

Oregon Standards for Design and Construction
of
Wastewater Pump Stations
May, 2001

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Oregon Standards for Design and Construction of Wastewater Pump Stations

May, 2001

I. Purpose

The goal of these guidelines is to provide for dependable sewage pumping facilities that protect the environment. The guidelines establish design standards and technical criteria for pump stations that can be reliably operated and economically maintained by state-certified operations personnel.

The guidelines provide a basis for review by DEQ review engineers, under Oregon Administrative Rule 340 Division 52 (OAR340-52), *Review of Plans and Specifications*. They also provide a reference for Design Engineers (hired by the Developer or the Owner), and for Sewer System Owners (usually a city or sanitary district).

Since these guidelines are broad and general, wastewater utilities and other sewer system Owners are encouraged to develop supplemental standards as necessary to address local needs, preferences, and existing equipment. Conflicts between the Owner's established standards and DEQ guidelines should be discussed and resolved at the pre-design stage. On request, these guidelines will be revised as warranted to reflect new information and advances in technology.

II. Applicability

These criteria apply to the design of sewage pump stations where DEQ has review responsibility under state law. Hence, the criteria apply to all pump stations serving two or more homes. They shall govern and take precedence over less stringent design requirements that may have been established by the Owner of a sewer system, unless otherwise approved by DEQ.

In general, the criteria apply to all public and private facilities from which sewage flows cannot readily be halted in cases of equipment breakdown or overload, potentially causing an uncontrollable raw sewage overflow. Examples of non-municipal facilities which are extremely impractical to close, and for that reason should observe these guidelines, include schools, apartment complexes, hospitals, mobile home parks, private housing, marinas, airports, prisons, large parks, resorts, and highway rest areas.

These criteria apply to both package-type and site-built stations. The criteria do not apply to on-site sewage disposal systems, which follow other state standards established in OAR 340-73. Also they are not applicable to pump stations at individual homes, factories, or manufacturing

plants where, in case of failure, sewage can readily be halted and the entire station can be removed from service without risk of a sewage overflow.

III. General Design Criteria

Design of the pump station shall include:

- A station with firm capacity to pump the peak hourly and peak instantaneous flows associated with the 5-year, 24-hour storm intensity of its tributary area, without overflows from the station or its collection system.
- A design consistent with EPA Class I reliability standards for mechanical and electrical components and alarms.
- A pumping system consisting of multiple pumps, with one spare pump sized for the largest series of same-capacity pumps to provide for system redundancy.
- Pumps with a minimum of five years' service history for a similar duty and size, unless otherwise approved by the Owner. To ensure a valid warranty, pumps shall either be supplied directly by the manufacturer, or by suppliers who are authorized and licensed by the manufacturer to provide manufacturer's warranty services for the pumps to be furnished
- Inlet, station, and force main piping with all necessary pressure control and measurement features, surge protection systems, air-vacuum/release valves, isolation valves, couplings, odor control systems, and other appurtenances required for a complete and operable system.
- Mechanical systems for heating and ventilating as required by the selected station equipment, local climatic conditions, and applicable codes.
- Plumbing systems for potable water, washdown, and drainage, unless otherwise approved by the Owner.
- Appropriate sound attenuation for noise created by pumping, mechanical, or electrical systems, including a standby generator.
- Electrical systems for lighting, power, communications, security, control, and instrumentation. A motor control center is to be provided for motor starters, accessories, and devices. The motor control center shall provide an isolated, ultra-filtered power, 120 VAC section designed with separate branch circuits for microprocessor-based instrumentation, controls, etc.
- A secondary source of electrical power. Standby generators shall be of sufficient size to start and run the Firm Pumping Capacity of the station, along with all other associated electrical loads necessary to keep the station operational and functioning. At the Owner's discretion, a secondary power feeder from an independent substation may be required as a redundant

power source. With the Owner's approval, the requirement for standby power may be satisfied by providing a trailer-mounted generator and an emergency power connection with manual transfer switch meeting the Owner's specifications.

- A complete system of alarms and alarm telemetry to facilitate operation and maintenance of the station at all hours, including an autodialer or radio telemetry.
- Where required by the Owner, a design to allow remote monitoring of the station through a connection with a Supervisory Control and Data Acquisition (SCADA) system so the Owner can remotely control and monitor station activities. Programmable logic controllers and alarm telemetry must meet the Owner's preferences and standards.
- Structures of adequate size, with interior and exterior clearances to facilitate access for ease of operation and maintenance of all systems. Architectural aspects shall be subject to the Owner's approval.
- Site development including an access road and parking, security, lighting, drainage, signs, and landscaping meeting the Owner's requirements.

IV. Design Report

A. General

The Design Engineer shall prepare a design report meeting the DEQ guidelines for pump station design reports, as published on the internet at the following location:

<http://www.deq.state.or.us/wq/rules/div052guides.htm>

In conjunction with preparation of the report, design will involve the following activities and responsibilities of the Design Engineer:

- Review the Owner's *Wastewater Management Master Plan* and applicable Technical Memoranda, to identify future capacity and facility requirements related to the pump station. The Design Engineer shall verify through analysis that the assumptions in the *Wastewater Management Master Plan* are applicable and, if warranted, recommend revisions. The Design Engineer shall confirm that the proposed design capacity meets or exceeds the peak instantaneous sewage flow associated with a 5-year storm, as defined in DEQ flow-projection guidelines.
- As part of this work, the Design Engineer shall develop system-head curves to verify pump and piping sizing and selection. A series of system head curves shall be prepared to reflect force main system aging, maximum and minimum wet well operating levels, and various combinations of pumps running at various flow requirements.

- The Owner may require the Design Engineer to conduct a detailed hydraulic physical scale model of the proposed wet well. A report documenting the study process, results, conclusions, and recommendations shall then be prepared. Video documentation of the model testing of the final configuration shall also be prepared.

B. Site Selection

Site selection shall be based on the following criteria:

- The *Wastewater Management Master Plan*, and any subsequent work by a Developer and by Owner's staff to refine siting for a specific pump station;
- Proximity to existing or future gravity trunk, force main, and receiving sewer;
- Collection system hydraulic capacity requirements;
- Access to facility including construction access;
- Elevation and drainage (i.e., above the 100-year floodplain);
- Size of the parcel;
- Topography of the site including sufficient setback to allow for fill, cut, and transition to existing contour elevations at the property lines;
- Utilities on and near the site;
- Geotechnical considerations including liquefaction and landslide potential;
- Environmental considerations (i.e., wetlands, sensitive habitat, greenway, etc.);
- Zoning requirements;
- Permits;
- Operation and maintenance considerations;
- Impact to the public including visual impacts;
- Ownership and easement aspects, avoiding difficult acquisitions when possible;
- Capital, operating, and maintenance costs over design life.

Final selection of the site must be approved by the Owner.

C. Design Report Contents

The Design Engineer's report shall contain the following elements, as appropriate for the particular type of facility:

- Vicinity map
- A complete table of Design Data, which shall generally follow applicable portions of the design data example from the DEQ website:
<http://waterquality.deq.state.or.us/wq/wgrules/Opsplans.htm>.
- Wet well and vault buoyancy calculations, which shall be based on immersion with an assumed groundwater level at the surface.

- Site development showing existing, new, and future planned improvements.
- Flow projections, capacity requirements, and system-curve calculations.
- Pump and force main selection based on system-head curve analysis.
- Proposed pump curves and system-head curves.
- Piping plans, crosssections, and elevations, which shall include above-ground and below-ground facilities, tie-ins, and surge protection.
- Storm drains and water lines.
- Mechanical systems including HVAC.
- Plumbing systems.
- Electrical systems including lighting, power, communications, security, controls, instrumentation, and SCADA.
- Backup power system.
- Proposed sequence of work
- When warranted, or when requested by the Owner, a surge analysis to establish sizing and
- characteristics of surge-protection devices. Surge protection shall be designed to prevent damage to the existing infrastructure, prevent column separation in the discharge piping, and excessive surge-related pressures at the pump station.
- When warranted, or when requested by the Owner, an analysis of flowmeter selection and sizing alternatives.
- Force main detention calculations for the dry-weather period, including an evaluation of sulfide control alternatives where average detention will exceed 35 minutes, with design calculations for the selected control system.
- For projects to expand or replace existing facilities:
- An approach and plan to maintain pump station operations during construction
- The Design Engineer's field investigation data and professional evaluation of the force main discharge manhole and downstream sewer system, in accordance with DEQ guidelines, with respect to hydraulic capacity, corrosion, and serviceability.
- To the extent required by the Owner, cost alternatives, plans, schematics, photographs, test results, etc.

In conjunction with report preparation, the Design Engineer shall identify and work with all permitting agencies that have jurisdiction or authority over the work as required to gain the necessary reviews, approvals, and permits. Agencies which may have permitting authority for a particular project are:

- Department of Environmental Quality (predesign report and plan review, approval to construct, review of draft and final O&M manual, approval to operate, and NPDES 1200C erosion control permit).
- Municipal and county building and construction permits, roads and street permits, greenway permits, floodplain development permits, and conditional use/zone change.
- Division of State Lands (wetlands and creek or river crossing permits).
- U. S. Army Corps of Engineers (wetlands and creek or river construction

- permits).
- United States Fish and Wildlife Service, Oregon Department of Fish and Wildlife, and National Marine Fisheries Service (wetlands, creek or river crossings, and other permits).
 - Oregon Department of Transportation Highway Division (permit to work within State highway right-of-way).
 - Federal Aviation Administration.
 - Any affected railroads (crossings, access easements, and other permits of entry).

V. Pumps

A. General

The minimum number of pumps per station shall be two.

The Design Engineer shall select pumps to provide the required firm capacity and pressure. Firm pumping capacity is defined as the ability to deliver the rated station capacity with the largest pump out of service.

The rated station capacity is defined as the five-year, peak hourly wet-weather flow or the 10-year peak hourly dry-weather flow, whichever is higher. A higher rated station capacity may be established at the Owner's discretion.

It is the Design Engineer's responsibility to make the determination and recommendation regarding the appropriate type of pumping units. However, the Owner shall have the right to review the recommendation and select an alternate pump type.

Due to overall reliability, economy, and the availability of replacements, submersible pumps in a dry well or in a wet well shall be the standard for new wastewater pump stations. Grinder pumps, self-priming pumps, vacuum-primed pumps, vertical turbine pumps, and nonclog pumps in dry wells with close coupled or extended shaft motors shall not be considered for the construction of new pump stations, unless otherwise approved by the Owner.

System-head curve data shall include the following: system curves considering new and aged pipe, high and low wet well levels, initial and build-out conditions for dry and wet weather flows; design operating point; net positive suction head requirements; hydraulic efficiency; force main discharge elevation; horsepower requirements; revolutions per minute; and other operating conditions required for each pump and combination of pumps.

Selection of pumps with flat pump curves shall be avoided where a small change in total dynamic head will result in a large change in pump flow.

Minimum size solid to be passed by the selected pumps shall be a three-inch sphere, unless otherwise approved by the Owner.

Pumps shall be selected with the required operating point near the maximum efficiency point on the pump curve, within the pump's recommended operating range, and within the manufacturer's recommended limits for radial thrust and vibration. The size and number of pumps shall be selected so that the range of inflow can be met without starting and stopping pumps too frequently and without requiring excessive wet well storage.

The motor size shall be selected so that entire pump curve is non-overloading and within the manufacturer's recommended limits. Pump equipment shall be dynamically balanced to prevent vibration. No surge cavitation or vibration shall be allowed within the limits of the stable operating range indicated on the pump curve.

Unless waived by the Owner, a factory-certified pump test curve for each of the actual pump units to be installed at the station shall be required. Where the Owner has required an adjustable-frequency drive, the pump shall be shop tested using the actual drive unit. The pump manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design effort to limit harmonics. However, a factory pump test shall not be grounds for waiver of any pump acceptance tests after installation.

The criteria set forth below in Section B, Piping and Appurtenances, shall be followed for the recommended suction velocity. If necessary to prevent cavitation and excessive turbulence for high-flow pumps, a larger suction line than the pump inlet diameter may be provided to reduce velocity and maintain available net positive suction head.

Pumps shall be adequately anchored to pump bases in accordance with applicable codes and the manufacturer's recommendation. Anchor bolts shall be stainless steel, 300 series minimum. Wedge-type or chemical-type anchor bolts are not allowed for rotating equipment. Edges on concrete pump bases shall be chamfered with a minimum one-inch chamfer.

B. Submersible Pumps in a Dry Well

Submersible pumps housed in a dry well shall be equipped with moisture-sensing probes, over-temperature detectors, positive oil circulating cooling of motor, stainless steel motor and pump shafting, gray iron impeller, powder epoxy bowl and impeller, silicon carbide mechanical seals, bearing retaining rings on the shaft, and stainless steel wear rings. Pumps shall have volute and suction inlet handholes and inspection plates. Pumps shall have cleanout-type suction elbows.

Each pumping unit shall be complete with pump, motor, and anchor bolts all mounted on a common baseplate. Each pump shall be supplied with lifting eye bolts or lugs, and plugged gauge cock connections on the suction and discharge nozzles.

C. Submersible Pumps in a Wet Well

Submersible pumps in a wet well shall be equipped with moisture-sensing probes, over-temperature detectors, positive oil circulating cooling of motor, stainless steel motor and pump shafting, gray iron impeller, powder epoxy bowl and impeller coating, silicon carbide mechanical seals, bearing retaining rings on the shaft, and stainless steel wear rings.

Guide-rail connection assemblies shall be provided to set and remove the pumps without entering the wet well. Alternatively, cable-guide assemblies with tensioner nut may be allowed for setting and removing the pump from the wet well. Rails, lifting chains, and cables shall be stainless steel. Each pumping unit shall be complete with pump, discharge elbow, motors, couplings, coupling guard, anchor bolts, and guide-rail connection assemblies.

The check valves and pressure gauges shall be located in a shallow valve vault outside of the wet well. The gauge shall be upstream, and the isolation valve downstream, of the check valve for each pump. A bypass pumping system, additional downstream gauge, and additional main isolation valve may also be required at the discretion of the Owner.

D. Sump Pumps

In a dry well, sump pumps shall be installed and permanently wired into the station. Pump controls shall be provided as a package by the sump-pump manufacturer.

E. Temporary Pumping Plan

The Design Engineer shall provide a temporary pumping plan to maintain wastewater system operations during construction. This plan shall include requirements for firm pumping capacity, piping installation, controls, standby power requirements, and sequence of construction.

F. Pump Motors

Motors shall be either Factory Mutual or Underwriter's Laboratories approved. Unless otherwise required by the Owner, motors shall be rated 460 volts, 3 phase, 60 Hz. Motors shall meet Federal Department of Energy efficiency requirements as currently established in the Energy Policy Act of 1992.

All motors installed below the 100-year flood elevation or overflow elevation of the wet well shall be submersible motors. All pumps installed in the wet well shall be total enclosed fan cooled explosion-proof motors for operation in Class 1, Division 1, hazardous locations, in accordance with Article 500 of the NEC.

For all pumps installed in the wet well, the design of the motor shall permit full-load continuous operation either completely dry or fully submerged in the pumped liquid. Motor windings are to be all copper and epoxy encapsulated (aluminum windings or components are not acceptable). All motors shall be close coupled unless otherwise approved by the Owner.

National Electrical Manufacturers Association motor design shall be "B." Starting code letter/locked rotor kilovolt amps per horsepower rating shall be "F" or better. Motor windings shall be all copper with class "H" rating or approved equivalent. 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 a maximum ambient temperature of 40°C.

Motor nameplate horsepower must exceed the maximum required by the pump under all possible operating conditions. Bearing temperature rise at rated load shall not exceed 60°C.

Significant over-sizing of motors should be avoided since both efficiency and power factors drop in motors running below their full load rating. A 1.15 service factor shall be specified. The number of motor starts per hour is dependent upon the size of the motor, and must not exceed the manufacturer's recommendation for the intended service and starting conditions.

G. Variable-Speed Drives

The design engineer may select variable-speed pump drives as a non-standard feature, with the Owner's approval. Variable-speed drives shall be designed and programmed to provide a flushing velocity in the force main of at least 3.5 feet per second at the beginning of each pumping cycle.

After an initial flushing of the maximum practical duration, depending on wetwell volume, the pumping velocity may be reduced. Velocities shall not be allowed to fall below 2 feet per second, due to solids settlement, eventual plugging of the force main, and station failure. All variable-speed drives on raw sewage pumps shall be programmed to maintain a fluid velocity of at least 2 feet per second in the force main after initial flushing at minimum 3.5 feet per second.

Variable-speed drives shall not be installed on stations without an installed flowmeter to facilitate verifying the percent-of-speed necessary to accomplish self-cleansing velocities. As a standard, unless otherwise required by the Owner, one

spare ¾-inch buried PVC electrical conduit shall be routed from the control center to the flow meter vault.

H. Spare Parts

For each size and type of pump, a complete set of mechanical seals, a gasket set, wear rings, and a spare impeller (for each size of pump in the installation and for each pump direction if side discharge) shall be provided, unless otherwise approved or required by the Owner.

VI. Piping and Appurtenances

A. General

Piping and valves shall be in accordance with AWWA standards. Design fluid velocities shall be:

Pump suction lines.....3 to 5 feet per second
Pump vertical discharge lines..... 6 to 10 feet per second
Pump discharge lines including force mains.....3.5 to 8 feet per second

Vertical discharge piping on pumps with variable-speed drives shall be sized to maintain minimum design velocities during the programmed initial flushing period. All valves shall be accessible to the operators for operation and maintenance without entering a wet well.

B. Pipe

The Design Engineer is responsible for selecting pipe material for the project, subject to approval of the Owner. The standard for station wastewater piping shall be cement-mortar lined or plastic-lined ductile iron pipe and fittings.

The standard for force-main piping shall be cement-lined ductile iron pipe or cement-mortar lined and coated steel pipe. Heavy-wall PVC plastic and high-density polyethylene pipe may be allowed for force mains with the Owner's approval. Plastic-lined ductile iron, PVC, or HDPE pipe shall be used for air-injected force mains. Cast iron and asbestos cement shall not be allowed for force mains.

Suction piping from the wet well and discharge piping to the force main headers shall be provided for installed pumps and for any future pumping units. Pump discharge piping for stations containing three or more pumps shall connect to the force main discharge manifold with wyes. In manifolds, wyes shall be the same size diameter as the manifold, unless otherwise required by the Owner. Discharge

piping shall be designed for disassembly and removal from the station.

To the extent possible, the force main shall be designed to avoid a reduction in gradient or a change from a positive to a negative gradient, intermediate high points, and plateaus. In the force main, two 45 degree elbows shall be used in lieu of 90 degree elbows. Cutoff walls shall be used in the trench for slopes of 20 percent and over, per standard practice.

Unless otherwise approved by the Owner, all force mains shall have a connection with an isolation valve for temporary bypass pumping. The connection shall be located in a valve vault. Force mains shall discharge into a separate manhole offset from the gravity sewer, except as otherwise approved by the Owner. Dual force mains may be required at the Owner's discretion.

C. Joints

To accommodate minor settlement, buried joints should be push-on type or other flexible joint. Mechanical joints may be used on fittings. Restrained joints may be used to limit or eliminate the need for thrust blocks to provide restraint against thrust forces due to internal pressures.

Where harnessed mechanical joints are used for joint restraint, stainless steel rods shall be used. Thrust screws or thrust nuts will not be allowed as joint restraints for sewage force mains. To allow for differential settlement, flexible couplings or sleeves shall be installed on the inlet and discharge piping where piping enters the pump station floor, foundation, and wall.

Penetration of the wall between the wet well and dry well shall be made using embedded pipe spools with attached weep ring. Joints under concrete floors shall be all welded. Grooved-end couplings (Victaulic or equal) will not be allowed, except on specific approval of the Owner.

Exposed joints shall be flanged (AWWA C115 or ANSI B16.1). Flexible-sleeve type couplings shall be provided on the suction and discharge of pumps in the dry well. Piping runs with mechanical joints and couplings must be adequately supported. Flexible couplings must be constrained by tie rods. Couplings and anchorage on pump suction and discharge pipes shall be designed to prevent the pump from being used as restraint.

D. Check Valves

A check valve on each pump discharge shall be the standard. The check valve shall be mounted in the horizontal position to avoid solids from settling back on the check valve. Check valves shall be located outside of the wet well.

The valve shall be a swing-check valve with external arm and spring lever. Ball check valves shall not be allowed on sewage pumps without the Owner's specific approval. The check valve may have an electronic position indicator wired to a SCADA system, where required by the Owner.

The Design Engineer shall do a hydraulic surge analysis for each system to determine that the standard check valve will meet the needs of the system. If not, then check valves shall have a hydraulic cylinder or equivalent surge control.

E. Isolation Valves

An isolation sluice gate shall be provided to isolate the wet well from the inlet sewer, unless otherwise approved by the Owner. Isolation valves shall be provided on the inlet and discharge of each installed pump in a dry well. For submersible pumps in a wet well, an isolation valve shall be provided in a separate valve vault on the discharge side of each pump.

Unless waived by the Owner, isolation valves with a blind flange shall be installed for future pumps in a dry well. An intermediate isolation valve may also be required by the Owner on the force main, as a special station requirement. Discharge isolation valves shall be resilient seated full-port gate valves, plug valves, or knife gates at the Owner's discretion.

Sluice gates shall only be allowed for isolation of the trunk sewer from the wet well or to isolate two wet well compartments. Knife gate valves shall only be allowed on the suction piping from the wet well to the pump when space is limited and the hydraulic head is less than 20 feet.

Valves for buried service shall be provided with standard AWWA operating nut and protected from vehicular traffic.

F. Air Release Valves

Air relief, air-vacuum release, or combination air release and vacuum valves shall be of a type and brand manufactured for the specific purpose in sewage service, and shall be provided at critical locations in the pump station and force main. The valves shall serve to prevent air being captured inside the piping system, or prevent collapse of the piping system because of vacuum conditions. Each valve shall be sized with the proper orifice size suitable for the volume of air to be admitted or released and each shall be provided with an isolation valve.

For each air-valve assembly, the pipe-nipple connection to the manifold and all other piping in the assembly shall be copper. An insulated coupling, ball valve, and pipe union shall be provided on each assembly to allow maintenance and removal of

the air valve. The air-release valve discharge piping in pump stations shall be piped to the station wet well.

G. Surge Protection

Pump and pipeline systems shall be protected against damage from transient pressures. A reduction in gradient or a change from a positive to a negative gradient in piping shall be avoided if possible. Protection against surges and water-column separation shall be provided by means of air-cushion check valves, surge-anticipation and surge-relief valves, air-relief valves, and surge tanks. Discharge piping and the force main shall be analyzed by the Design Engineer, who is then responsible for preparing a surge analysis which documents surge aspects of the installed system.

H. Vents and Drains

Manual vents and drains shall be provided at all high and low points in the piping and at all locations required to facilitate draining and filling equipment or piping for maintenance. A ¼-inch gauge cock shall be provided on the top of the volute discharge to allow removal of air after servicing and prior to putting pumps in the dry well pump back in service. This vent line shall be plumbed to discharge to the wet well or sump pump. Vaults containing valves and meters shall drain by gravity to the wet well.

I. Flow Meters

Unless waived or otherwise approved by the Owner, a properly sized magnetic or transient-time flow meter shall be installed on the pump station force main inside the station, or in a shallow vault located in the yard. Meter sizing shall take into consideration installed capacity, flow ranges, and future capacity of the station. A drainable bypass around the flow meter shall be provided for use during meter maintenance and repair. Flow meters shall be installed on all stations with variable-speed pump controllers.

J. Gauges

A pressure gauge shall be installed on the suction and discharge side of each pump that is installed in a dry well, and in the valve vault on the discharge side of each submersible pump. Discharge gauge range shall be adequate to measure the shutoff head on the pump. Suction-side gauges shall be compound type.

Gauges shall be mounted on suction and discharge piping immediately adjacent to the pump, without intervening check or isolation valves. Permanent gauges on pumps under 5 HP may be waived at the Owner's discretion. The standard

mounting for gauges in sewage service shall be a flanged, liquid filled, annular seal, designed to protect the gauge from sewage contact.

Alternatively, gauges may be side-mounted on a pipe saddle in horizontal position, following a normally closed horizontal isolation valve. Isolation valves shall be stainless steel ball valves.

Assemblies for side-mounted gauges shall be installed using ½” Schedule 80 stainless steel pipe. Each side-mounted gauge shall be protected with a diaphragm seal. A drip leg shall be provided below the seal, containing a normally open drain valve.

Both annular and diaphragm seals and gauges shall be liquid filled, with suitable taps, gauge cocks, and pressure relief. Gauge face size, units, and style shall be as approved by the Owner.

As a special requirement of the Owner, pressure transducers may also be provided for suction and discharge pressure monitoring, and shall provide 4 to 20 milliamp (mA) signals to a programmable logic controller or wastewater SCADA system. Transducers shall be adequately supported for vertical and lateral support.

Mounting assemblies for pressure transducers shall be similar to those required for pressure gauges. Gauge and transducer assemblies may be configured on a single manifold, if desired, allowing independent isolation of each component, provided that they are mounted on a flanged annular seal.

K. Piping and Fittings

Piping less than two inches in diameter connected to the wastewater piping shall be 316 stainless steel or PVC. Screwed pipe shall be minimum Schedule 80. Galvanized steel piping shall not be allowed except for seawater, tapwater, and potable applications.

L. Supports

All pipe supports shall be painted to match the piping and shall have a grouted base of at least 1½-inches. Properly located and sized pipe supports shall be provided. No loads shall be transmitted to pump flanges.

All pipe restraints shall be designed to resist maximum expected surge and earthquake forces. Pipe restraints shall be adequately anchored for vertical and lateral support.

Base ells shall be installed on pedestals at vertical ells. Base ells shall not be required to provide any horizontal thrust restraint.

M. Cleaning of Force Main

Force mains less than 300 feet shall be cleaned by conventional methods provided there is access from both the discharge manhole and the station and discharge force main. Pig launch and retrieval systems shall be provided at all other stations, unless waived by the Owner as not being required, particularly at stations equipped with variable-speed drives.

The minimum acceptable system for package-type stations is a camlock type connection with an isolation valve. This type of pig-launcher connection may be acceptable to an Owner equipped with a portable sewage pump that has total dynamic head and flow capacities exceeding the proposed pump station. For other package-type stations and site-built stations, a pig launch system shall be provided that is permanently piped to utilize the station's installed sewage pumps.

N. Galvanic Corrosion Control System

Corrosion control equipment shall be provided as needed to adequately protect the station piping, force mains, and downstream sewers for the design life of the facility.

Galvanic corrosion control systems shall be designed, inspected, and tested by a corrosion control engineer. Design shall include an impressed current system with rectifiers, insulation flange kits, and pipe-flange bonding wires for continuous bonding. Nylon insulation bushings are to be installed between all dissimilar metals in piping (i.e., brass fittings connected to manifolds), between pumps and inlet, and discharge piping, so as to insulate from inductance current caused by motors.

An electrolytic insulating blanket shall be provided on all corrosion-protected pipelines installed near corrosion-protected natural gas lines. A separation of 25 feet or greater, if required by corrosion control design or the gas utility, shall be maintained between pipelines installed parallel to corrosion-protected natural gas lines. Where lines cross, the electrolytic blanket shall extend 25 feet on either side of the pipeline at the crossing or greater if required by corrosion control design or the gas utility.

O. Airborne Odor Control System

The Design Engineer shall conduct an odor control evaluation of the upstream collection system, wet well, and discharge system. The odor control system shall include minimizing or preventing production of odorous compounds, treatment of odorous compounds, containing and treating foul air, and enhancing dispersion of foul air. The Design Engineer shall design an odor control system, when required by the Owner, in accordance with current practice and the Owner's preference.

P. Dissolved Hydrogen Sulfide Controls

Dissolved H₂S concentrations discharged from force mains into gravity sewers shall be consistent with a design life of 75 years for concrete manholes and concrete or ductile-iron sewers. To prevent premature collapse of pipelines and manholes, and to minimize odor problems and employee hazards, the H₂S content of force mains shall be designed to remain below 0.1 mg/l at 20° C at the point of discharge into a gravity sewer system.

H₂S controls shall be provided to meet this standard where warranted, either designed for summer operation, or year round, as necessary. H₂S controls shall be provided for all stations where the anaerobic detention in a force main averages more than 35 minutes during low-flow periods in July-August-September. Detention time shall be computed as the volume contained in the force main divided by the average daily flowrate that is tributary to the station during July, August, and September.

Backdrainage

Where feasible on ascending mains of moderate size and length, H₂S controls should preferably consist of an inexpensive backdrainage system to drain the entire force main automatically on a daily basis. The design of the wet well must be oversized to accommodate the contents of the force main.

Backdrainage systems shall employ a full-port pneumatic pinch valve or electrical plug valve wired to close during pumping, and to reopen when the pump stops. To minimize excessive re-pumping, an adjustable timer may be installed to prevent the valve from opening for a period of 60 – 120 minutes after pump operation.

Solenoid valves may be installed on pneumatic lines, but shall not be used in place of pinch or plug valves on sewage lines.

Backdrainage valves shall be installed in a shallow vault at an elevation which permits the entire forcemain to drain empty. A manual isolation valve shall be installed to permit maintenance of the valve without disrupting pumping operations.

Electrical operators for plug valves shall be explosion-proof type where required by code for installation in a valve vault.

Air Injection

Alternatively, where backdrainage of a force main is not feasible, continuous air injection should be considered to prevent anaerobic conditions from developing. The design air delivery shall be at a rate of 2 standard cubic feet per minute (SCFM) per inch diameter of force main. Air injection systems shall be designed for continuous injection, and shall be installed without timers.

Force mains utilizing air injection for sulfide control shall be constructed of plastic, plastic-lined steel, or plastic-lined ductile iron, and shall not be fitted with air-release valves. Temporary blow-offs that may be installed at high points for acceptance testing shall be capped or plugged prior to placing the main in service.

Pumps shall be sized to pump against the head of the pressurized force main. Due to absence of air-release valves in a pressurized main, static head on the pumps shall be computed as the sum of all ascending segments in the main. Vertical undulations in pipe and bedding during the installation of a pressurized force main must be prohibited during construction, unless accounted for in the static head calculation and accommodated in sizing the pump.

Static head at the air injector shall be computed as the sum of all ascending segments, including pipe undulations caused during construction, that are downstream from the injection point. The ascending pipe segments between the pump and the air injector tap should be disregarded for the purpose of computing the actual air injection rate and sizing air injection controls.

Design calculations for sizing the compressor, receiver, and controls shall address both standard airflows and actual airflows under static pressure. Design calculations shall include a schematic profile of the force main based on surveyed topography and the proposed installation.

Air injection equipment must be fully gauged, metered, and adjustable. The pressure regulating valve between the compressor receiver and the airflow meter shall be adjustable between the working pressure of the receiver and the static head on the injector. All compressor receiver tanks shall be fitted with an automatic condensate purge. Airflow meters shall be rotameter type. Airflow shall be trimmed using a needle valve or equivalent control valve.

Rotameters shall be sized for actual airflow, and not for the theoretical airflow at standard temperature and pressure. Range of the airflow pressure gauge shall be based on the static head of the pressurized main at the point of air injection, instead of the dynamic head that would be attained during pumping. .

Due to heat, no plastic components shall be employed in the air injection system.. Rotameter tubes shall be pyrex body. The bottom of the vertical riser in the air piping which houses the rotameter shall contain a drip leg with purge cock. Air injection piping will normally be 1" annealed copper, unless otherwise approved by the Owner.

Due to the slow growth of sulfide bacteria, the mechanical and electrical design of air injection and backdrainage systems will not require redundant or standby equipment, unless stipulated by the Owner.

Chemical Controls

Where an economical air injection or backdrainage system is impractical or undesirable, chemical alternatives must be considered. However, the design of chemical addition systems which do not prevent the growth of sulfide forming bacteria systems must conform to EPA Class I reliability with respect to component redundancy, standby power, and failure alarms. Chemical systems to be considered include solution feeders for calcium nitrate, hydrogen peroxide, hypochlorite, and potassium permanganate. The selection of chemical controls shall be based on the recommendation of the design engineer, subject to the Owner's approval.

Systems shall be designed for continuous feed to maintain the H₂S concentration of the force-main discharge below 0.1 mg/l at all times. Systems shall be complete and operational, including all tankage and spill containment, pumps, piping, valves, gauges, meters, recorders, control panel, electrical systems, controls, and failure alarms.

Sewer and Manhole Coatings

For extremely small discharges or low-sulfide situations arising from detention times of less than one hour, the durability of the system may be sufficiently protected by installing a corrosion-proof armoring or durable acid-proof coating to the downstream gravity sewer system.

Headworks Controls

For long force mains which discharge directly into the headworks channel of a treatment plant, the corrosion hazard is minimal, compared with gravity sewers. However, the Owner may desire some degree of sulfide control to minimize nuisance odors and gas hazards at the plant. Ferrous chloride or calcium nitrate solution should then be injected into the wet wells of pumps discharging into a treatment plant headworks, so as to reduce sulfides to a range of 1 - 2 mg/l. Such systems are non-critical, may operate seasonally, and may not require a Reliability Class I design approach unless stipulated by the Owner.

VII. Structures

A. General

All structures and equipment shall be designed per applicable Codes. The seismic importance factor for wastewater pump stations shall be in accordance with the UBC and local municipal standards. Proper anchorage including seismic design requirements shall be provided to tie the related structure walls to the foundation and the roof to the walls.

The purpose of the structure is to provide a protective environment for the equipment, controls, and appurtenances. Structures will not normally be occupied. All equipment shall have adequate clearance from other equipment and walls to allow performance of maintenance and repair work.

All electrical, control, and instrument panels have a minimum 42-inch clearance in front of the panels, or greater if required by Code. All freestanding panels shall be set on a three-inch or higher concrete curb. All wall-mounted panels shall be affixed to the wall at an elevation that allows easy accessibility, generally 4 to 6½ feet.

A plastic vapor barrier shall be provided under the pump station structures. Waterproofing shall be provided on the exterior buried walls of the structures. Water stops shall be installed at all cold concrete construction joints. Seals at piping and conduit wall penetrations into the station shall be watertight.

Noise from electric motors, pumps, generator, and fans shall be controlled to the satisfaction of the Owner and adjacent property owners. The engineer shall use an effective combination of barriers (building walls, sound-deadening panels, etc.) and sound-absorbing material to reduce noise to a level that is acceptable to them.

B. Buildings

Pump station buildings should be suitable for the intended service, site, and neighborhood. For example, unless otherwise approved or required by the Owner, above-grade building walls shall be gray, split-face block or precast concrete construction, with pattern, color scheme, and roofline as required by the pump station location and land use ordinances. Interior walls must be suitable for wet environment where washdown may occur.

The engineer should review station requirements with the Owner prior to design. Normally the standard wet well-dry well pump station should include at least three separate rooms: a pump room, a control room, and a generator room. As an alternative, the generator may be housed in an approved outdoor enclosure. The generator room may be eliminated, at the Owner's discretion, where a portable generator can provide standby power of sufficient reliability.

Buildings for submersible pump stations shall consist of two separate rooms: a control room and a generator room. However, where the Owner can provide reliable standby

power with a portable generator, an above-grade structure is not required for submersible pump stations.

For all stations having an above-grade building, a restroom should be provided unless otherwise approved by the Owner.

C. Wet Well

The wet well shall be constructed of shrinkage-control concrete mix with low specific conductivity and suitable for wastewater storage structures. The pump station shall be designed to provide a self-cleaning wet well. Wet well bottom hopper walls shall be sloped a minimum of 45 degrees, and ideally 60 degrees, to the inlet of the pumps.

All equipment and fixtures in the wet well shall be explosion proof and corrosion proof. Corrodable metals including galvanized steel, brass, aluminum, and zinc-cadmium plated steel shall not be used in wet wells.

Unless otherwise approved by the Owner, the wet well shall be isolated from the inlet gravity sewer to allow for maintenance of the wet well.

Inlet discharge into the wet well shall not be lower than the pump high-water alarm elevation. Unless otherwise approved by the Owner, the inlet shall discharge onto a shelf or fillet with noncascading discharge into the wet well. Location of the inlet discharge shall provide for proper flow patterns to each pump suction. The wet well shall be designed to avoid vortexing, approach velocity imbalance, cavitation, and low local velocities.

The wet well shall be designed to prevent septic action from taking place during periods of extreme low flow. The dissolved hydrogen sulfide content of the wet well shall be maintained below 0.1 mg/l.

A steeply sloped incoming sewer entrance with a trench-type wet well, designed to create a hydraulic jump for self-cleaning, may be provided at the Owner's discretion. Such designs must provide adequate storage volume in the approach sewer and wet well to operate a trench-type wet well.

Stations without on-site standby generators or a second source of power shall be designed for a minimum one hour of holding time at the 5-year peak hourly design flow. Inlet sewers shall not be used to provide wet-well storage, except for linear self-cleaning designs.

Bar racks or inlet grinders may be special station requirements of the Owner, as may arrangements where the wet well is split into two compartments. Each compartment shall then be designed with an independent level control system. Approximately one-half of the station pumping capacity shall be connected to each compartment, isolated by a slide gate. The station shall be designed to operate with either half of the wet well

out of service.

D. Dry Well

The dry well shall be constructed of concrete at site-built stations. At package-type stations, the dry well shall be constructed of concrete or steel.

Adequate cathodic protection shall be provided for steel dry wells. The standard for cathodic protection of permanent pump stations shall be impressed current, as designed for each specific site by a qualified corrosion engineer.

At the Owner's discretion, "temporary" pump stations which will be abandoned or removed and salvaged in the near future may be protected using an adequate number of sacrificial metal anodes with a suitable a test station.

E. Floors and Roof

Elevations of pump station ground-level finished floors and the top of submersible pump station wet wells shall be designed for a minimum of two feet above the 100-year base flood elevation.

Interior concrete floor surfaces shall be protected with a sealer-hardener coating. Nonskid-type floor coatings shall be provided around pumps and equipment where maintenance will be performed.

Floors shall be sloped to floor drains or sumps at a slope of not less than 3/8-inch per foot (3%), or greater where warranted. Floor drains or gratings shall be located to minimize drainage across the floor. Floor drains shall be provided in every room except generator and control rooms.

Floor gratings shall be made of galvanized steel, aluminum, or fiberglass-reinforced plastic, as approved by the Owner.

The roof for aboveground structures shall be a metal or wooden truss system with commercial-grade standing seam metal roofing, unless otherwise approved by the Owner. Selection of pitch and colorations shall harmonize with the surroundings, subject to Owner approval.

If access to the roof is required for removal or maintenance of equipment, fall-protection anchors must be located where personnel can attach to anchors before stepping on the roof. In the area of the roof access hatch, the roof surface shall provide for traction and adequate footing for safety.

F. Doors, Windows, Stairs, Ladders, and Hardware

Unless otherwise approved by the Owner, the pump station shall have pressed-steel, insulated, continuously welded, hollow metal doors and frames. Exterior doors shall be 16-gauge construction with 14-gauge frames. Access to the pump room, generator room, and wet well access room shall be through an exterior door.

Door pulls, cover plates, and striker plates shall be stainless steel. Locks shall allow personnel to secure the door from the inside to provide security for personnel while performing maintenance operations. The contractor shall provide locks with interchangeable-type cylinders that can be keyed to the Owner's standard. Locks shall be deadbolt type as manufactured by Best Universal Lock keyed to the Owner's standards, or approved equal. The Owner is responsible for changing out the lock core after construction is complete.

Double access doors shall be provided for access to the wet well. All internal areas of the wet well shall be visible from the access doors. Hatches shall be installed with either safety webbing across the hatch opening or removable handrails that can be placed in chocks around the opening, according to the Owner's preference.

Dry well access shall provide for removal of the equipment installed in it. Doors, hatches, and access shaft shall provide for removal of the largest piece of equipment. The full-size access hatch and shaft shall be minimum 36 inches in diameter.

No exterior windows shall be provided, unless required by the Owner.

A stairway for access into an underground pump station dry well shall be installed instead of a ladder. Stairways instead of ladders shall also be constructed between floors of a pump station where applicable and feasible.

Ladders shall be stainless steel, anodized aluminum or fiberglass reinforced plastic, as approved by the Owner. Provide handrails or a safety post that extends three feet above the ladder for safe access onto the ladder.

Also provide a safety climb rail (ladder full protection system) for use with a full-body safety harness per the Oregon OSHA standards where use of a tripod retrieval system is not feasible. Unless otherwise approved by the Owner, provide the Oregon OSHA standard tripod with a full-body safety harness.

Provide railings around access openings in the floor inside pump stations for safety. Areas around any confined space entry shall be designed to be suitable for use of the Owner's retrieval equipment.

Permanent access ladders and manhole steps shall not be installed in wetwells.

G. Painting

Pumps, piping, and appurtenances shall be painted with an epoxy enamel and colored

according to the following chart:

| ITEM | COLOR OF PIPING | COLOR OF LETTERING |
|--|-------------------------------------|--------------------|
| Pumps | OSHA Safety Blue | n/a |
| Potable Water and Valves | Light Blue | Black |
| Non-Potable Water | OSHA Safety Red | n/a |
| Industrial and Seal Water System Water | Dark Blue w/Red Bands | White |
| Air Compressor | Instrument Air | n/a |
| Odor Control System | Dark Green w/Light Brown Bands | White |
| Drive Shaft Guard Cage | OSHA Safety Red | n/a |
| General Hazardous Equipment | OSHA Safety Red | n/a |
| Overhead Crane Rail/Lifting Hook | OSHA Safety Yellow w/Black Striping | n/a |
| General Warning—Equipment | OSHA Safety Yellow | n/a |
| Outside Parking Post (Bollards) | OSHA Safety Yellow w/Reflectors | n/a |
| Ventilation System | White | n/a |
| Electrical Conduit | Dark Green | n/a |
| Generator | Manufacturer's Standard | n/a |
| Generator Exhaust | Heat Resistant Aluminum | n/a |

Paint scheme for other equipment shall comply with the *Scheme for Identification of Piping Systems* (ANSI A13.1).

Identification of piping and other utility lines shall include the use of pipe markers that indicate the type of utility line and the direction of flow. Moving parts of operating units, mechanical and electrical parts, and motor or fan shafts shall not be painted. Code-required labels, or any equipment identification, performance rating, name, or nomenclature shall not be painted.

Copper, brass, and stainless steel shall not be painted. Stencil the weight on all major equipment, including wastewater pumps and motors and all other equipment over 500 pounds.

Unless waived by the Owner, the exterior and interior surfaces of building walls and interior surfaces shall be painted with two coats of 100 percent acrylic latex in an approved color consistent with the pump station location and zoning ordinances.

A sacrificial, clear anti-graffiti coating shall be applied to all exterior vertical building walls.

H. Equipment Removal

Pump Room

A load test certified electric hoist and trolley or approved equal shall be provided in the pump room above the dry well, as the Owner's preferred method for moving equipment. These preferred criteria are subject to waiver at the Owner's discretion, based on pump size and station layout and accessibility. The rated capacity of the hoist shall be stenciled on the rail and clearly visible.

Design shall ensure adequate horizontal and vertical clearance between the overhead crane hoists and other installed equipment to allow for lifting and moving of motors and pump equipment to the station doors via the monorail.

Hoist and trolley shall utilize fastened or retractable power cords to supply power to the unit as it moves along from the wall. The hoist and trolley shall have two speeds and be controlled from a pendant-type controller.

Stations Without an Above Grade Structure

If the weight of the pump exceeds the Owner's truck-mounted crane capacity, or if site constraints restrict use of a truck-mounted crane, a hoist-jib crane shall be provided at the station. It shall be capable of lifting, removing the equipment from the below grade structure, and loading the equipment onto the Owner's maintenance vehicle.

Design shall ensure adequate horizontal and vertical clearance between the hoist and other equipment.

Generator Room

For installations with a generator room installed at the time of building construction, eye-bolts shall be installed for assisting with maintenance and repairs of the generator. If eye-bolts are not installed, a portable hoisting system for generator maintenance and repairs shall be provided.

I. Bulletin Board and Reference Shelf

Unless waived by the Owner, a three-foot x four-foot bulletin board shall be provided in the control room for posting operating information with an adjacent shelf to hold Operations and Maintenance Manuals and other reference data. Each shall be placed in a suitable and functional location, as approved by the Owner.

J. Fire and Safety

Appropriate safety warning signs shall be posted near all hazardous equipment in plain unobstructed view and shall include warnings for automatic starting of pumps, generator, and other equipment. Adequate and safe access shall be provided to all equipment. Smoke detectors shall be installed in every room and the alarms shall interface with the station alarm telemetry system. Fire extinguishers rated for class A, B, and C fires shall be provided in the pump room, control room, and generator room. Install a fire suppression system per National Fire Protection Code requirements in the generator room.

VIII. Mechanical

A. HVAC

Stations with pumps in a dry well shall be designed with ventilation systems for the dry well to be a Class 1 Division 2 classification per NFPA 820. At a minimum, separate ventilation systems shall be provided for the wet well and dry well. Interconnections between the dry well and wet well ventilation systems are not allowed.

All equipment in the wet well and dry well shall be classified according to NFPA 820. The dry well shall be designed for a minimum of six air changes per hour. Dehumidification equipment shall be provided in the dry well to protect equipment located there. At stations with a dry well, the wet well shall be designed for a minimum of 12 continuous complete air changes per hour. At stations where submersible pumps are installed in the wet well and there is no structure above the wet well, a passive ventilation system is standard.

The HVAC system shall provide for the protection of the equipment in the control room or exterior-mounted control panel. The HVAC system in the control room shall be for the entire room and not for the individual cabinets. If a generator room is provided, a separate ventilation system shall be provided in that room. The ventilation system in the generator room shall be designed for cooling of the operating generator. The ventilating system shall maintain operation following generator shut-down and cool-off to provide for operators to occupy the room.

The amount of heat necessary for the station is that amount required to keep pipes and other water containing equipment from freezing. An indoor temperature of 54°F and an outdoor temperature of 10°F should be used for heating design, unless otherwise stipulated by the Owner. Heating of the wet well is not required.

The amount of cooling required shall be based on equipment motor and device requirement. Ventilation shall be adequate to ensure that equipment motors and devices, including sensitive electronic equipment, are operated in their intended design temperature range.

Ventilation openings shall be screened with a sufficiently fine mesh to prevent entry by birds, rodents, snakes, and bugs.

B. Plumbing

Potable water service for use at the station shall be provided from a metered 1½-inch copper service connection, or as approved by the Owner. A reduced pressure backflow prevention device shall be provided on the water service as required by OAR 333-61-070. A backflow preventor shall be provided for the hose bibb used for wet-well washdown, isolating it from all other water usage at the station. If the reduced-pressure device or backflow preventor is located outside of a structure, it shall be insulated and heat traced.

In the pump room, at least two ¾-inch hose bibbs shall be provided, unless otherwise approved by the Owner. Hose bibbs shall be located a minimum of five feet away from any electrical equipment. One hose bibb shall be installed inside the aboveground structure near the access doors for interior-exterior use.

One hose bibb shall be installed for wash down of the wet well. Each hose bibb shall be provided with a hose rack with 75 feet of approved hose. If hose bibbs are installed outside of the building, locking hose bibb covers shall be provided.

Safety showers and eye wash stations shall be provided wherever chemicals are used requiring such safety equipment.

C. Drainage

The building drainage system shall consist of floor drains and hub drains with cast iron drain pipe, unless otherwise approved by the Owner. If required, a holding sump and sump pumps shall be provided. The drainage system shall be designed to handle drainage from the pump seals, air release valves, and housekeeping. Vaults containing valves or meters shall be drained by gravity drains or sump pumps to the wet well.

D. HVAC Performance Test

Unless waived by the Owner, a certified performance test of the ventilation system shall be performed is prior to acceptance of the station.

IX. Site Improvements

A. Access

Vehicular access to pump stations shall have a 24-foot-wide public right-of-way and a minimum 16-foot-wide paved road at a 15 percent maximum slope, unless otherwise approved by the Owner. Site layout of the pump station shall take into consideration vehicle access. Provisions shall be made for adequate turning radius and room for outriggers for the Owner's equipment, such as a dump truck, backhoe, and crane truck required for the removal of equipment.

Access shall be provided around the entire perimeter of the pump station for required maintenance equipment. For completely buried stations, room shall be provided to access hatches and vents with equipment, including adequate clearance from overhead power lines to allow for safe operation of a crane. Parking space shall be provided for two maintenance vehicles.

Pump station access hatches, vaults, manholes, and equipment, including pad-mounted transformers, shall be located to minimize access problems. Access for maintenance trucks shall be provided at all manholes and vaults.

Above-grade equipment and piping shall be protected by bollards. A concrete pad shall be placed around vaults which is suitable for confined space personnel-retrieval equipment. Vaults shall be designed for expected vehicle loading, with a minimum H-20 loading. Site layouts must allow maintenance vehicles to access the site when the vaults are open.

B. Vaults and Manholes

Vaults, manholes, and drains shall be located inside the fenced pump station site. Vaults shall be designed for the expected vehicle loading with a minimum H-20 vehicle loading.

Vaults shall be provided with standard lockable, spring-loaded, double-leaf access doors, and fitted with a safety net system.

If feasible, vaults shall be designed to avoid designation as a confined space. Areas around any confined space entry shall be suitable for use of standard retrieval equipment.

Vaults that are six feet and deeper shall have stairways or installed ladders with extensions per OSHA standards.

C. Landscaping

Landscaping and irrigation systems shall meet the requirements of the Owner.

If an automatic irrigation system is required by the Owner, the controls should be inside the pump station aboveground structure. If no aboveground structure is provided, then the controls for the irrigation system should be housed in a lockable enclosure.

D. Fencing

Unless otherwise approved by the Owner, pump station sites should be enclosed by a fence, or other approved enclosure. A double-leaf gate should be provided that is wide enough for all vehicles and equipment accessing the site.

Fence webbing or other screening may also be required, at the Owner's discretion.

E. Drainage

Building internal drains shall connect to a sanitary sewer or the station wet well.

Vaults shall be drained to the station wet well by sump pumps, or through gravity drain lines fitted with a discharge flap-gate.

All gravity drains shall be trapped with a P-trap. P-traps need not be primed, unless a trap-priming system is required by the design Engineer, Owner, or plumbing inspector.

Building roof drains and site drains shall connect to the stormwater system. On-site stormwater detention shall be provided, if required by the permitting agencies having jurisdiction.

An emergency overflow pipe from the wet well is recommended to minimize the potential for sewage contact under extreme conditions exceeding the design capacity of the station. Overflow pipes shall be installed in the wet well as high as possible without causing a sewer backup or basement flooding, and shall be equipped with a dedicated overflow alarm.

X. Electrical, Controls, and Instrumentation

A. General Criteria

All instrumentation, controls, and alarms shall be integrated with the Owner's existing systems, unless otherwise approved by the Owner. If this includes a programmable logic

controller or SCADA system, then the Design Engineer shall coordinate and comply with the Owner's requirements.

All panels, equipment, and materials shall bear the Underwriter's Laboratories label or Factory Mutual rating as applicable. All design, materials, and installation shall comply with the NEC, NFPA, UBC, and other applicable local Codes.

The project design engineer shall verify during design that sufficient electrical service capacity for the planned build-out condition is available at the site, and that space for it is provided.

Control circuit design drawings shall be represented in a power-off position. In a control power-off position, the manual or automatic controls shall not allow the start of any pumps. The pump controller shall include a control power on/off switch so that in a control power-off condition the manual or automatic controls shall not allow the start of any pumps.

Unless waived by the Owner, pump control and alarm circuit diagrams shall be included in the design plans and shall include the following identification to aid in reading the diagram:

Buss #, wire #, switches (pressure, temperature, H-O-A, etc.), relay contacts, relays (control, alarm, time delay, etc.), buss #, control description label , and # of control relay contacts. In the design plans, provide a relay schedule adjacent to the diagram indicating the function of each relay.

The Design Engineer shall assign the contractor responsibility for labeling all wires and control devices inside the control panel, or on the face of it. All labeling shall be in accordance with the Owner's specifications and direction.

A pump-control-sequence description shall be prepared by the Design Engineer. The sequence shall be included in the design specifications and the Operations and Maintenance Manual.

B. Lockout Safety

Removable disconnects shall be provided in the main panel to ensure open circuits for safety while working on switch gear. Alternatively, provide circuit breakers with a lockout tag out safety switch handle to provide a switched disconnect of power for use during maintenance operations on machinery.

C. Circuit Breakers

Specify magnetic motor protector application circuit breakers with adjustable trip setting and built-in ground fault protection in accordance with sizing deemed required by the site electrical provider.

D. Switch Gear Rating Coordination

The circuit breakers shall be designed so that the main circuit breakers will not trip when a supplied breaker is overloaded. The current interrupting capacity rating of switch gear including the main service breaker, circuit breakers, and the transfer switch shall be coordinated per NEC requirements.

E. Power System Monitoring

Power System Monitor shall be as approved by the Owner.

F. Ground Fault Protection

The specification shall require the contractor's bid to include the services of a competent independent contractor who will test and provide written certification of complete ground-fault testing and verification.

G. Junction Boxes

Junction box connections for the pump power cable shall be located above flood elevation at stations with dry wells. Junction box connections for the pump power cable shall be located out of the wet well, sealed at both ends with duct seal, and accessible for maintenance at submersible pump stations. Conduits for power cables for submersible pumps installed in a wet well shall be oversized to facilitate maintenance.

H. Motor Starter Design

All motor starters shall be equipped to provide under-voltage release and overload protection on all three phases. Motor starter coil and contacts shall be easily replaceable without removing the motor starter from its mounted position or without the removal of the phase conductors. Fuses shall be provided on the primary and secondary sides of the control power transformers and separate power control transformer for each motor starter.

Motor starter circuits shall be designed to allow operation of the circuit in HAND mode, should failure of the programmable logic controller occur. The circuit interlocks, including the over-temperature and starter-overload contacts, shall be hard-wired in HAND mode outside of the programmable logic controller. The control circuit shall be designed so that an alarm does not result for an H-O-A switch selection of OFF or HAND mode, or upon lockout of the circuit breaker.

Soft-start reduced voltage type solid-state motor starters shall be required on all pump motors, unless otherwise approved by the Owner. On larger capacity stations, also provide manual bypass contacts with soft-start, allowing for manual operation of the starters should solid-state starter controls fail.

I. Motor Control Center Switch-Gear Equipment

Unless otherwise approved by the Owner, motor control center switch-gear equipment shall be factory-assembled sections. All motor control center circuit breakers and motor starters shall be NEMA-approved equipment consistent and compatible with their location and use.

Each motor shall have an individual disconnect and shall have provisions for lock-out and tag-out.

J. Wiring and Buss Bars

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

The motor control center and other control panels shall have buss bars and connectors constructed of tin-plated solid copper. Split buss shall be provided at very large stations, and stations where the approved standby power is not sufficient to supply the full load of the station.

All wires shall be permanently labeled in a manner as approved by the Owner.

K. Seismic Braces

Seismic braces shall be installed on all electric service cabinets and other freestanding equipment per Code requirements. Details of the seismic braces shall be included in the design drawings.

L. Service Panel

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

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

All circuit breakers shall be labeled in accordance with the NEC.

Panels shall have 25 percent spare circuits for future use.

M. Electrical Conduit

Underground conduit shall be in accordance with the NEC.

Indoor aboveground conduit shall be rigid galvanized steel with sealed fittings. Liquid-tight flexible conduit shall be used at motor terminations and all other locations where required by Code.

N. Electrical Outlets

For operation of miscellaneous station equipment or power tools, provide 20-amp, 120-volt electrical outlets with ground-fault protection. All outlets shall have wet-location gasketed covers to protect against splashing.

O. Equipment Grounding Conductors

Equipment grounding conductors shall be run to each motor and properly bonded to the motor frame. Conductors shall be one continuous length, with no splices, and sized according to the latest NEC requirements. Conductors shall be grounded to the grounding buss at the motor control center. All other metallic devices shall also be properly grounded.

P. Fail-Safe Design Alarm Relays

Alarm relays shall be designed to be energized during normal pump station operation. Relay fail-safe design shall alert operators through the wastewater alarm system should an alarm condition occur that de-energizes the alarm relay as designed, or should an alarm relay fail and de-energize.

Where electro-mechanical relays are installed, standard relays with bayonet base mounting shall be provided to simplify replacement of defective units.

Q. Pump Station Control Circuits

The project design engineer shall contact the Owner's staff to review the applicable requirements, as established by the Owner:

- Alarm relays shall be normally energized-type relays (i.e., fail-safe).
- Control relays shall be normally de-energized (i.e., energize to initiate control functions).

- Provide hard-wire motor starter circuit including interlock protection devices (i.e., hard-wire logic not part of programmable controller programming) to allow manual control of pumps when programmable logic controller failure occurs.
- Check valve open signal from limit switch prevents pump start at call signal.
- Pump fail alarm and pump shutdown if check-valve limit switch does not actuate within specified adjustable time delay at pump startup.

R. Pump Status Indication

For each pump include the following indicator lights: pump call (white); pump running (green); pump off (red); and pump failure (flashing red), unless otherwise approved by the Owner.

All indicating lights shall be connected to a push-to-test button to test for proper functioning of the bulbs. Indicator lamps shall be either transformer or diode-type device.

Provide an externally non-resettable elapsed time meter for each pump in service.

S. Alarms, Telemetry, and SCADA

Separate alarms and discrete alarm points shall be provided for sewage overflow level, high wet well level, and loss of standby reserve capacity, which occurs when the reserve pump or standby pump is called to RUN.

The overflow alarm enables the Owner to meet DEQ requirements for immediate reporting of a sewage overflow. The loss of standby reserve capacity, defined as simultaneous operation of all installed pumps, shall also be alarmed. Each occurrence of this alarm condition indicates a potential sewage overflow. For that reason, they should be reported to DEQ on a monthly basis, indicating the status of system reliability.

The loss of standby alarm shall be initiated with a call for the reserve pump or “last pump”, resulting in all pumps running. To avoid nuisance alarms, this function should be disabled whenever the station is attended. Kill switch for the alarm may be either manual or automatic, at the Owner’s discretion. A “high water” alarm level in the wet well will not be accepted as a substitute for alarm conditions involving simultaneous operation of all pumps or overflows.

The Owner may require additional alarms to facilitate operation and maintenance. Consideration should be given to alarming the following:

pump vibration and temperature

low wet well level
dry well flooding
intrusion
check-valve failure to open
seal water pressure failure
loss of utility power
standby generator failure to start or energize
chemical feed failure
volatile gas detection
air or instrument compressor failure

Station status and alarm conditions shall be displayed on the station panel view.

All alarms shall be transmitted to the Owner's operations staff by means of an autodialer or radio telemetry system.

Supplemental alarm lights may be installed at the station. Audible alarms shall not be installed in residential areas.

T. Alarm and Control Relay Resets

Provide an alarm push-button reset. Reset of alarm indication or conditions shall not occur automatically after an alarm condition clears unless otherwise programmed by the software.

U. Backup Power

For stations without a dedicated backup generator or a secondary electrical feed, install a manual transfer switch and an emergency plug-in power connection to the station for use with an approved portable generator. The plug-in connector shall be as approved by the Owner.

V. Standby Generator

A diesel-oil fueled, engine-driven electric generator unit shall be provided for all pump stations, unless otherwise approved by the Owner.

Skid-mounted package generator units shall consist of an engine, alternator, controls, switchgear, and auxiliary systems suitable for installation inside a building. The generator unit shall be installed on spring isolation supports to reduce vibration from the unit into the foundation and for seismic protection. The generator unit shall be fully shop assembled, wired, and tested from a single engine-generator manufacturer.

Generator Unit

The electrical generator unit shall be designed with the following features, except as otherwise approved or required by the Owner:

- 1) The frequency output of the generator shall be 60 Hertz +/- 1 Hertz.
- 2) The voltage output shall be 480 volt, 3-phase, +/- 4.8 volts. The generator shall have a solid-state voltage regulator capable of maintaining voltage within 2 percent at any constant load from 0-100 percent of rating.
- 3) The generator shall be the brushless alternator type. All generator windings are to be constructed of copper only.
- 4) The generator unit shall have sufficient capacity to supply all starting current requirements of the firm station pumping capacity. Upon application of the rated load, the instantaneous voltage dip shall not exceed 20 percent of the load and shall recover to the rated voltage within one second.
- 5) The generator shall be provided with a unit-mounted circuit breaker.
- 6) The generator unit shall be provided with a permanently installed load bank equal to 100 percent of the capacity of the generator. The load bank shall utilize the radiator discharge for cooling.
- 7) In residential areas, provide a hospital-grade silencer and sound-dampened inlet air louvers to reduce engine noise at the property line. For pump stations in industrial and commercial areas, a critical-grade silencer may be allowed if approved by the Owner.
- 8) All exhaust piping inside the building shall be insulated and lagged and the cold face temperature shall be 150°F maximum. On the exhaust manifold, install a water drain trap and wrap the exhaust piping in non-asbestos insulation.
- 9) Oil fill system, oil pan spill dike, and oil drain line including hose extension shall be provided as part of the skid-mounted unit.

Fuel

The fuel tank installation shall be a double walled steel sub-base fuel tank on the emergency generator unit for 24 hours of operation at fuel pumping capacity load. The tank size shall be within allowable Code requirements. When required by Code, the fuel tank shall be installed in a protective vault located adjacent to the generator structure.

All diesel storage tanks shall have a desiccant dry air filter on vents to prevent the condensation of water within the tank.

A large-capacity 2-micron combination fuel filter and water separator shall be included on the fuel line between the fuel tank and the engine.

The engine fuel injector control shall include an energize-to-run solenoid and an automatic throttle to close by spring tension upon stop signal, control system failure, or engine alarm.

Engine Unit

The engine unit shall be designed with the following features:

- 1) An air-cooled engine shall be provided where air cooled engines in the required horsepower are available and noise mitigation measures can be met. If a water-cooled engine is provided, it shall be furnished with anti-freeze.
- 2) The engine shall not be equipped with a turbocharger unless one it is required to provide an economically sized unit.
- 3) The maximum engine speed shall be 1800 RPM.
- 4) The engine shall be equipped with an oil-sump heater (for an air-cooled engine) or an engine-block coolant heater (for a water-cooled engine). The heater units shall be rated to ensure a preheating temperature of 100°F. The heater shall automatically disconnect upon engine start and run.
- 5) The battery shall be sized to provide sufficient charge for five cranking cycles, each a minimum of ten-second periods. The battery trickle charger shall be a float-equalize type. The charger output shall be sized to recharge the batteries to full charge within one hour after five automatic cranking cycles in a row. The charger shall be equipped with an ammeter and voltmeter to allow proper adjustment of the unit. The generator shall automatically supply power to the battery charger when it is operating and service power is not available.
- 6) The engine shall have an electronic speed governor that shall hold the engine speed to within ½ cycle per second of rated value.

Controls

The engine shall include the following instruments with analog or digital readouts for monitoring performance: oil pressure gauge; engine temperature gauge; RPM tachometer; and a non-resettable hour-run meter.

The panel shall be equipped with the following instruments to monitor the three-phase generator: voltmeter; ammeter; frequency meter; and panel illumination light.

Light-emitting diode-type panel lights shall be provided to indicate run status (as green lights), anticipatory warnings to the operator (as yellow lights), and failure conditions (as red lights) including the following conditions: emergency generator run status; engine failure due to overheat; low oil pressure; over RPM; low fuel; and low battery voltage.

A remote indicator shall be provided and installed in the control room to indicate run status and whether connected to operating load.

A push-to-test button shall be provided for testing all panel indicator lights.

A test/auto/off engine-control switch shall be provided to allow exercising the engine under load.

An automatic emergency shutdown shall be provided for the following conditions: over cranking, over speed, low oil pressure, and high coolant temperature. The controls shall be interlocked to drop the electrical load prior to the emergency shutdown. The engine starting controls and transfer switch shall include an unloaded generator cool-down delay.

An exercising timer shall be provided with the generator, providing for automatically or manually exercising the generator. A three-position MANUAL-OFF-AUTO selector switch shall be provided. The timer shall be a programmable timer designed to automatically exercise the engine-generator for a period of one to four hours per one- to seven-day interval.

The load bank control shall accept a contact from the automatic transfer switch that is closed when the utility source is normally operative and open when the utility source is inoperative. The load bank shall also accept a contact that is closed when the generator is running, and open when the generator is off. These contacts shall be interlocked so the load bank will not energize when the generator is connected to the plant load. In addition, the load-bank control shall provide a set of auxiliary contacts which open to inhibit the transfer switch from transferring to the generator source while the load bank is energized.

Selector switch in AUTO — Normal Operation

When the timer provides a signal to start the engine-generator, a maintained signal shall be provided to the engine-generator control panel. The load bank shall be energized if the generator is running, the voltage is within limits, the utility source is operative, and

all other permissive conditions have been met. When the exercise is complete, the load bank shall de-energize. The engine-generator shall continue to run through the cool-down cycle. If the utility source is lost during the exercise period, the exercise circuit shall be disengaged, the engine-generator shall remain running, and the transfer switch shall connect the generator to the station load.

Selector switch in AUTO — Standby Operation

The exercise timer shall be disengaged during this period.

Selector switch in MANUAL — Normal Operation

The load bank shall be permitted to energize if the generator is running, the voltage is within the limits, the utility source is operative, and all other permissive conditions have been met.

Selector switch in MANUAL — Standby Operation

The exercise timer shall be disengaged during this period.

Transfer Switch — Automatic

The station shall have an interlock-protected emergency power transfer switch to automatically start the generator in the event of loss of any phase of power, reverse power, or low voltage brownout.

The transfer switch shall include time-delay controls for the following functions: prevent start-stop short cycling of the standby generator due to momentary dips in line voltage, transfer the load to the generator when it is at the rated voltage and frequency, return to line power with adjustable time delay when line power is restored, and initiate an engine shutdown. Note: provide programmed neutral time delay (i.e., adjustable 0-10 seconds to allow equipment to coast off before transfer) or in-phase monitor (i.e., large units to match generator-to-line phasing).

The generator shall have a disconnect plug and interlock at the transfer switch for isolation of the unit to prevent automatic operation during maintenance.

A load-sequencer control with four normally closed and four normally open auxiliary contacts for the control system shall be provided. These shall be capable of operating prior to transfer in either direction, so as to avoid control/alarm relay problems at transfer. If applicable, the Owner may require inputs to a wastewater SCADA system to indicate the normal condition (i.e., automatic transfer switch not switched to standby power source), transfer by the automatic transfer switch to standby power, generator run, and generator fail-to-run after an automatic switchover to standby power.

The automatic transfer switch shall be mounted within sight of the generator control panel or generator remote-status annunciator panel for ease of operation.

Transfer switch operation by a programmable controller is allowable.

Transfer Switch — Manual

A manual transfer system shall require the use of an enable key to sequentially open the line power service and then transfer it to the standby power service connection.

The Design Engineer shall ensure the transfer switch is rated at the same amperage-interrupting capacity rating as the line power service.

The following warning sign shall be posted in OSHA Safety Red color on the transfer switch panel:

“DO NOT TRANSFER POWER UNDER LOAD”

Maintenance Service Contract

A one-year service contract shall be required of the standby generator vendor, to be furnished by the contractor as part of their requirements as listed in the design specifications. This service contract shall include all routine service checks recommended by the manufacturer during the first year of operation. The contractor shall coordinate this work with the operations staff of the Owner.

W. Lighting

Provide motion detector exterior lighting on all four sides of the above grade structure with interior manual on/off switch. Low-level exterior evening lighting compatible with the surrounding area shall be provided mounted on a pole or above grade structure. Fluorescent lighting shall be used in the structure interior. No permanent lighting shall be provided in the wet well. An emergency battery-powered lighting system shall be provided in the station. Provide lighted exit signs at the station access doors that are interconnected with the emergency lighting system.

XI. Construction Management Specifications

A. Design Engineer’s Responsibilities

The Design Engineer, with concurrence of the Owner, shall specify testing, inspection, startup, documentation, and warranty work for the project. The Design Engineer shall

have ultimate responsibility for inspection and certification of the quality and dependability of the facility, in accordance with ORS 468 and OAR 340-52.

The Design Engineer shall include in the project specifications suitable requirements for quality of construction, material testing, and inspection. Material testing shall be performed by a qualified testing service acceptable to the Owner.

Inspectors familiar with pump station construction (including electrical, mechanical, and structural construction) shall be provided during construction by the Design Engineer or his approved representative.

In all projects, the Design Engineer shall be assigned the task of writing the Operations and Maintenance Manual for the pump station, or for updating an existing station manual, as applicable. Manuals shall meet DEQ guidelines. By the 50% and 90% construction points, the Design Engineer shall provide draft and final manuals for submittal to DEQ.

The Design Engineer shall also be responsible for obtaining manufacturer's manuals and operating instructions from the contractor. The Engineer shall assemble them into an organized supplement or separate companion volume to the Operations and Maintenance Manual, for the use of the Owner.

The Owner shall be responsible for submitting one copy of the final manual, in a form fully acceptable to the Owner, to DEQ for review. The manual shall be submitted without the supplemental manufacturer's materials or instructions. The Owner shall be responsible for obtaining DEQ approval of the manual prior to authorizing startup of the pump station.

B. Coordination of New Construction at Existing Stations

During construction of an expanded or renovated pump station, the contractor shall be required by the contract specifications to maintain wastewater system operations at existing facilities. If this necessitates a temporary pump system, then its firm capacity shall be no less than the instantaneous 5-year peak flow tributary to the station. Temporary pump systems shall be furnished with standby power and alarms, and shall operate at EPA Class I Reliability.

Where temporary pumping at an existing station is required, the plans shall note the required construction sequence for pipe connections, pumps, and standby power requirements.

C. Pump Inspection

The Design Engineer shall provide services to confirm proper pump installation, as applicable to the project:

- Upon initial installation and prior to startup, conduct a “soft foot check” to verify proper installation of the equipment base plate to the concrete supporting structure.
- Upon initial installation and startup, measure the level of vibration. Submersible pumps in a wet well shall be checked prior to submersion. As applicable in dry well stations, also check shafts for correct alignment, including parallel and angular misalignment, and shaft end-float.

D. Operational Testing

The Design Engineer shall include in the project specifications an operational test procedure to demonstrate the proper operation of all equipment at the station. This shall include simulated failure conditions to demonstrate the warning displays.

The contractor shall be responsible for performing all required operational tests under active inspection by the Design Engineer. The contractor shall be required to test and adjust all equipment after all construction is completed to ensure proper operation. The contractor shall field align and balance pumps and motors per manufacturer’s recommendations. The Engineer shall coordinate and assist in resolving deficiencies during operational tests including all pump station mechanical equipment, electrical controls, emergency power operations, and control warning displays.

As applicable, the operational acceptance test shall include the following equipment run test demonstrations:

- Operate the pump station in hand or on automatic control for 48 hours without an equipment or control failure.
- Operate the generator under full load conditions using a resistance load bank as required for eight hours. The test shall be performed with the station access doors closed to test the ventilation system capacity.
- Provide certified performance testing of the ventilation system.
- Perform a hoist equipment load test and provide certification.

E. Field Acceptance Tests

During or immediately following operational testing by the contractor, the Design Engineer shall conduct and record all field acceptance tests. The following tests shall be performed on clean water:

- Measure total head at shutoff head for each centrifugal sewage pump. Note any discrepancy from the manufacturer's test curve. Show measured elevations and

shutoff head calculations on a diagram for each pump, along with the manufacturer's pump curve. At stations without pressure gauges, the Design Engineer shall determine shutoff head using a temporary gauge mounted between each pump and its check valve.

- Measure total dynamic head, motor rpm, and power draw for each pump during operation.
- Measure flowrate of each pump using the station flowmeter. At stations without flowmeters, flow shall be estimated using pressure gauges and the pump curve, as described in DEQ guidelines posted on the internet at:

<http://waterquality.deq.state.or.us/wq/wgrules/Opspump.htm>

The Design Engineer shall conduct, review, and approve the inspection establishing substantial completion. Unless otherwise agreed with the Owner, the Design Engineer shall then provide the Owner with a copy of results of the inspection and obtain the Owner's consent to proceed with startup and final testing.

The Design Engineer shall provide the start-up coordinator and other professional staff as necessary to work with the construction contractor in the successful start-up of the completed facilities, in accordance with the start-up checklist.

F. Operator Training

Prior to startup, the Contractor shall provide training of Owner's personnel by factory-trained representatives of equipment, pumps, controls and other devices in accordance with the approved specifications. This training shall emphasize theory of operation and maintenance of electrical controls, hydrogen sulfide control system, pumps, motors, generators, instruments, HVAC equipment and controls, alarm telemetry devices, and other major equipment.

Training should be coordinated by the contractor to minimize Owner's staff time in multiple training sessions. Unless otherwise approved, eight hours of training for Owner's staff shall be standard. The training proposal shall be subject to Owner's acceptance prior to conducting the training.

G. Acceptance and Startup

Pump station acceptance shall be subject to the Owner's approval and written notice of acceptance. The date of acceptance shall be the effective date for transfer of operational responsibility for a new pump station from the contractor to the Owner.

Equipment warranty dates shall commence on the effective date of the transfer, unless otherwise agreed.

At the Owner's discretion, the contractor may be required to submit the electrical utility billing and other utility billings, paid up to the effective date of the transfer, to the Owner, and to transfer billings to the Owner.

No startup shall be undertaken or allowed without completion of operator training and DEQ approval of the Operations and Maintenance Manual, in accordance with OAR 340-52. DEQ approval of the manual constitutes permission for startup.

H. Project Close Out

Unless otherwise approved by the Owner, the Design Engineer shall be responsible for closing out the project, including:

- The Design Engineer shall restore property-corner monumentation which is disturbed or destroyed during construction. Set new corners after construction is complete.
- Provide full and complete survey and measurements for record drawings.
- Complete all documentation for close-out of the project, including preparation of record drawings. The record electrical drawings shall show the actual wire number labels if different from the design drawings.
- Provide services to perform and confirm equipment calibrations.
- Provide services to perform point-to-point checkout of systems from field devices or contacts through control panels and remote terminal unit, if applicable.
- These services may include programming and integration of the pump station remote programmable logic controller into a SCADA System, where applicable, along with control schematics.
- Unless otherwise agreed by the Owner, the Design Engineer and the Contractor shall be responsible for all programming costs, including costs for programming and loading into the Owner's devices performed through a programming service selected by the Owner.
- The Design Engineer shall send DEQ a certification of proper construction in accordance with the approved plans, per OAR 340-52-045, or as required in DEQ's plan approval.

I. Warranty

All equipment at the station shall include at least one-year full parts and service warranty from the date of acceptance by the Owner. Normally the manufacturer's warranty documentation shall name both the contractor and the Owner as holders of the warranty.

Unless otherwise agreed, the manufacturer or equipment supplier who is fulfilling the manufacturer's warranty shall commence all required warranty repairs within 24 hours of notification by the Owner of the requirement for warranty service.

J. Warranty Tests

Warranty tests shall be as approved and required by the Owner. The Design Engineer may be required to conduct or witness additional vibration checks and measurements at intervals of 3-months, 6-months and at the 10-month warranty inspection.

K. Operations and Maintenance Manual

For all pump stations, an Operations and Maintenance Manual shall be compiled and written by the Design Engineer, and shall be approved by DEQ prior to startup.

Format and Content

The format and contents of the manual shall meet the requirements of DEQ's guidelines for pump station O&M manuals, as published at

<http://waterquality.deq.state.or.us/wq/wqrules/Opsman.htm>

The name of the pump station shall be noted on the spine of the manual. Binding shall be three-ring binder, preferably locking type to prevent accidental opening. Binding shall be sized to prevent a "bulged" condition. Tabbed dividers and a table of contents shall be included.

Manuals for the operation of pump stations that are equipped with pressure gauges shall include DEQ standard instructions for the use and maintenance of gauges:

<http://waterquality.deq.state.or.us/wq/wqrules/Opspump.htm>

Equipment literature, including supplier's and manufacturer's manuals, shall be separately bound, and shall not be submitted to DEQ for review.

One copy of the final manual acceptable to the Owner shall be submitted to DEQ for approval prior to startup.

O&M Manual Information

The contractor shall be required by the project specifications to furnish the following information for inclusion in the Design Engineer's operations and maintenance section:

- a. Sequence of operations including description of the operation and interaction of systems and subsystems during startup, operation in automatic mode, operation in manual mode, and operation with backup power. This includes, but is not limited to, equipment, pumps, piping, valves, HVAC, electrical, controls, and instrumentation.
- b. Station operation including updated information on the actual pumps installed.
- c. Utilities.
- d. A consolidated summary of required routine scheduled maintenance and scheduled preventative and predictive maintenance for all station equipment along with references to the location within the manual where detailed information may be found.
- e. Safety.
- f. Spare parts list including name, address, and telephone number of supplier and manufacturer.
- g. Emergency plans and procedures.

Equipment Literature Supplement

The contractor shall be required by the project specifications to furnish the following information for the equipment literature supplement:

- a. Disassembly and reassembly instructions.
- b. Parts lists, by generic title and identification number.
- c. Name, location, and telephone number of nearest supplier and spare parts warehouse.
- d. Manufacturer's certifications, including calibration data sheets and specified calibration procedures and/or methods, for installed equipment.
- e. Warranty forms and information for all installed equipment as provided by the contractor.

Maintenance Programs

The Design Engineer's Operations and Maintenance Manual shall include a planned maintenance program of preventive and predictive maintenance activities. Maintenance shall be triggered by frequencies (elapsed calendar days, run time, etc.) or on demand. Maintenance shall include lubrication, cleaning, inspection, oiling, adjusting, equipment condition monitoring, and rebuilding to factory specifications.

Preventive Maintenance

Unless waived or otherwise approved by the Owner, the Design Engineer's O&M Manual shall include a table of planned maintenance activities and actions for each piece of equipment and other components of the facilities. The table shall include the recommended schedule for periodic opening and inspection of equipment, and other standard maintenance procedures including lubrication.

Predictive Maintenance

Unless waived or otherwise approved by the Owner, the Design Engineer's O&M Manual shall include a table of periodic performance testing of equipment. The table shall include recommendations for using and interpreting various investigative techniques such as thermography, vibration analysis, precision measurements, lube oil analysis, nondestructive testing, electrical resistance tests, corrosion tests, and declining shutoff head.