, Recommended Practice for Electrical Power Distribution for Industrial Plants. The selected electrical equipment interrupting and withstand ratings shall be based upon results of this study.

4. Line Power Monitoring: The following line power failure conditions shall be monitored by protective devices such IQ Data Plus (brand name) with interlock protection: Phase sequencing; loss of phase; uneven phase current; high/low voltage. In the even that any of these conditions are detected, the controls shall prevent power from being distributed.

5. Ground Fault Protection

   a. The project specifications shall include a requirement for the Contractor to provide a competent independent sub-contractor who will test and provide written certification of complete ground fault testing and verification.

   b. Ground fault protection (GFP) shall be provided on main circuit breakers, when the service is 800A or larger.

   c. (Special Station Requirement). A permanently installed ground fault meter shall be installed in the motor control panel.

   d. Ground fault protection shall be provided in the feeder circuit for each motor.

6. Grounding System: Install a 10-foot copper clad grounding rod in a lockable electrical box. Grounding to cold water piping is not acceptable (could be insulation copper system). Ground connections to the buried grounding system shall be made at all electrical enclosures and equipment. Ensure adequate corrosion protection of the ground rod system and bare copper grounding wire. All ungrounded connections shall be exothermic (welded) connections. No bolted connections shall be buried.

7. Motor Starter Design

   a. “Soft start” reduced voltage type solid state motor starters shall be required for all pumps to reduce starting currents to motors and reduce electrical service and generator capacity requirements. Also, provide manual bypass contactors with “soft-start” in order for manual operation of the starters should solid state starter controls fail. The solid state motor starters shall have adjustable current limit of 50 to 150 percent of full load current and acceleration time adjustments. The solid state starters shall have over temperature protection.

b. All motor starters shall be equipped to provide under-voltage release and overload protection on all three phases. Provide a “Motor Saver, Inc” protective device with digital fault record on each motor starter. Motor starter coil and contacts shall be easily replaceable without removing the motor starter from its mounted position or the removal of phase conductors. Provide fuses on the primary and secondary sides of the control power transformers. Install separate power control transformer for each motor starter. For small appurtenant equipment and other applications, motor starters shall b vertical actuation type and manufactured by Allen-Bradley, or equal. Motor starters shall meet NEMA standards. Overload relays shall be block-type, utilizing eutectic melting alloy type spindles, and shall have visual trip indication with trip-free operation. Pressing of the overload reset lever shall not actuate the control contact until such time as the overload spindle has reset. The reset lever shall be accessible through the control panel door. Resetting of the overload reset lever will cause a snap-action control contact to reset, thus reestablishing a control circuit. Overload relays shall be manually reset only and not convertible to automatic reset. Trip setting shall be determined by heater element only and not be adjustable settings. Overload elements shall be melting alloy type.

8. Motor Control Center Switchgear Equipment

a. Motor control center switchgear equipment shall be factory prepared section manufactured by Allen-Bradley, Inc or equal.

b. All motor control center circuit breakers and motor starters shall be NEMA approved equipment.

9. Wiring and Bus Bars

a. Stranded copper wire shall be used for all power and control wire sizes; solid copper wire is not acceptable. No aluminum wire or connectors shall be allowed for any station wiring.

b. The motor control center and other control panels shall have bus bars and connectors constructed of tin-plated solid copper. All wiring within MCC shall be pre-wired in the factory to reduce field wiring by Contractor. NEMA Class II B wiring shall be specified.

10. Seismic Braces: Seismic braces shall be installed on all electric service cabinets and other free standing equipment per code requirements. Provide a detail drawing of the seismic braces in the design drawings. All electrical equipment shall be anchored to satisfy UBC Zone 4 Requirements.

11. Service Panel

a. The service breaker panel for lighting and auxiliary equipment shall have balanced loads within 15% for each phase.

b. The panel shall have its own transformer and not rely on a transformer in the control panel for service voltage.

12. Electrical Conduit

a. Underground conduit shall be schedule 40 PVC and concrete encased. Underground conduit shall be constructed with water-tight glued joints. Stub-ups shall be galvanized steel, Robroy, or equivalent. All couplings and fittings for stub-up shall be coated and threaded. Use long radius conduit fittings to allow pulling cable.

b. Above ground conduit and stub-ups shall be rigid galvanized steel, PVC coated 40 mils thick exterior and 2 mil thick phenolic on the interior. All exterior PVC coating shall be green color.

c. The Contractor shall provide a pull cord in completed conduit installation for future use.

13. Conduit Routing Schedule: Provide a table in the design drawings that shows the conduit routing schedule.

14. Electrical Outlets

a. Provide 120 V electrical outlets in the station for operation of miscellaneous station equipment and/or repair power tools. All outlets below grade and at exterior locations shall be GFI (ground fault interrupter) protected by GFCI (ground fault circuit interrupter) circuit breakers at panels.

b. Provide two (2) 230 volt, 1 phase, 30 amp outlets in the MCC room for supplying power to emergency breathing apparatus that is used by personnel when entering the wet well.

c. All outlets shall have wet location covers for protection against splashing even when receptacles are in use.

C. Instrumentation and Controls

1. General: This Section describes in general the features of the standard design of electrical controls and instrumentation. Electrical controls and instrumentation have been standardized by the individual agencies. The Design Engineer shall obtain a copy of these standards from the agency, and shall incorporate them in the design after making modifications to meet project specific requirement.

2. Dedicated Gas Monitoring

a. Methane/explosive gas, hydrogen sulfide, low oxygen, and carbon monoxide (CO) detector shall be installed in the dry well. Methane/explosive gas, low oxygen, and carbon monoxide detectors shall be installed in the power plant room. Methane sensors shall be infrared types which do not require periodic calibration.

b. The gas detectors shall be calibrated to alarm at the following set point gas concentrations: Combustible gas – 10% LEL; H_2S – 10 ppm; O_2 low -19.5%; O_2 high – 23%; CO – 35 ppm.

3. Flow Meter: The Contractor shall provide Transducer Transit type ultrasonic flow meter with panel display on each discharge manifold.

4. Level Control: Provide two pressure transducers for level measurement and control. These shall be KSI series 700 with stainless steel construction and rated as submersible. The transmitter output shall be selected per electrical design requirement (4-20 mA, 0-5 VCD, etc). Higher of the two signals shall be selected by the control system for the pump start/stop and control purposes.

10.1.9 REFERENCE

A. Should the reader have any suggestions or questions concerning the material in this section, contact one of the member agencies listed.

B. The publications listed below form a part of this section to the extent referenced and are referred to in the text by the basic designation only. Reference shall be made to the latest edition of said publications unless otherwise called for. The following list of publications, as directly referenced within the body of this document, has been provided for the users convenience. It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document.

   1. Water Agencies' Standards (WAS):

      a. Design Guidelines

         1. Section 4.2, Sewer Planning
         2. Section 6.4, Pressure Systems (Force Mains)

END OF SECTION