FOX POINT PUMPING STATION: MECHANICAL & ELECTRICAL FEATURES

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THIS will be a brief outline of the mechanical and electrical features of the pumping station which forms a part of the Hurricane Barrier.

Hydrology studies of the water shed established the design flood of 7,000 c.f.s., a rate close to 200 million gallons per hour. This represents the inflow at the barrier which the pumping plant must be able to lift against the hurricane ocean tides. The design operating head is 20 feet, representing the differential between the maximum hurricane tide still water elevation and the Providence River stage of 0 m.s.l.

Five 120″ diameter, 164 rpm pumps, each rated at 1400 c.f.s. at 20 foot head will provide the required capacity. An item about the Fox Point project in the September 7, 1961 issue of the *Engineering News Record* referred to these pumps as the largest ever built. This is not quite true, as I understand that there is a pump in service at Grand Coulee Dam capable of delivering 1500 c.f.s. at a head in excess of 20 feet. In this respect, therefore, we cannot claim to be pioneering.

Selection of five units is predicated on considerations of overall economy and the range of anticipated river flows. Although a greater number of smaller units would cost less, because these could be designed to operate at higher rotating speeds, the savings would be more than offset by the higher cost of the structure to house the pumps. A lesser number of larger units would sharply raise the equipment cost. Moreover, the higher capacity of each pump would result in a pumping rate excessive for conditions other than very severe floods and bring about undesireably short pumping cycles and unwieldy operating conditions.

Figure 1 is the floor plan of the pumping station with the five

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pumps arranged in line on 33 foot centers. The structure is approximately 214 feet long, 38 feet wide and 95 feet high from bottom of base slab to the roof. The west end of the station accommodates two control gates for the cooling water canal provided for the Narragansett Electric Company, which was mentioned earlier this evening.

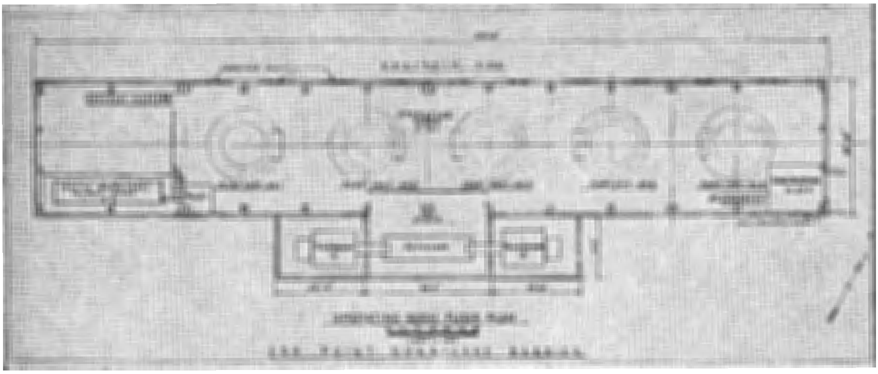


FIGURE 1.

The pumps (Figure 2) are of the vertical flared tube design. This design was adopted rather than the more conventional draft tube arrangement because of its simplicity and low cost. The pumps will be loaded so infrequently and then for so brief a period that costly refinements in pumps or water passages for gain in efficiency, such as forming and fabrication of elaborate curved surfaces characteristic of the conventional design are not warranted. You will note the simply formed shapes of the suction and discharge chambers. A rather unusual feature incorporated in the pump design is the backwater closure provided to prevent the reverse flow of water under hurricane tide conditions when the pump is not in operation. The reverse flow must not be permitted to take place for it would cause reverse rotation of the pump and its motor, converting the pump into a turbine, so to speak. Starting the pump under such conditions would be difficult or even impossible. Positive means of preventing back flow in the idle pumps must be provided. The closure will normally be kept in the uppermost or fully open position and will be lowered manually into closed position when the hurricane is in the offing. It will be raised automatically when the pump is to be placed in operation by a hydraulic mechanism which must be designed to achieve accurate coordination of the upward motion of the closure with the starting characteristics of the pump and its prime mover. The raising of the closure must be rapid enough to avoid starting the pump against closed discharge and yet slow enough to prevent the establishment of excessive reverse flow.

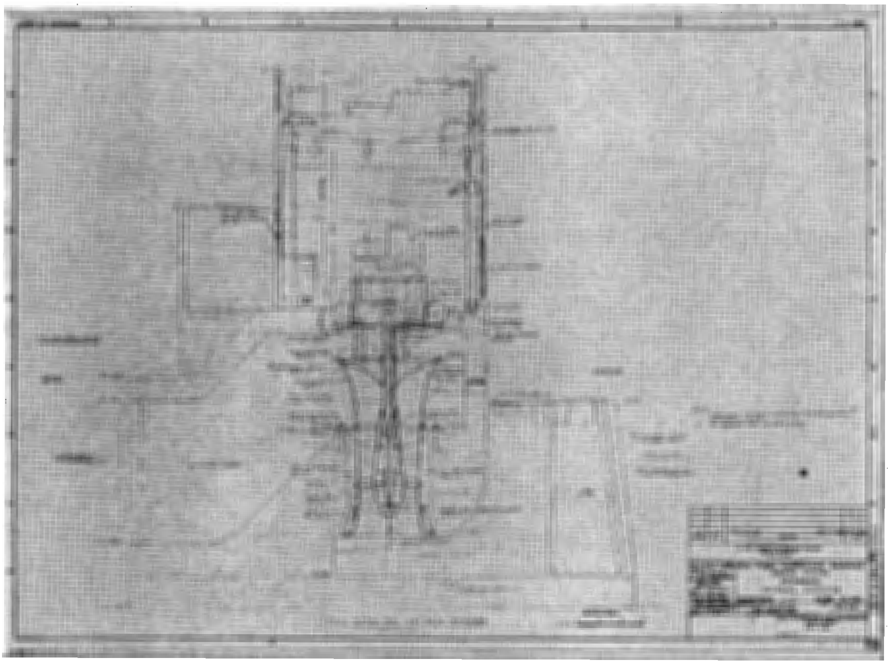


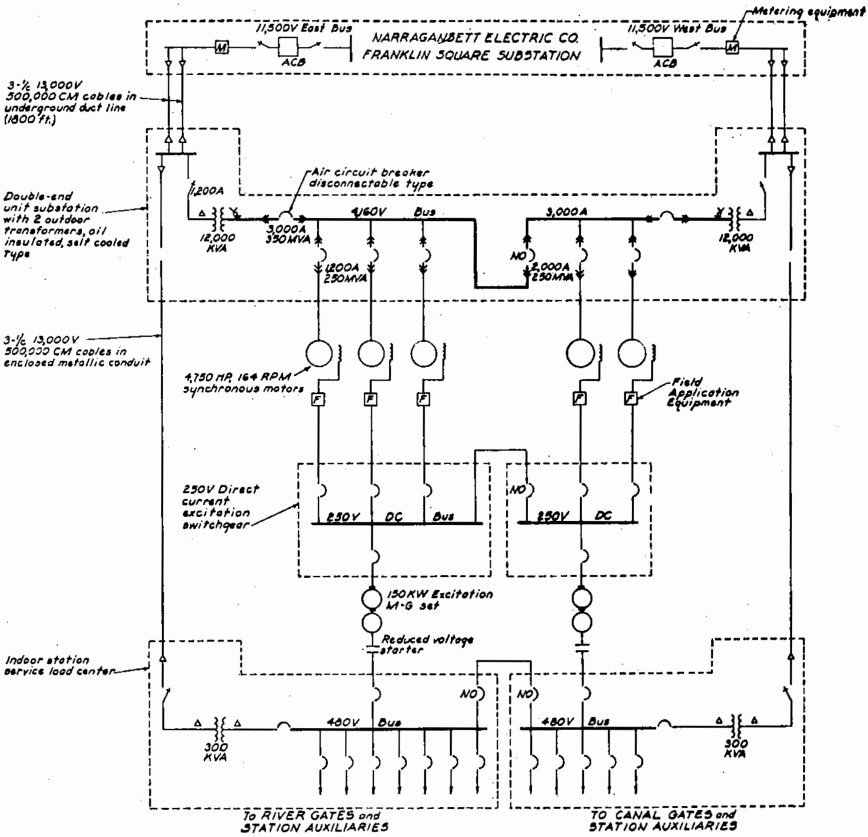
FIGURE 2.

All pump parts normally submerged in salt water, i.e., those located below the high tides—elevation 5 m.s.l.—will be manufactured of Ni-resist, a high nickle chrome alloy cast iron. This metal is virtually immune to corrosion in salt water environment and its use eliminates the necessity of costly dry sump arrangement, with its suction chamber gates, operating mechanisms and accessories.

Now a few words about the selection of prime mover for the pumps and the electrical features of the project. The electric motor is the simplest and least costly prime mover, but it is no more reliable than the electric power supply it requires. Unless the power supply possesses the attributes of absolute dependability, especially during severe storms which often raise havoc with electrical transmission and distribution lines, a self sufficient prime mover such as the internal combustion engine, should and most often is employed for driving pumps and other essential devices of flood control projects. At Fox Point we are peculiarly fortunate in this respect, for the project is situated immediately adjacent to a large and diversified electric power supply complex. The west abutment of the barrier is at the Narragansett Electric Company's plot containing the 150,000 kva Manchester Street power generating station, 120,000 kva South Street power generating station and Franklin Street substation. The substation is inter-connected with these two power plants and with the 110,000 volt transmission lines of the New England Electric system.

Thus selection of electric drive for the pumps was made possible. Each pump will be driven by a direct connected 4500 hp, 4000 volt synchronous motor. Two independent 11,000 volt underground cable circuits, approximately one quarter mile long and located in the protected area north of the west dike, will connect the pumping station with the Franklin Street substation of the Narragansett Electric Company. These two circuits will feed a double-ended substation in the pumping station, having two 12,000 kva identical transformers for stepping the supply voltage to 4160 volts which is the utilization voltage of the pump motors.

Figure 3 is a simplified one line diagram of the pumping station. Each transformer and the cable circuit feeding it is designed to have the capability of sustaining the entire operation of the pumping station in the event of failure of the other cable or transformer. These power transformers are very efficient pieces of apparatus with efficiency better than 99%. The so called no load losses amount to only two-tenths of 1%. But because of the size of these units this, what might appear to be a negligible loss, would consume, in the course of a year, some one-half million kilowatt hours without even turning a pump. Even at the favorable power rate enjoyed by the project, the cost of these losses would approximate $7,000 per year. For this reason, the transformers will normally remain deenergized until there is an indication of an approaching storm requiring the operation of the station. The station will also be activated periodically for testing the equipment. A pair of smaller transformers is provided to supply station auxiliaries, lights and other utilities.



FOX POINT HURRICANE BARRIER
PUMPING STATION
ELECTRICAL POWER DIAGRAM

FIGURE 3.

Figures 4 and 5 are the artist's renderings of the pumping station. The superstructure is of pink or salmon colored brick with darker brown shade used to set off the vertical panels in this windowless structure. The sizeable area of the ventilating louvers is dictated by the cooling requirements of the pump motors. To the east of the pumping station, located between the center and east barriers, are three 40 by 40 tainter gates. These will be normally kept in fully open position to permit the river flows to discharge into

FIGURE 4.

FIGURE 5.

the bay. The only navigation taking place in the river is that of coal barges and pleasure craft. Clearance of 25 feet below the fully opened gates is provided to permit this traffic. The gates are electrically operated and controlled from the pumping station. They can be lowered at the rate of one and one-half feet per minute. Full closing cycle of 40 feet would take close to one-half hour and it is expected that the gates will be partially lowered and poised in this position when a storm is anticipated so that complete closure can be effected promptly when this becomes necessary.