R309-540 Facility Design and Operation: Pump Stations

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R309-540. Facility Design and Operation: Pump Stations.

R309-540-1. Purpose.

The purpose of this rule is to provide specific requirements for pump stations utilized to deliver drinking water to facilities of public water systems. It is intended to be applied in conjunction with rules R309-500 through R309-550. Collectively, these rules govern the design, construction, operation and maintenance of public drinking water system facilities. These rules are intended to assure that such facilities are reliably capable of supplying adequate quantities of water which consistently meet applicable drinking water quality requirements and do not pose a threat to general public health.

R309-540-2. Authority.

This rule is promulgated by the Drinking Water Board as authorized by Title 19, Environmental Quality Code, Chapter 4, Safe Drinking Water Act, Subsection 104(1)(a)(ii) of the Utah Code and in accordance with 63G-3 of the same, known as the Administrative Rulemaking Act.

R309-540-3. Definitions.

Definitions for certain terms used in this rule are given in R309-110 but may be further clarified herein.

R309-540-4. General.

Pumping stations shall be designed to maintain the sanitary quality of water and to provide ample quantities of water at sufficient pressure.

R309-540-5. Pumping Facilities.

(1) Location.

(a) The pumping station shall be designed such that:

(i) the proposed site will meet the requirements for sanitary protection of water quality, hydraulics of the system, and protection against interruption of service by fire, flood or any other hazard;

Guidance: Subsurface pits or pump rooms and inaccessible installations should be avoided.

(ii) the access to the pump station shall be six inches above the surrounding ground and the station located at an elevation which is a

minimum of three feet above the 100-year flood elevation, or three feet above the highest recorded flood elevation, which ever is higher, or protected to such elevations;

(iii) the station is readily accessible at all times unless permitted to be out of service for the period of inaccessibility;

(iv) surrounding ground is graded so as to lead surface drainage away from the station; and

(v) the station is protected to prevent vandalism and entrance by animals or unauthorized persons.

(2) Pumping Stations.

(a) Building structures for both raw and drinking water shall:

(i) have adequate space for the installation of additional pumping units if needed, and for the safe servicing of all equipment;

(ii) be of durable construction, fire and weather resistant, with outward-opening doors;

(iii) have an interior floor elevation at least six inches above the exterior finished grade;

(iv) have any underground facilities, especially wet wells, waterproofed;

(v) have all interior floors drained in such a manner that the quality of drinking water contained in any wet wells will not be endangered. All floors shall slope at least one percent (one foot every 100 feet) to a suitable drain; and

(vi) provide a suitable outlet for drainage from pump glands without discharging onto the floor.

(b) Suction wells shall:

(i) be watertight;

(ii) have floors sloped to permit removal of water and entrained solids;

(iii) be covered or otherwise protected against contamination; and

(iv) have two pumping compartments or other means to allow the suction well to be taken out of service for inspection, maintenance, or repair.

(c) Servicing equipment shall consist of:

(i) crane-ways, hoist beams, eyebolts, or other adequate facilities for servicing or removal of pumps, motors or other heavy equipment;

(ii) openings in floors, roofs or wherever else needed for removal of heavy

or bulky equipment; and

(iii) a convenient tool board, or other facilities as needed, for proper maintenance of the equipment.

(d) Stairways and ladders shall:

(i) be provided between all floors, and in pits or compartments which must be entered; and

(ii) have handrails on both sides, and treads of non-slip material. They shall have risers not exceeding nine inches and treads wide enough for safety.

Guidance: Ramps are preferred in areas where there is frequent traffic or where supplies are transported by hand. Where ramps are not possible, stairs are preferred to ladders.

(e) Heating provisions shall be adequate for:

(i) the comfort of the operator; and

(ii) the safe and efficient operation of the equipment.

Guidance: In pump houses not occupied by personnel, only enough heat need be provided to prevent freezing of equipment or treatment process.

(f) Ventilation shall:

(i) conform to existing local and/or state codes; and

(ii) forced ventilation of at least six changes of air per hour shall be provided for all rooms, compartments, pits and other enclosures below ground floor, and any area where unsafe atmosphere may develop or where excessive heat may be built up.

Guidance: In areas where excess moisture could cause hazards to safety or damage to equipment, means for dehumidification should be provided.

(g) Lighting.

Pump stations shall be adequately lighted throughout. All electrical work shall conform to the requirements of the relevant state and/or local building codes.

(h) Sanitary and other conveniences.

Plumbing shall be so installed as to prevent contamination of a public water supply. Wastes shall be discharged in accordance with the plumbing code, R317-4, or R317-1-3.

(3) Pumps.

(a) Capacity.

Capacity shall be provided such that the pump or pumps shall be capable of providing the peak day demand of the system or the specific portion of the system serviced.

The pumping units shall:

(i) have ample capacity to supply the peak day demand against the required distribution system pressure without dangerous overloading;

(ii) be driven by prime movers able to meet the maximum horsepower condition of the pumps without use of service factors;

(iii) be provided readily available spare parts and tools; and

(iv) be served by control equipment that has proper heater and overload protection for air temperature encountered.

(b) Suction Lift.

Suction lift, where possible, shall be avoided. If suction lift is necessary, the required lift shall be within the pump manufacturer's recommended limits and provision shall be made for priming the pumps.

(c) Priming.

Prime water shall not be of lesser sanitary quality than that of the water being pumped. Means shall be provided to prevent back siphonage. When an air-operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source.

(4) Booster Pumps.

(a) Booster pumps shall be located or controlled so that:

(i) they will not produce negative pressure in their suction lines;

(ii) automatic cutoff pressure shall be at least 10 psi in the suction line;

(iii) automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent excessive cycling; and

(iv) a bypass is available.

(b) Inline booster pumps (pumps withdrawing water directly from distribution lines without the benefit of storage and feeding such water directly into other distribution lines rather than storage), in addition to the other requirements of this section, shall have at least two pumping units (such that with any one pump out of service, the remaining pump or pumps shall be capable of providing the peak day demand of the specific portion of the system serviced), shall be accessible for servicing and repair and located or controlled so that the intake pressure shall be at least 20 psi when the pump or pumps are in normal operation.

(c) Individual home booster pumps shall not be allowed for any individual service from the public water supply main.

Guidance: Refer to Guidance found in R309-550-11(3)

(5) Automatic and remote controlled stations.

All remote controlled stations shall be electrically operated and controlled and shall have signaling apparatus of proven performance. Installation of electrical equipment shall conform with the applicable state and local electrical codes and the National Electrical Code.

Guidance: All automatic stations should be provided with automatic signaling apparatus which will report when the station is out of service.

(6) Appurtenances.

(a) Valves.

Valves shall be used to permit satisfactory operation, maintenance, and repair of the equipment. If foot valves are necessary, they shall have a net valve area of at least 2 1/2 times the area of the suction pipe and they shall have a positive-acting check valve on the discharge side between the pump and the shut-off valve.

(b) Piping.

Piping within and near pumping stations shall:

(i) be designed so that the friction losses will be minimized;

(ii) not be subject to contamination;

(iii) have watertight joints;

(iv) be protected against surge or water hammer; and

(v) be such that each pump has an individual suction line or that the lines shall be so manifolded that they will insure similar hydraulic and operating conditions.

(c) Gauges and Meters.

Each pump shall:

(i) have a standard pressure gauge on its discharge line;

(ii) Have a compound gauge (capable of indicating negative pressure or vacuum as well as positive pressure) on its suction line; and

(iii) have recording gauges in the larger stations.

Guidance: Larger pumping stations should have a means for measuring the discharge. The station should have indicating, totalizing, and recording metering of the total water pumped.

(d) Water Seal.

Where pumps utilize water seals, the seals shall:

(i) not be supplied with water of a lesser sanitary quality than that of the water being pumped; and

(ii) when pumps are sealed with potable water and are pumping water of lesser sanitary quality, the seal shall be provided with a break tank open to atmospheric pressure, and have an air gap of at least six inches or two pipe diameters, whichever is greater, between the feeder line and the spill line of the tank.

(e) Controls.

Controls shall be designed in such a manner that they will operate their prime movers, and accessories, at the rated capacity without dangerous overload. Where two or more pumps are installed, provision shall be made for alternation. Provision shall be made to prevent energizing the motor in the event of a backspin cycle. Electrical controls shall be protected against flooding. Equipment shall be provided or other arrangements made to prevent surge pressures from activating controls which switch on pumps or activate other equipment outside the normal design cycle of operation.

(f) Standby Power.

Standby power, to ensure continuous service when the primary power has been

interrupted, shall be provided from at least two independent sources or a standby or an auxiliary source shall be provided. If standby power is provided by onsite generators or engines, the fuel storage and fuel line must be designed to protect the water supply from contamination.

(g) Water Pre-Lubrication.

When automatic pre-lubrication of pump bearings is necessary and an auxiliary direct drive power supply is provided, the pre-lubrication line shall be provided with a valved bypass around the automatic control so that the bearings can, if necessary, be lubricated manually before the pump is started or the pre-lubrication controls shall be wired to the auxiliary power supply.

R309-540-6. Hydropneumatic Systems.

(1) General.

Hydropneumatic systems shall comply with all appropriate sections of R309-540-5 except as otherwise indicated herein.

Unpressurized ground level or elevated storage, designed in accordance with R309-545, shall be provided for community type public water systems or non-transient non-community systems where a demand in excess of the capacity of the source(s) is required, in addition to the diaphragm or air tanks. Diaphragm or air pressure tank storage shall not be considered for fire protection purposes or effective system storage for community type systems.

(2) Location.

If diaphragm or air tanks and appurtenances are located below ground, adequate provisions for drainage, ventilation, maintenance, and flood protection shall be made and the electrical controls shall be located above grade so as to be protected from flooding as required by R309-540-5(6)(e). Any discharge piping from combination air release/vacuum relief valves(air/vac's) or pressure relief valves located in below ground chambers shall comply with all the pertinent requirements of R309-550-6(6).

Guidance: It is preferred that pressure tanks and appurtenances be located above ground and be protected.

(3) Operating Pressures.

The system shall be designed to provide minimum pressures in R309-105-9 at all points in the distribution system. A pressure gauge shall be installed on the pressure tank inlet line.

(4) Piping.

In addition to the bypass required by R309-540-5(4)(iv) on the pumps, the diaphragm or air tanks shall have sufficient bypass piping to permit operation of the hydropneumatic system while one or more of the tanks are being repaired, replaced or painted.

(5) Pumps.

At least two pumping units shall be provided except for those type systems not requiring unpressurized storage in R309-540-6(1); they may use the pump within their groundwater source to pressurize the diaphragm or air tanks. With any pump out of service the remaining pump or pumps shall be capable of providing the peak instantaneous demand of the system as described in R309-510-9(2), while recharging the pressure tank at 115 percent of the upper pressure setting. Pump cycling shall not exceed 15 starts per hour, with a maximum of ten starts per hour preferred.

(6) Pressure Tanks.

(a) Pressure tanks shall meet the requirement of state and local laws and regulations for the manufacture and installation of unfired pressure vessels. Interior coatings or diaphragms used in pressure tanks that will come into contact with the drinking water shall comply with ANSI/NSF Standard 61. Non diaphragm pressure tanks shall have an access manhole, a drain, control equipment consisting of pressure gauge, water sight glass, automatic or manual air blow-off, means for adding air, and pressure operated start-stop controls for the pumps.

Guidance: Sizing of hydropneumatic storage tanks should consider the need for disinfectant contact time.

Guidance: For larger pressure tanks, the access manhole should be a minimum 24 inches in diameter.

(b) The minimum volume of the pressure tank or combination of tanks shall be greater than or equal to the sum of S and the value of CX divided by 4W.

Guidance: Volume (min) > = S + CX/4W

where the following values are used in the equation above:

C = minutes per operating cycle, four minutes to meet the requirements of R309-540-6(5) above or preferably six minutes, and is equal to pump ON time plus pump OFF time.

X = output capacity rating of the pump(s) at the high pressure condition in the tank(s), in gpm.

W = percent of volume withdrawn during a given drop in tank pressure:

specifically, between P_h and P_l. $W = 100(P_h - P_l)/P_h$ where P_h = high pressure in tank in psia (high absolute pressure) and P_l = low pressure in tank is psia (low absolute pressure). Values of W range typically from 0.26 to 0.31 for pressure differentials of 15 to 30 psi and high system pressures of 45 to 85 psi at elevations of approximately 5,000 feet.

S = water seal volume in gallons, the volume of inactive water remaining in tank at low pressure condition.

Guidance: As a rule-of-thumb the minimum volume of the hydropneumatic tank should be at least five times the capacity of the pump(s), rated in gpm. For example, a 200 gpm pump or combination of pumps should have a 1,000 gallon pressure tank.

(7) Air Volume.

The method of adjusting the air volume shall be acceptable to the Director. Air delivered by compressors to the pressure tank shall be adequately filtered, oil free, and be of adequate volume. Any intake shall be screened and draw clean air from a point at least 10 feet above the ground or other source of possible contamination, unless the air is filtered by an apparatus approved by the Director. Discharge piping from air relief valves shall be designed and installed with screens to eliminate the possibility of contamination from this source.

(8) Water Seal.

For air pressure tanks without an internal diaphragm the volume of water remaining in a air pressure tank at the lower pressure setting shall be sufficient to provide an adequate water seal at the outlet to prevent the leakage of air.

Guidance: To prevent the formation of a vortex, a covering baffle may be installed over a vertical bottom outlet large enough to limit the peripheral velocity of approach to the baffle to 0.5 ft/sec of less. At low absolute pressure the depth of water over the top of the baffle should be about one outlet pipe velocity head or greater. For either horizontal or vertical outlets, the pipe outlet itself should be large enough to limit the maximum axial velocity in the pipe to 4.0 ft/sec or less. The use of anti-swirl vanes is always desirable.

The following water seal depths shall be considered as minimum requirements.

(a) Horizontal outlets shall maintain sufficient depth, as measured from the centerline of the horizontal outlet pipe, such that the depth is greater than or equal to the sum of d and twice the value v^2 divided by 2G.

(b) Vertical outlets, if unbaffled, the depth shall be the same as in (a) except measured from the pipe outlet; if baffled, the depth shall be greater than or equal to the value v^2 divided by 2G.

where the following values are used in the equations above:

v = the axial velocity in the pipe outlet for the peak instantaneous demand flow rate of the system.

d = the diameter of the outlet pipe in ft.

G = the gravitational constant of 32.2 ft/sec/sec.

(9) Standby Power Supply.

Where a hydropneumatic system is intended to serve a public water system, categorized as a community water system as defined in R309-110, a standby source of power shall be provided.

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