Chapter 5
Equipment Selection

5-1. Number and Size of Pumps

a. General considerations. A detailed discussion of the selection of pumps, prime movers, electrical equipment, and other miscellaneous auxiliaries is given in EM 1110-2-3105. The design should obtain the desired operations at the lowest possible cost. The cost used to determine the pumping station design should be based on an annualized cost which should consider both first cost, operating and maintenance cost, and cost of equipment replacement over the life of the project. Generally, the lowest cost is obtained with a minimum number of pumps. However, a minimum of two pumps is recommended. Baseflow for combined-flow stations should have sufficient capacity for peak domestic and industrial flows, seepage, and runoff due to light rains.

b. Economic study. The number and resulting size of stormwater pumps must be determined by an economic study. This study should consider the consequences and related costs due to flooding if one pump malfunctions during a flood event. The greater the number of pumps, the smaller the reduction of the total station capacity if one pump malfunctions. This increased protection, however, results in higher equipment, facility, and operation and maintenance costs. The need to reduce the impact if one pump malfunctions will most likely be appropriate in urban areas where a pump failure could cause significant property damage and raise ponding more rapidly to life-threatening depths. The extra costs cannot normally be justified in areas where there are adequate flood warnings or no life threat. Any decision to add more pumps or more capacity to reduce pumping time and/or ponding stage in the event one pump malfunctions must be well justified and the justification well documented. An economist will normally perform the economic study, closely coordinated with the hydraulics and pumping station design engineers associated with the project.

c. Standby capacity.

(1) If seepage flows are more than 30 percent of the total required capacity of the pumping station, the number and capacity of the pumps shall be such that a 100 percent standby pumping capacity is available with failure of any installed pump.

(2) For stations pumping stormwater only or combined flows of stormwater and sanitary sewage, no standby capacity should be provided. Stations located in agricultural or tidal areas where pumping availability is 80 percent of the year, or the interval between operations is insufficient to allow proper maintenance of equipment, standby capacity equal to the largest pumping unit should be provided.

(3) For stations pumping sanitary and industrial sewage only, where one pump is required for the design capacity, a duplicate pump should be provided. Where more than one pump is needed to meet the required capacity, standby capacity equal to the largest pumping unit should be installed.

d. Sump size. The size of the sump may affect the selection of sizes and number of pumps with regard to the minimum desirable operating cycle. For a given sump size, the number and size of pumps should be such that the minimum operating cycle would be 6 min for submersible pumps, 20 min for wet-pit pumps with motor size up to and including 75 kW (100 hp), and 30 min between starts for pumps over 75 kW (100 hp). Pumping units over 375 kW (500 hp) should be started according to data furnished by the motor manufacturer. Where bypasses or variable discharge pumps are to be used, the size of the sump has little effect on the size or number of pumps.

e. Programming. Consideration of all pertinent factors may indicate that pumps of various capacities should be provided, at some installations, so that suitable operation would be obtained with minimum sump size. For such installations, the maximum increment in pumping rates may be made equal to the smallest unit, making it possible to pump at a rate approaching that of the inflow. Programming should not be done when the number of pumps becomes unduly great, or the controls so complicated, resulting in excessive costs and decreased reliability. Experience has indicated that variable speed motors for one or two of the pumps may be more advantageous than programming various size pumps. A note of caution about the use of variable speed drives: variable speed drives complicate pump selection, increase first costs and maintenance costs, require a higher level of technical ability for maintenance, and decrease reliability.

f. Limitations of in-rush demand on transmission system. An investigation should be made to determine whether the maximum pump size is limited by the maximum in-rush demand for pump starting that can be tolerated by existing power facilities. Where the existing power facilities place a limitation on starting demand kVA, pumps having relatively flat input horsepower demand characteristics and adjustable blade pumps or

variable speed pumps should be considered. Engine-driven pumps should also be studied to determine if these are required due to weak power supply conditions. If pumping stations are primarily used during periods of hurricane conditions, it may be required for the pumps to be engine driven and for the station auxiliaries to be supplied with backup power by engine-driven generators.

5-2. Pump Control

a. General. The decision as to the type of control to specify for a flood control pumping station should be based on providing maximum reliability consistent with economic design. In the majority of cases, controls providing for manual start and automatic stop will be the most economical. From the standpoint of reliability, such controls are preferred. The disadvantages of automatic controls include increased complexity due to the additional control equipment, greater cost, and reduction in reliability. However, some installations may find the use of automatic start and stop controls to be an advantage, such as where limited sump capacity and inflow conditions would make manual starting impracticable due to short operating cycles, or where economy is obtained by using pumps of different sizes operating in a predetermined sequence. The control circuits of automatic stations must provide protection against simultaneous starting of all pumping units following a power interruption. Automatic controls are more susceptible to deterioration due to long periods of disuse and will require more frequent inspection and maintenance to keep them in working order. Personnel with the skill and knowledge required for maintenance of automatic control equipment should always be available. Automatic controls must be compared with the justified alternate manual controls. Automatic controls must have a manual control backup.

b. Automatic operation. CFR 208-10 requires that "competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent." This statement basically eliminates all automatic and remote pump operation. However, considering the reliable automatic features available and the type of operation required at some facilities, it is recognized that this requirement is not always practicable or justified. Any Corps office considering the use of automatic or remote features should request and fully justify a deviation to the stated requirement. This request for deviation should be submitted to higher authority early in the design phase of the project.