CHAPTER 30
SEWAGE PUMPING STATIONS

31. GENERAL

31.1 Flooding

___ Sewage pumping structures and electrical and mechanical equipment shall be protected from physical damage by the 100-year flood. Sewage pumping stations shall remain operational and accessible and shall not be inundated by the 100-year flood (hurricane flood surges excepted). Design consideration shall be given to groundwater elevations and the risk of floating dry wells or empty wet wells.

31.2 Accessibility

___ The station shall be readily accessible by maintenance vehicles during any weather.

___ The station shall be inaccessible to the general public (by a locked fence or enclosure, by being built underground, etc.).

31.3 Grit

___ Where it is necessary to pump sewage prior to grit removal, the design of the wet well and pump station piping shall receive special consideration such as grit removal facilities to avoid operational problems from the accumulation of grit.

32. DESIGN

32.1 Type

___ Sewage pumping stations may be wet/dry well, suction lift, or submersible. Screw type lift stations may also be allowed. All equipment shall be designed specifically for the handling of raw or pretreated sewage, as appropriate.

32.2 Structures

32.2.1 Separation

___ Dry wells, including their superstructure, shall be completely separated from the wet well.

32.2.2 Equipment Removal

___ Provision shall be made to facilitate removal of pumps, motors, and other equipment.

32.2.3 Access

___ Suitable and safe means of access for persons wearing self-contained breathing apparatus shall be provided to dry wells, and to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

___ For built-in-place pump station dry wells, a stairway with rest landings shall be provided at vertical intervals not to exceed 12 feet (3.7 m). For factory-built pump station dry wells over 15 feet (4.6 m) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed 10 feet (3.0 m). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level. Where acceptable to the Department, an elevator may be used in lieu of landings in a factory-built station, provided emergency access is included.

___ Reference should be made to applicable safety codes which, if they are more stringent than provided herein or in the specifications, shall govern.

___ The provisions of Section 46.5 also apply.

32.2.4 Construction Materials

___ Due consideration shall be given to the selection of materials because of the presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage.

32.3 Pumps and Pneumatic Ejectors

32.3.1 Multiple Units

___ Multiple pumps or pneumatic ejectors shall be provided. A minimum of three (3) pumps should be provided for stations handling flows greater than 1 MGD (3800 m^3/d).

___ Units should be designed to fit actual flow conditions and shall be of such capacity that with any one unit out of service the remaining units will have capacity to handle maximum anticipated sewage flows.

32.3.2 Protection Against Clogging

___ All units shall be designed specifically for the handling of the types of sewage they will be subjected to.

___ Pumps handling sanitary sewage from 30 inch (76 cm) or larger diameter sewers shall be preceded by readily accessible bar racks to protect the pumps from clogging or damage. Bar racks should have clear openings not exceeding 2½ inches (6 cm). Where a bar rack is provided, a mechanical hoist shall also be provided. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks shall be provided.

Appropriate protection from clogging should also be considered for small pumping stations.

32.3.3 Pump Openings

___ Except where grinder pumps or septic tank effluent pumps are used, pumps shall be capable of passing spheres of at least 3 inches (8 cm) in diameter, and pump suction and discharge piping shall be at least 4 inches (10 cm) in diameter. See Section 37.2 for the size of force mains.

32.3.4 Priming

___ The pump shall be so placed that under normal operating conditions it will operate under a net positive suction head, except as specified in Sections 33 and 34.

32.3.5 Electrical Equipment

___ Electrical systems and components (e.g., motors, lights, cables, conduits, switchboxes, control circuits, etc.) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall be designed for safe use under such conditions to the extent practicable. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each cable shall be provided with watertight seal (and separate strain relief for flexible cables). A fused disconnect switch located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall meet the requirements of weatherproof equipment (NEMA 3R or 4). Lightning arresters and phase protection (for 3-phase motors) shall be provided. GFCI protection shall be provided for all outlets.

___ For each location requiring electrical power, the consulting engineer shall provide a written description of the type of power needed (voltage, amperage, phase, etc.) and shall give his written assurance (either in the P/S or in a separate letter) that the proper power will be available and when it will be available at each site. Phase protection and phase loss warning shall be provided for 3-phase power. Phase protection shall prevent automatic equipment restarting attempts upon power restoration until all three phases are restored.

32.3.6 Intake

___ Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intake. Intake piping should be as straight and short as possible.

32.3.7 Dry Well Dewatering

___ A sump pump equipped with dual check valves shall be provided in the dry wells to remove leakage or drainage, with the discharge located above the maximum high water level in the wet well. A connection to the pump suction is also recommended as an

auxiliary feature. Water ejectors connected to a potable water supply shall not be provided. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump. Shallow valve pits, etc. may be gravity drained to the wet well as allowed in Section 34.4.

32.3.8 Pumping Rates

___ The pumps and controls of main pumping stations, and especially the pumping station(s) to the treatment works or operated as part of the treatment works, should be capable of discharging sewage at approximately its rate of delivery to the pump station. Wet well sizes, influent flow rates, and pumping capacity shall all be balanced to ensure sufficient capacity without excessive pump run time or detention time in the wet well. See Section 32.6.2. Hydraulic surges detrimental to the proper operation of downstream facilities shall be avoided.

___ Design pumping rates should be established in accordance with Section 23 or Section 43.3.1, as appropriate. A minimum force main velocity of 2 fps shall be maintained.

32.4 Controls

32.4.1 Type

___ Control systems shall be of the transducer, air bubbler, encapsulated float or flow measuring type. Float-tube control systems or existing stations being upgraded may be approved. The electrical equipment shall comply with Section 32.3.5.

32.4.2 Location

___ The control system shall be located away from the turbulence of incoming flow and pump suction.

32.4.3 Alternation

___ Provisions should be made to automatically alternate the pumps in use.

___ Provisions shall be made for simultaneous operation of multiple units when flow conditions warrant. Generally, when multiple pumps are operating and the water level is falling, the pumps should not be sequenced off, but all on pumps should remain on until the lowest control level is reached, then all pumps should switch off together.

32.5 Valves

32.5.1 Suction Line

___ Suitable shutoff valves shall be placed on the suction line of each pump except on submersible and vacuum-primed pumps.

32.5.2 Discharge Line

___ Suitable shutoff and check valves shall be placed on the discharge line of each pump discharging into a pressurized header. The check valve shall be located between the shutoff valve and the pump. Check valves shall be suitable for the material being handled. Except for pre-manufactured stations, check valves shall not be placed on the vertical portion of discharge piping. Valves shall be capable of withstanding normal pressure and water hammer.

___ All shutoff and check valves shall be operable from floor level and accessible for maintenance. External levers should be provided on swing check valves.

32.5.3 Location

___ Valves shall not be located in the wet well, except as provided in Section 34.4.

32.6 Wet Wells

32.6.1 Divided Wells

___ Consideration should be given to dividing the wet well into multiple sections, properly interconnected, to facilitate repairs and cleaning.

32.6.2 Size

___ The wet well size and control setting shall be appropriate and in accordance with the pump manufacturer's recommendations to avoid heat buildup in pump motor due to frequent starting and to avoid septic conditions due to excessive detention time. No more than ten (10) pump starts per hour should be allowed. For duplex stations, the design wet well volume in gallons may be calculated as 15 min. x influent (gpm) / 8. Also see Section 32.3.8.

32.6.3 Floor Slope

___ The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the inlet.

32.7 Ventilation

___ Adequate ventilation shall be provided for all pump stations.

___ There shall be no interconnection between the wet well and dry well ventilation systems.

32.7.1 Ventilation in Pump Stations Less Than 350 gpm or Any Submersible Type Not Requiring Entry.

___ At a minimum, passive screened vent pipes shall be provided. Mechanical ventilation as described below is recommended.

32.7.2 Ventilation in Pump Station of 350 gpm or Larger

___ Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. In pits over 15 feet (4.6 m) deep, multiple inlets and outlets are desirable. Damper should not be used on exhaust or fresh air ducts and fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located conveniently. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting systems, which shall override any automatic controls. Consideration should be given also to automatic controls where intermittent operation is used. The fan wheel should be fabricated from non-sparking material. Consideration should be given to installation of automatic heating and/or dehumidification equipment.

32.7.2.1 Wet Wells

___ Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 changes per hour. Air shall be forced into the wet well rather than exhausted from the wet well.

32.7.2.2 Dry Wells

___ Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Air should be forced in, rather than exhausted.

32.8 Flow Measurement

___ Suitable devices for measuring sewage flow and/or run time should be considered at all pump stations.

32.9 Water Supply

___ There shall be no physical connection between any potable water supply and a sewage pumping station that under any conditions might cause contamination of the potable water supply. If a potable water supply is brought to the station, it should comply with conditions stipulated under Section 46.2.

33. SUCTION LIFT PUMPS

___ Suction lift pumps shall be of the self-priming or vacuum-priming type and shall meet the applicable requirements of Section 32. Suction lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of factory certification of pump performance and detailed calculations indicating satisfactory performance under the proposed operating conditions. Such detailed calculations must include static suction lift as measured from "lead pump off" elevation to center line of pump, friction and other hydraulic losses of the suction piping, vapor pressure of the liquid, altitude correction, required net positive suction head, and a safety factor of at least 6 feet (1.8 m).

___ The pump equipment compartment shall be above grade or offset and shall be effectively isolated from the wet well to prevent the humid and corrosive sewer atmosphere from entering the equipment compartment. Wet well access shall not be through the equipment compartment. The combined total of dynamic suction lift at the "pump off" elevation and required net positive suction head at design operating conditions shall not exceed 22 feet.

___ Suction lift pumps shall be equipped with an air release valve in the discharge piping. Drainage from the air release valve shall be piped back to the wet well at elevation higher than the maximum wet well water level.

33.1 Self-Priming Pumps

___ Self-priming pumps shall be capable of rapid priming and repriming at the "lead pump on" elevation. Such self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 25 feet (7.6 m) in total length. Priming lift at the "lead pump on" elevation shall include a safety factor of at least 4 feet (1.2 m) from the maximum allowable priming lift for the specific equipment at design operating conditions.

33.2 Vacuum-Priming Pumps

___ Vacuum-priming pump stations shall be equipped with multiple vacuum pumps capable of automatically and completely removing air from the suction lift pump. The vacuum pumps shall be adequately protected from damage due to sewage.

34. SUBMERSIBLE PUMP STATIONS

___ Submersible pump stations shall meet the applicable requirements under Section 32 (Pump Station Design), except as modified in this section.

34.1 Construction

___ Submersible pumps and motors shall be designed specifically for raw sewage use, including totally submerged operation during a portion of each pumping cycle and shall meet the requirements of the National Electrical Code for such units. An effective method to detect shaft seal failure or potential seal failure shall be provided, and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

34.2 Pump Removal

___ Submersible pumps shall be readily removable and replaceable without entering, dewatering, or manually disconnecting any piping in the wet well.

34.3 Electrical

34.3.1 Power Supply and Control

___ Electrical supply, control and alarm circuits shall be designed to provide strain relief and to allow disconnection from outside the wet well. Terminals and connectors shall be protected from corrosion by location outside the wet well or by the use of watertight seals. If located outside, weatherproof equipment shall be used.

34.3.2 Controls

___ The motor control center shall be located outside the wet well, be readily accessible, and be protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code to prevent the atmosphere of the wet well from gaining access to the control center. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

34.3.3 Power Cord

___ Pump motor power cords shall be designed for flexibility and serviceability under extra hard usage conditions and shall meet the requirements of the National Electrical Code standards for flexible cords in wastewater pump stations. Ground fault circuit interruption protection shall be used to de-energize the circuit in the event of any electrical failure in the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.

34.4 Valves

___ Valves required under Section 32.5 shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or to the soil. Sewage leaking into the valve pit shall not be drained to the soil. If the valve pit is drained to the wet well, an effective

method shall be provided to prevent sewage from entering the pit during surcharged wet well conditions. Check valves that are integral to the pump may be located in the wet well provided that the valve can be removed in accordance with Section 34.2.

35. ALARM SYSTEMS

___ **Alarm systems SHALL be provided for all pumping stations. The alarm shall be activated in cases of POWER FAILURE, high water elevation, pump failure, phase loss, or any cause of pump station malfunction**. Alarms for major pumping stations should be telemetered, including identification of the alarm conditions, to a municipal facility that is manned 24 hours a day. If such a facility is not available and 24-hour holding capacity is not provided, the alarm should be telemetered to city offices during normal working hours and to the home of the person(s) in responsible charge of the lift station during off-duty hours.

36. EMERGENCY OPERATION

___ Pumping stations and collection systems shall be designed to prevent or minimize bypassing of raw, diluted, or partially treated sewage. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, consideration should be given to providing storage/detention tanks or basins, which shall be made to drain to the station wet well. Where such overflows affect public water supplies, shellfish production, or water used for culinary or food processing purposes, a storage/detention basin or tank shall be provided having 24-hour detention capacity at the anticipated overflow rate.

36.1 Overflow Prevention Methods

___ A satisfactory method shall be provided to prevent or minimize overflows in the event of pumping station failure. The following methods should be evaluated on an individual basis (the choice should be based on least cost and least operational problems of the methods providing an acceptable degree of reliability):

a. Storage capacity, including trunk sewers, for retention of 24-hour design return wet weather flows (storage basins must be designed to drain back into the wet well or collection system after the flow recedes);

b. Other methods meeting the requirements of Section 46.1.1

36.2 Equipment Requirements

36.2.1 General

The following general requirements shall apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives, or electrical generating equipment.

36.2.1.1 Engine Protection

___ The engine must be protected from operating conditions that would result in damage to equipment. Unless continuous manual supervision is provided, protective equipment shall be capable of shutting down the engine and activating an alarm on site and as provided in Section 35. Protective equipment shall monitor for conditions of low oil pressure and overheating, except that oil pressure monitoring is not required for engines with splash lubrication. Oil level monitoring for such engines is recommended.

36.2.1.2 Size

___ The engine shall have adequate rated power to start and continuously operate under all connected loads.

36.2.1.3 Fuel

___ Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.

___ Above ground liquid fuel tanks exceeding 660 gallon single tank capacity or 1320 gallon total capacity require a Spill Prevention Control and Countermeasure (SPCC) Plan and containment in accordance with 40 CFR 112. It is recommended that all above ground liquid fuel tanks have spill containment devices with a minimum capacity equal to the largest tank's volume plus an allowance for precipitation.

___ Underground fuel tanks require compliance with state and federal regulations contained in 40 CFR 280.

36.2.1.4 Engine Ventilation

___ The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

36.2.1.5 Routine Start-up

___ All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

36.2.1.6 Protection of Equipment

___ Emergency equipment shall be protected from damage at the restoration of regular electrical power. In addition, emergency generating equipment shall be provided with a means of disconnecting such equipment from the regular incoming power source during emergency operating conditions in order to protect others who may be in contact with the failed power system. In the case of automatic systems, such disconnect shall also be automatic. In the case of manual systems, the load transfer switch or connection shall be

designed such that it is impossible to connect the auxiliary power source to the primary power source.

36.2.2 Engine-Driven Pumping Equipment

Where permanently-installed or portable engine-driven pumps are used, the following requirements in addition to general requirements shall apply.

36.2.2.1 Pumping Capacity

Engine-driven pump(s) shall meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable.

36.2.2.2 Operation

___ Unless continuous manual supervision is provided, the engine and pump shall be equipped to provide automatic start-up and operation of pumping equipment. Provisions shall also be made for manual start-up. Where manual start-up and operation is justified, storage capacity must meet the requirements of Section 36.2.2.3.

36.2.2.3 Portable Pumping Equipment

___ Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity to allow time for detection of pump station failure and transportation and hookup of the portable equipment shall be provided. This is likely to be 24 hours. A riser from the force main with quick-connect coupling and appropriate valving shall be provided to hook up portable pumps.

36.2.3 Engine-Driven Generating Equipment

Where permanently-installed or portable engine-driven generating equipment is used, the following requirements in addition to general requirements shall apply.

36.2.3.1 Generating Capacity

___ Generating unit size shall be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safe and proper operation of the lift station. The operation of only one pump during periods of auxiliary power supply must be justified. Such justification may be made on the basis of maximum anticipated flows relative to single-pump capacity, anticipated length of power outage, and storage capacity. Special sequencing controls shall be provided to start pump motors unless the generating equipment has capacity to start all pumps simultaneously with auxiliary equipment operating.

36.2.3.2 Operation

___ Unless continuous manual supervision is provided, provisions shall be made for automatic and manual start-up and load transfer. The generator must be protected from operating conditions that would result in damage to equipment. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity must meet the requirements of Section 36.2.3.3.

36.2.3.3 Portable Generating Equipment

___ Where portable generating equipment or manual transfer is provided, sufficient storage capacity to allow time for detection of pump station failure and transportation and connection of generating equipment shall be provided. The use of special electrical connections and double throw switches is recommended for connecting portable generating equipment.

37. FORCE MAINS

37.1 Velocity

___ At design average flow a velocity of at least 2 fps (0.61 m/s) shall be maintained.

37.2 Size

___ Except where grinder pumps or septic tank effluent pumps are used, force mains shall be at least 4 inches in diameter. See Section 32.3.3 for pump sizes.

37.3 Depth

___ The requirements of Section 23.2 shall apply.

37.4 Air and Vacuum Relief Valves

___ Automatic air relief valves shall be placed as needed (at high points) in the force main to prevent air locking. Vacuum relief valves may also be necessary.

37.5 Termination

___ Force mains should enter the gravity sewer system at a point not more than 2 feet (61 cm) above the flow line of the receiving manhole.

37.6 Design Pressure

___ The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

37.7 Special Construction

___ Force main construction near streams or used for aerial crossings shall meet applicable requirements of Sections 27 and 28.

37.8 Design Friction Losses

___ Friction losses through force mains shall be based on the Hazen and Williams formula or other acceptable method. When the Hazen and Williams formula is used, the following values for "C" shall be used for design.

Smooth plastic or smooth lined iron or steel - 130 to 140
Unlined iron or steel - 100
All other - 120 (maximum)

When initially installed, force mains will have a significantly higher "C" factor. The higher "C" factor should be considered only in calculating maximum power requirements.

37.9 Separation from Water Mains

___ The requirements of Section 28.3 shall be met for all sewage force mains.

37.10 Identification

___ Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main should be appropriately identified.

37.11 Leakage

___ Force main leakage tests shall be specified, including the testing methods and leakage limits.