Chapter 9
Miscellaneous Equipment

9-1. Sump Closure

a. Purpose and use. Pumping stations with wet pit type sumps and with motor-operated closure gates should be kept in a dry condition during non-operation periods of 6 months or longer to prevent increased deterioration of the equipment located therein and to provide opportunity for inspection and repair of the pumps. Some means of sump closure are required for all stations except where hydrology conditions provide long periods where the entrance to the station is dry and the station sump can be made self draining. Consideration should also be given to the need for unwatering the sump to perform inspection or maintenance and repairs during pumping operations when operational periods are long. Due to their structural design, some pumping stations cannot be completely unwatered at one time. Individual sump bays may be required so the whole station does not need to be shutdown.

b. Types. Stop logs and gates are two types of sump closure. Stop logs or bulkheads are barriers that are placed in wall slots across a flow path. Gates are usually of the slide or roller type depending on their size and provided with an individual operator for raising or lowering. Selection of the sump closure should consider opening size cost and the severity of flow disturbance created by the different types of closures. Usually sidewall disturbance is less with stop log and roller gate slots than with slide gate construction.

(1) Stop logs. Most closures by stop logs require multiple stop logs, stacked, to reach the level of protection desired. Stop log placement usually requires a mobile crane. A mobile crane will not be furnished as part of the station construction. Sufficient stop logs should be furnished to allow one pump sump to be unwatered. Stop logs should be constructed of a material that requires a minimum amount of maintenance. In most cases, aluminum stop logs best satisfy the weight and corrosion requirements. Storage at the station with convenient access should be provided.

(2) Gates.

(a) Slide gates. Slide gates are classified as either pressure-seating or pressure-unseating type and having either a rising or a non-rising stem. In all cases, slide gates should be designed to provide positive seating by means of suitable wedges. Slide gates provide a more positive means of sealing than any other types of closure. In selection of sizes and shapes of slide gates, the utilization of manufacturers' standard products should be used in order to avoid necessity for special designs. Figure D-2, Appendix D shows dimensions of typical standard slide gates. In general, the use of pressure-unseating gates should be avoided unless the stem threads are exposed to fouling or abrasive materials, it would be difficult to maintain the wedges due to continuous submergence, or it would be costly to either bulkhead or cofferdam the upstream side. Rising-stem gates are preferred due to their easy maintenance and the locations of thread engagement outside the corrosive area. Non-rising stems are to be used only if there is insufficient head room for a rising stem. Slide gates are normally limited to a 3.0-meter (10-foot) opening width. Gates used for pumping station service are usually of the flush bottom style. This style gate permits station design without steps in the flow line. All slide gates should be mounted on an "F" type wall thimble which is cast into the concrete wall. A flange back type gate is recommended since they are the strongest. The slide gate frame and slide should be of cast material with all wedges, seats, and fasteners to be constructed of bronze or stainless steel. The gate stems should be made of stainless steel.

(b) Roller gates. Roller gates are used when the gate opening is too large for slide gates. A roller gate consists of a fabricated steel leaf with cast iron wheels and rubber seals. Vertical recesses at the sides of the gate opening are provided with opposing rails to guide movement of the leaf. The top and side rubber seals on the gate seat on embedded stainless steel rubbing plates. These seals are of the "J" bulb type and are aided in sealing by water pressure deforming the stem of the seal. The bottom seal is usually a strip of heavy rubber across the bottom of the gate leaf which seats on an embedded stainless steel plate in the floor of the opening. Roller gates can be constructed with the wheels on the dry side of the leaf; however, this construction makes it more difficult to obtain a seal since an unseating head is on the seals. Since current construction uses self-lubricating bearings on the wheels, the need to be in the dry is not as important. In most cases, the structural design of the leaf is done by the gate manufacturer. The embedded metal rail assemblies on each side of the gate along with the top and bottom embedded metals are furnished by the gate manufacturer. Installation of all of the embedded metals for the roller gates should be supervised by an erection engineer from the gate manufacturer. Roller gates have a higher maintenance cost, and it is more difficult to obtain a water tight seal; therefore, they are to be used only when standard-size slide gates are not available.

(c) Operators. Slide and roller gates are usually raised and lowered by means of a manual or electric motor-operated geared hoist. In special cases, hydraulic cylinders can also be used for raising and lowering operations. For manual operation, portable electric power wrenches may be used when the gates are small, easily accessible, gate operation is infrequent, and the time required to open or close the gates is short. For larger gates, when electric service is available (less than 1.49 square meters (16 square feet)), the gate operator should be motor operated. Where the size and weight of a gate, or the quantity of gates, are such that manual operation would require two persons for more than 30 minutes, provision for power operation should be considered. Fixed power operators should be provided when portable units must be manhandled to inconvenient and difficult to reach places. These hoists should be equipped with torque and position-limiting devices. All power hoists should also be equipped for manual operation. Tandem-operated hoists using two stems but one motor are required for any gate whose width is equal to or greater than twice its vertical height, or for a roller gate whose width is greater than 3.66 meters (12 feet). The hoist is usually mounted on a steel beam system which must be designed to take both the up thrust developed during seating and the down thrust developed during unseating. A computation method used to determine thrust loads and stem diameters is shown in Appendix D. The surface finish on the threads should not be greater than 63 rms, a radius of 0.76 millimeters (0.030 inch) should be provided on the thread corners, and the lift nut and stem should be manufactured at the same location so that their fit may be confirmed. Hydraulic cylinder operation of the gate stems is usually considered only for large stations with eight or more gates where the costs required for multiple hydraulic units are justified. Operator motors should be rated for continuous duty.

9-2. Trash Protection

a. General. Trashracks are required to protect the pumps from debris which could clog or damage the pumps. Accumulated debris in front of the racks should be removed to prevent structural damage to the trashracks or damage to the pumps due to restricted flow into the pump sump. Hand raking and power raking are two methods used for removing trash from the rack. Hand raking should be used only for the smallest stations and then only when the amount of trash can be handled with manually raked methods. Hand raking should not be used when the rake handle has to be longer than 20 feet to reach the bottom of the rack with the operator standing on the trashrack platform. Trashrack sizing and bar spacing are furnished in EM 1110-2-3102. Pump manufacturers should also be consulted concerning their recommended bar spacing. Any hand rake to be furnished that is of a length greater than 2.74 meters (9 feet) should be constructed of a non-electrically conductive material as the operator may inadvertently touch energized overhead electrical lines while cleaning the trashrack. Handrailing should be provided for safe handraking operations.

b. Power rake types. There are three general types of power-raking equipment: cable hoist, mechanical, and catenary. These types were classified based on operating characteristics or drive mechanisms used to remove trash. Each of the types has several sub-categories. All the types are described and shown in Appendix C. In general, only one raking unit will be provided for a station if it is of the type that can be moved from trashrack to trashrack. On large stations with four or more pumps or those stations where extreme amounts of trash are possible, multiple trashrakes should be used. Most types of rakes will not handle all types of trash. They should be selected to handle the trash that will be in greatest quantity and is most likely to cause clogging problems. Power-raking units should not be remotely operated unless specifically designed to protect the mechanism from breakage should a lock up occur due to trash. Consideration should be given to the method of handling the trash after it is raised to the forebay platform.

c. Selection. Selection of the type of trashraking equipment is based on the anticipated types of trash and its quantity. Field surveys may be performed to determine the type of trash and possible amounts. Similar drainage basins can also be used for comparison as can other pumping stations in the same general area. An attempt should be made to estimate the amount of trash to be removed and the time period during which this trash would accumulate at the station. In general when comparing two different drainage basins, the amount of trash per unit of area diminishes as the total contribution area increases. The greatest quantity of trash usually occurs during the first peak inflow to the station during rising water conditions. Consideration should be given to the installed equipment costs, operating costs, and maintenance costs in addition to the rake's efficiency. Because of its raking capabilities, it is sometimes necessary to select the raking system that might have the highest costs. Additional information on selection procedures used is indicated in Appendix C.

9-3. Equipment Handling

a. General. A station crane should be provided, for all but the smallest stations, for handling the major items of equipment. Small stations may be built with removable ceiling hatches so that a mobile crane may be used when work is required.

b. Station cranes. Since the service expected of the crane is standby, a Class 1-A in accordance with the Crane Manufacturers Association of America can be used. Bridge-type cranes are usually used, but a monorail type over the pumping units may be used if that is the only requirement for the crane and it is capable of doing the job. Cranes of less than 2,722-kilogram (3-ton) lifting capacity should be of the manual type. Cranes with capacities from 2,722- to 9,072-kilogram (3- to 10-ton) lifting capacity may be equipped with a motorized hoist while still retaining manual travel arrangements. Cranes over 9,072-kilogram (10-ton) capacity should be of the three-motor type, where all functions of the crane are motorized. Hoist and travel speeds can be kept to a minimum since the crane will be used only for major maintenance. Cranes over 10-ton capacity should be equipped with multi-speed type controls with speeds such that "inching" is possible to permit close positioning of the loads. The high position of the crane hook should be at such an elevation to permit removal of the pump in pieces; however, allowance should be made for use of slings and lifting beams plus some free space. If a hatch is provided in the operating floor, the crane hook should have sufficient travel to reach the sump floor to permit removal of items from the sump. The crane should have a capacity large enough to lift either the completely assembled motor or pump, but not both at the same time except for submersible pumping units, in which case the entire unit is lifted. Consideration should be given to removal of equipment from the station when determining the crane travel requirements. It may be necessary to run the crane rails to the outside of the station in order to load the equipment onto hauling equipment rather than provide space inside the station for this equipment. Because most stations are usually located some distance from rail facilities, trucks should be considered for movement of the equipment to or from the station. Station design may permit the use of chain blocks from I-beams or from arrangements of hooks in the operating room ceiling where the loads are small. Permanently embedded eyes or hooks in the sump may be required for those pump parts that cannot be raised overhead with the station crane. This is usually required only for those pumps that have part of the pump bowl embedded in the sump ceiling.

9-4. Ventilation

a. General. Ventilation is provided for both safety and heat removal purposes. Ventilation facilities should be segregated between pump sump and operating areas. Except for those stations in urban areas where explosive conditions are known to occur in the sewer adjacent to the station or in the sump area, gravity ventilation will be adequate for all zones during inoperative periods. For those cases where the hazard of an explosion exists, the station should be designed so that it may be completely ventilated. All equipment used in connection with the ventilating system should be electrically rated for use in the explosive condition expected. The operating period, equipment ratings, duct arrangements, locations of outlets and fresh air inlets, and all other details should be based on accepted principles outlined in publications of the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

b. Sump ventilation. Mechanically forced ventilation should be provided for all wet and dry sumps during operating periods to prevent accumulation of gases. Gravity ventilation of the sump will be adequate if the trashrack is not enclosed, operation is not required from a lower platform, and the sump is not exposed to sewer gases. The mechanical ventilation of sumps should be accomplished using motor-driven blowers removing air from the sump while fresh air is ducted into the sump. The blower should be located outside the sump and should be connected to ductwork from the sump and to ductwork which discharges to the atmosphere outside the station. The discharge from the blower should be located such that recirculation of fumes into the operating area is minimum. The suction ducts from the blower should run to a point near the sump floor and shall be equipped with louvers that allow suction from either the floor or ceiling area of the sump. The louvers should be operable from outside the sump. If the sumps are separated in such a way that openings are not located at both the top and bottom of the sumps, individual ventilation will be required for each sump. It is a requirement that all sump areas must be ventilated before any personnel enter. The ventilation rate should provide a minimum of 15 air changes per hour based on the total volume of an empty sump. The fresh air inlet areas should be a minimum of twice the outlet area to prevent high losses. For stations pumping sanitary flows or a mixture thereof, the ventilation system should be in operation continuously when in a pumping mode.

c. Operating area ventilation. The operating area is ventilated to remove any gases and to remove excess heat buildup caused by the operation of the electrical and mechanical equipment. The system design is based on the amount of air to be removed in order to have an inside temperature not greater than 40 degrees C (104 degrees F). The design should consider outside maximum temperatures occurring coincident with operation. As a minimum, the ventilation equipment should be designed for at least six air changes per hour to provide ventilation during nonpumping periods. Gravity or mechanical ventilating equipment can be used to satisfy these requirements.

9-5. Equipment Protection

Various means have been used to protect equipment, particularly the electrical equipment, of flood-protection pumping stations from deterioration and general moisture. The methods employed are:

(1) Providing electric heaters within the housings of the motors and switchgear.

(2) Heating the operating room.

(3) Dehumidification of the operating-room area, which includes sealing of the motor room and the application of vapor barrier material to the interior surfaces.

(4) Heating the interior of the motors and switchgear by means of a central heating plant.

(5) Dehumidification of the interior of the motors and switchgear by means of individual dehumidifiers.

Operating experience indicates that method (1) above is the most practical and economical for small- and medium-size stations. For the larger stations, using motors rated 1,500 kW (2,000 HP) and above, methods (4) and (5) may be feasible. Dehumidification methods are usually less costly to operate; however, maintenance and replacement costs are such that local users seldom keep the units running after initial failure. The sizing of electric heating elements in system (1) is done by the equipment supplier; however, the ambient conditions should be specified for this equipment.

9-6. Sump Unwatering

a. General. Provisions should be provided to unwater the sumps between pumping periods for inspection and to perform maintenance and repairs. The unwatering may be accomplished by means of one or more sump pumps. The wet sumps should be made to drain to an unwatering sump location where the sump pump is installed. The sump pumps should be of the submersible motor/nonclog pump type. The sump pumps should be sized to allow stations of 11 m^3/s (400 cfs) of less capacity to be completely unwatered within a 6-hour period. The 6-hour period allows the unwatering to be accomplished within a normal work day. For large stations with more complex systems, the unwatering system may be designed to unwater one-third of the station within the 6-hour period. Unwatering sumps are normally located outside the main pump sumps to avoid disturbing flow patterns to the main pumps. Any interconnecting piping should be kept to a minimum and should be installed so that it may be unclogged. Consideration should be given to designing the unwatering piping and valve arrangement or providing other means to allow rewatering of the sumps. If bulkheads are used as the means of sump closure, this can be accomplished by providing a valve on the bulkhead.

b. Sump pumps.

(1) General. The sump pump should be of the submersible motor, nonclog sewage type suitable for passing maximum-sized trash. The pump should be rated to pass a minimum of 64-millimeter- (2.5-inch-) diameter solids. The pump/motor should be capable of pumping down until it breaks suction and rated to run with its motor above the water surface for a minimum of 1 hour without damage.

(2) Semipermanent. This type of sump pump is mounted on a discharge shoe that allows the pump to be removed using a system of rails or cable guides without unbolting from the discharge piping. Unless the station crane can be centered over the pump, a separate hoist should be provided for pump removal. This is usually accomplished by using a wall-mounted jib with a hoist. Head room limitations may require multiple lifts to be made. This is accomplished by fitting the lifting chain connected to the pump with evenly spaced eyes on short lengths of chain that allow the pump to be hung from a

beam or embedded hook while releasing the load from the lifting hoist for a lower attachment.

(3) Portable. The pumps used for this type would be similar to the semipermanent type except that it would discharge through a hose. When this type of pump is used, a means of placing and removing must be furnished if the pumping unit weighs more than 27 kilograms (60 pounds). Usually the station crane provided for equipment removal can be used if a lifting chain similar to that described in the previous paragraph is provided along with an access opening in the operating floor. Usually two different-sized pumps are provided, since it may not be possible to use a depressed sump. In this case, a larger pump would be used to unwater down to approximately 0.5 meter (1.5 feet) (shutoff point of pump provided) of water remain. A small pump would then be used to remove the remainder of the water and handle leakage. This method usually does not permit complete removal of water from the sump floor.

(4) Control. Operation of the semipermanent sump pumps is by means of a bubbler system or electrodes. Portable sump pumps are usually operated by manual means; some pumping units are equipped with current sensors that control the on-off cycling of the pump by sensing the change in motor current which occurs when the pump breaks suction.

9-7. Pump Bearing Seal and Lubrication Systems

Grease lubrication of all mixed-flow/axial-flow vertical lineshaft pump bearings is the standard lubrication utilized because of the type of bearing system used and the usual infrequent periods of operation. Rubber pump bearings are not used since a dependable water supply is usually not available and the use of pumped liquid for lubrication is not always available when periodic test operation is necessary. Bearings exposed to water pressure should be provided with seals. Usual pump construction provides for a shaft seal immediately above the impeller. This seal is usually a lip-type seal installed so the water pressure seats the lip against the shaft. In time these seals will leak, letting pumped water at discharge bowl pressure enter the shaft enclosing tube. To preclude this water from traveling up the tube and leaking onto the operating floor, the pump should be equipped with an overflow pipe connected to the enclosing tube and leading to the sump or a built-in catch basin where the shaft leaves the baseplate with a drain to the sump. Individual seals for each bearing are not used except for the bearing below the impeller, if used. Guide Specification CW15160, Vertical Pumps, Axial and Mixed Flow Impeller Type, has a section that covers the grease lubrication system for stormwater pumps. Each bearing should have a separate grease line and a feed indicator. All lubrication lines below the maximum water level should be protected against damage or breakage from floating debris. The lubrication system should be automatic with a control system that provides a prelube cycle before the pumps are allowed to start and an adjustable period between greasing cycles. Manual greasing systems should be considered for use only on pumps such as sump pumps and for flood control pumps whose capacity is less than 600 liters per second (ℓ/s) (20 cfs) and where the time of operation is such that daily greasing would not be required. The frequency of greasing is based both on the manufacturer’s recommendations and how the equipment will be operated.

9-8. Pump Bearing Temperature System

Pumping units with discharges greater than 600 millimeters (24 inches) should be fitted with detectors to determine the temperature of each pump bowl bearing. If the pump will operate less than 100 hours per year, a temperature detector should be installed only at the impeller bearing. The system should consist of resistance temperature detectors (RTD) mounted so that they are in contact with the bearing, and a monitoring system that allows display of individual bearing temperatures and alarms when preset high temperatures are exceeded. It is recommended that the monitoring and alarm system be designed as part of the electronic control system of the station and not part a separate system. A detail of a pump bearing RTD mounting is shown on Plate 9.

9-9. Pump Reverse Rotation Protection

Pumping units are subject to reverse rotation when the unit is shut down. Depending on the available head and the design of the unit, reverse rotation may reach 165 percent of the forward running speed of the unit. This can occur as a planned operation such as occurs for pumping units when the water runs out of piping between the top of the protection or the discharge flap gate and the pump or possibly on an extended basis during failure of a siphon breaker valve or discharge flap gate. All pumping units should be designed to withstand this reverse rotation. Two means are used for this protection. The first is to prevent reverse rotation by the use of a reverse ratchet or overrunning clutch mounted on the motor or gear reducer. The second is to design the pumping unit, including the drive motor, to withstand the maximum speed possible during reverse rotation. Units driven by engines must be equipped with a reverse ratchet or overrunning clutch since any reverse rotation could damage the engine. Reverse ratchets of the rolling pin or drop pin design should be used.

9-10. Comfort Heating and Air Conditioning

A heated and air-conditioned space should be provided for operator use during pumping operations. This space can be heated and cooled with a small packaged unit. The entire operating room should be provided with electric heat capable of maintaining a temperature of 13 degrees C (55 degrees F) when outside temperatures are at the normal low for that area. These heaters are provided to permit maintenance operations at any time of the year and are usually electric since their operation time will be limited.