THE WASHINGTON SUBURBAN SANITARY COMMISSION

TECHNICAL SERVICES GROUP	NUMBER:	APPROVED BY/DATE	EFFECTIVE DATE	PAGE
	28-ME-DG-02 Revision 1	Stanley J. Dea, Director Bureau of Planning and Design	January 1984	1 OF 40

SUBJECT

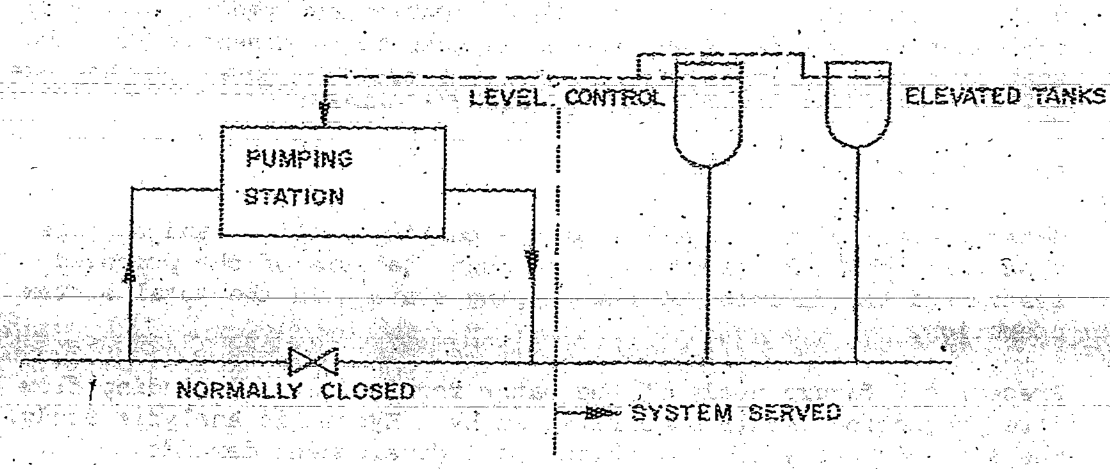
MECHANICAL AND ELECTRICAL DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

1.0 INTRODUCTION

This guideline is intended to facilitate engineering and design of Water Booster Pumping Stations by Consultants or WSSC personnel. It provides the basic requirements and design features, both mechanical and electrical, for small and medium size water booster pumping stations (up to about 25 MGD).

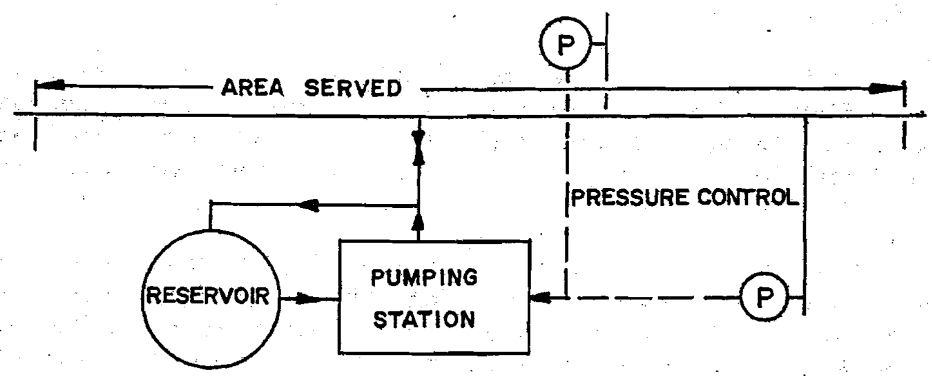
Booster pumping stations are installed "to increase the pressure in a pipe line or in a zone of the distribution system, to aid in meeting peak demands such as fire demands, to supply water to elevated storage tanks and for other purposes." The booster pumping stations covered here fall under the following two main categories:

1. Booster pumping stations that draw suction from the system mains and/or storage reservoirs and pump into a distribution system with elevated storage and isolated from the remainder of the system by the pumping station and valving. These stations are necessitated because the pressure in the system mains served by other pumping stations is insufficient to meet the water demands in some zones because of topography and other factors. These stations generally operate on level control. (These types of stations will be referred to as "in-line booster stations".)



IN - LINE BOOSTER STATION

2. Booster pumping stations which draw suction from storage reservoirs which normally get filled from system mains and pump into the distribution system when the pressure in the distribution system normally fed from the system mains falls. These stations are necessitated because of the difficulty in getting elevated storage approved and built. These stations generally operate on pressure control. (These types of stations will be referred to as "booster stations with pumped storage".)



BOOSTER STATION WITH PUMPED STORAGE

This guideline does not cover hydraulic analysis study, criteria for determination of the type of station, siting, civil, structural and architectural aspects, chlorination facilities or storage reservoir design, though some references are made.

The pumping station shall, in general, accommodate the pumps, piping, valves, electrical, control and communication equipment, emergency generator (if standby power source is considered essential for the station and if reliable dual power feeds from the power company are not feasible) and chlorination system (if needed).

2.0 PUMPING STATION CAPACITY

Determination of the capacity of the pumping station (and storage reservoir) shall be based on a thorough analysis of the proposed system and the function of the pumping station in the total system operation.

Present and future needs of the water requirements, including flow for fire protection, shall be arrived at by a Hydraulic Analysis Study. The Analysis Study should include full development demands.

Pumping Station shall then be sized for anticipated demands for 20 years or full development, with initial installation of only enough pumping capacity for 5 to 10 years, with provision for installing additional pumps, as directed by future demands. The initial and the final installations shall include one spare unit of the largest size.

3.0 RELIABILITY

Design shall be such as to ensure reliability of individual pieces of equipment and to avoid interruption to water service. Reliability consideration shall also be taken into account in the location of the pumping station, power supply and choice of equipment. Pumping units and auxiliary equipment should be of ample capacity and in sufficient numbers of units to permit continuance of service with the largest unit out of service. The reliability of individual pieces of equipment depends on their design, construction, installation, ease of maintenance, availability of spare parts, etc. Attention to these factors to avoid interruption of service to customers is justified.

4.0 INTERIOR ARRANGEMENT

The interior arrangement shall be such as to isolate chlorination, generator (if there is one), and restroom facilities from the main operating area or pump room for reasons of noise control, safety, and privacy. Separate exterior doorways shall provide access to each isolated area, except the restroom.

Location and spacing of pumps, piping, and valves shall be such as to provide ease of maintenance and ease of removal and replacement without disturbing other pieces of equipment. Adequate space shall be provided for installation of future pumps to meet projected growth demand. Design shall also allow for limited upgrading of the station without major structural or electrical changes.

Pump elevation shall be such that the pumps would operate under a positive suction head.

The motor control center shall be located at a higher elevation than the pump room floor to provide easy accessibility and convenience and to prevent damage by flooding.

There shall be enough stairs to provide access to each pump without having to climb over pipes. The stairs shall conform to MOSH Safety Standards, and shall be of aluminum.

Suction and discharge headers shall be located outside the pumping station.

The main pump room shall be equipped with a bridge type crane for servicing all equipment. The crane and hoist shall have a capacity to handle the biggest piece of equipment at the station. Consideration shall be given to future possible upgrading of pumps and motors in selecting this capacity.

Space for driving trucks inside the station shall be provided and the bridge crane shall be capable of traversing this area.

For facilities to handle chlorine containers, refer to Mechanical and Electrical Design Guidelines for Chlorination Facilities.

A preferred pumping station plan showing physical arrangement is shown in Drawing DG-02-1.

5.0 ACCESS

A paved macadam access road shall be provided from the nearest existing roadway for vehicles to reach the pumping station. Adequate turn around area shall be provided.

6.0 PUMPS AND PUMP MOTORS

6.1 Pumps

The pumps shall be horizontal centrifugal, split case, single stage with cast iron casing and enclosed double suction, bronze impellers. Pumps shall have casing and impeller wear rings. Stuffing boxes shall be of the packing type with braided graphite asbestos. Motor to pump shaft coupling shall be of the flexible type with no non-metallic power transmitting components. Coupling shall be of the type having a flexible steel circumferential grid engaging two steel hubs or shall be of the gear type. Couplings shall have removable grease lubrication plugs and grease seals and hubs shall be keyed to their respective shafts. Bearings may be of the ball type, grease lubricated for pumps below 500 HP. For pumps 500 HP and above, split sleeve bearings and Kingsbury type thrust bearings shall be used, with water cooling (with solenoid valve) for the thrust bearing, if necessary. The pump units shall be mounted on cast iron or structural steel frames (preferably cast iron) and shall be equipped with:

- coupling safety guards
- suction and discharge pressure gauges of appropriate ranges
- drain tubing for seal leakage
- pump vent valve and
- gauge glasses for bearing oil levels (where applicable).

The seal leakage and pump vent line shall be led to the floor drains by copper piping with unions on the drain piping very near the drip pockets.

All bearings of pump units (pump and motor) 500 HP and above shall also be provided with bulb type temperature detectors and bearing temperature indicating controllers. The temperature indicating controllers shall be of the two stage type-alarm and trip-Fenwall Series 400 or equal with a range of 50° to 200° F. Relays for the motor bearings shall be located on the motor and relays for the pump bearings shall be located near the pump. See Drawing DG-02-13 for details.

Pump units of the constant speed type are preferred, unless there is an overwhelming reason for variable speed pumps. Low speed pumps are preferred (1200 RPM or less).

Pumps shall be performance tested in accordance with Hydraulic Institute Standards and certified performance data furnished to and approved by the WSSC before shipment of pumps to the job site.

Acceptable Manufacturers: A-C Pump, Flowserve, Patterson Pump, or Peerless Pump.

6.2 Motors

Motors shall be of open drip-proof construction NEMA Design B, constant speed poly-phase, squirrel-cage induction type, having normal starting torque with low starting current.

The pumps shall start and stop automatically depending on system demand and even though the system is designed to avoid starts and stops in quick succession; frequent starts and stops will happen. As the effective life of a motor depends on the number of starts, and as it may be difficult to get custom-made motors in the lower horsepower ranges, as an insurance against premature failure, insulation for motors shall be specified as follows: Class F insulation, with Class B temperature rise; that is, 80° C above the ambient temperature of 40° C.

It is recognized that such motors will cost more, and availability has to be checked with manufacturers.

Motors shall have a service factor of 1.0.

Motor voltage characteristics shall be as indicated under Section 21.1 – Utilization Voltage.

Motors 50 HP and above shall have built-in space heaters with thermostats rated at 120V, 1∅, and are to be controlled by a normally closed auxiliary contact of the motor starter. Power for the space heater may be from the Control Power Transformer in the starter or from the lighting panel.

Medium voltage motors shall be specified with terminal boxes of adequate size to accommodate lightning arrestors and surge capacitors in addition to cable terminations.

Motors and pumps of the highest efficiency available in their capacity range shall be specified.

The minimum motor horsepower requirement shall be determined by the Consultant and given in the Specifications. However, the pumping unit, including the selection of a proper size motor (the motor should not be overloaded at any point along the pump performance curve) shall be specified to be the responsibility of the pump manufacturer. This shall also include any variable speed devices in case of variable speed drives.

Acceptable Manufacturers: Continental, General Electric, Ideal, Teco-Westinghouse, or U.S. Motors.

6.3 Spare Parts and Special Tools

The following spare parts and tools shall be specified to be furnished for pumping units of each size:

One set of pump bearings including thrust bearing
One set of pump sleeves
One set of impeller and case wear rings
One set of motor bearings
One set of packing gland bolts
and One set of any special tools necessary.

The above spare parts list is for constant speed pumps. If variable speed pumps are used, the list shall be enlarged to include spare parts recommended by the manufacturer of the variable speed system. (Additional spare parts required shall be spelled out.)

6.4 Selection of Pumps

Pumps shall be selected to provide firm capacity to meet emergency and peaking demands of service area system.

Economical selection requires that attention be given to:

1. The normal pumping rate and also the minimum and maximum rate that the pump will be called on to deliver.

2. Total head capacity to meet flow requirements.

3. Net Positive Suction Head (NPSH available must exceed NPSH required.)

4. Pump characteristics, including speed, number and spatial, environmental, and other special requirements.

5. Possible cavitation and vibration problems.

The proper pump must be selected to suit the system conditions. For booster stations with pumped storage, it is desirable that the pressure in the piped water distribution system remain as much as possible, constant, regardless of the demand on the system. When constant speed pumping units are used, pumps with flat (as opposed to steep) Flow vs TDH performance curves best achieve this condition. However, an extremely flat pump curve may result in an unacceptable large number of start and stop cycles because the flatter the pump performance curve, the more rapid is the approach towards "shut-off" as system demand is reduced.

Pumps that have an operating point at or near their peak efficiency should be selected. Emphasis on efficiencies is increasing because of high energy costs. Therefore, in order to have pump capacities close to demand (for good efficiency), installation of pumps large enough to handle present and future flows, but with smaller impellers originally which can be replaced by larger impellers as demand grows, may have to be considered.

Other factors previously outlined must also be considered in selecting from the multitude of options available, but meeting the system discharge requirement at reasonable efficiency is paramount. As far as possible, pumps of the same capacity shall be selected.

System head curves, with the pump (pumps) characteristics curves superimposed, showing operating points, and pump performance curves showing range and efficiencies shall be submitted for review and approval.

7.0 SURGE ANALYSIS

Hydraulic transient problems shall be analyzed in detail and surge control measures shall be incorporated in the design, as dictated by the results of the analysis.

One of the elements for control of transients is an automatic pump control valve (plug valve) hydraulically operated. The criteria for incorporating such a valve on the pump discharge shall be as follows:

1. In-Line Booster Stations

   Hydraulically operated, automatic pump control valve shall be installed:

   a. if the results of the surge analysis dictates the need for such a valve or

b. if the total dynamic head (TDH) of the pumps exceed 175 feet.

2. Booster Stations with Pumped Storage

Hydraulically operated automatic pump control valve shall be installed:

a. if the results of the surge analysis dictates the need for such a valve

or

b. if the total dynamic head (TDH) of the pumps exceed 150 feet.

If the surge analysis does not dictate the need for an automatic pump control valve and the total dynamic head of the pump is below 150 feet, a spool piece to accommodate the possible future installation of a hydraulically operated plug valve shall be incorporated in the design.

8.0 PUMP STATION PIPING AND VALVES

8.1 Piping

1. Suction and discharge piping shall be designed to minimize head loss and turbulence.

2. Suction and discharge headers shall be located outside the pumping station.

3. Interior station piping and fittings (supply, discharge, and drain piping) shall be cement mortar lined ductile iron. Exposed pipes shall be jointed by means of flanged connections or flexible couplings. Wherever a pipe passes from a concrete structure to earth, a push-on or mechanical joint or a flexible coupling shall be installed within three feet of the structures. Valved drain outlets shall be installed in the header loop system for maintenance drainage.

4. Couplings of the dresser type shall be installed on the suction and discharge piping, so that the pumps or valves can be easily removed. Coupling shall have joint harnesses. See piping schematic on Drawing DG-02-1 for preferred locations of couplings.

5. At booster stations with pumped storage, piping inter-connections to recycle the stored water in order to obtain desired residual chlorine levels in the stored water shall be provided.

8.2 Valves

1. Pumping Units

The normal valve arrangement for pumping units shall be as follows:

Inlet Side

Butterfly valve, Class 150B, rubber seated, flanged and conforming to the latest revision of AWWA C504 with handwheel, for isolation (with gear operators for valves sized 8 inches and larger).

Acceptable manufacturers: CMB Industries, DeZurik, Henry Pratt, or Olson Technologies.

Discharge Side

a. Swing check valve of the outside lever and weight type.

Acceptable manufacturers: American Flow Control, Apco-Willamette, GA Industries, Val-Matic.

b. Automatic Pump Control Valve

The function of this valve is for waterhammer control. For criteria for including such a valve on the pump discharge side, see Section 7.0 – SURGE ANALYSIS.

This valve shall be a hydraulically operated, flanged eccentric plug valve consisting essentially of a semi-steel body, non-lubricated type with rubber faced eccentric plugs, nickel alloy steel seat, permanently lubricated stainless steel upper and lower stem bushings, plug operating mechanism consisting of an enclosed gear quadrant attached to the plug shaft, a toothed steel rack, hydraulic cylinder with piston and three limit switches (one for fully open, one for fully closed and one momentary break on valve closure). The design of the valve shall be such that it can be repacked without removing the valve bonnet.

The hydraulic operating cylinder shall be of the size required to permit opening and closing the valve under the worst condition maximum unbalanced differential pressure across the valve and with available pressure to the cylinder at only 40 psi. Metallic parts to be in contact with water shall be stainless steel or bronze. The cylinder shall be vertical and the plug stem horizontal.

Acceptable Manufacturers: DeZurik, Val-Matic, Victaulic

The valve is to operate in conjunction with its respective pump motor, and a complete control system especially designed to perform the control and operating functions described below shall be provided. All control valves and other devices associated with a particular valve (except certain remotely located devices) shall be located adjacent to the valve on a floor mounted panel.

For discharge valve control schematic and details, see Drawing DG-02-2.

Water for the operation of the valve is to be taken from the discharge side of the pump ahead of the check valve and also from the system side of the pump control valve. Pressure piping complete with check valves, ball valves, strainers and unions shall be provided from the two sources to the pump discharge valve control panel.

For normal opening and closing, the hydraulically operated plug valve shall be controlled by means of a 3/4" four-way valve, suitable for unlubricated water service and piped exhaust, Valvair No. M110-646-19 or equal. The four-way valve shall be positioned by means of two three-way solenoid pilot valves, Skinner V53 DB 2150, one being normally closed. Operating coils shall be heavy duty molded (water-tight) for continuous operation on 120V 60 cycle current.

The solenoids shall be connected by moisture, heat and oil resistant flexible cords that plug into a duplex receptacle wired to the pump control system and located on the valve control panel.

The timing for opening and closing of each plug valve shall be readily adjustable and independent. During the entire time that a pump unit is running, its plug valve shall be held in the full open position by the normal hydraulic control.

The speed of opening and closing of the plug valve shall be readily adjustable over a wide range by means of Pneutrol needle valves at the output side of the 4-way control valve, so that the most satisfactory speed can be determined by trial.

The control system of the discharge valve shall be sufficiently complete and capable of performing the following functions:

For operating during the starting period of the pump, the valve shall open slowly, starting its cycle only after a time delay relay has allowed the pump motor to reach its running speed. The timer shall be so set that the valve does not begin its opening cycle until approximately 15 seconds after the pump motor starts. For each of the valves this time delay shall be readily adjustable over a range of 0-1 minute to permit changing of initial time delay setting to secure the most satisfactory performance of this function.

Also, during the starting period, in the event that the valve has not reached the fully open position within a preset time after the pump motor has started, the pump motor control circuit shall be interrupted to cause the pump to stop and remain locked-out until the abnormal condition (incomplete sequence) is corrected and the controls manually reset. This timer shall be adjustable over a range of 0-10 minutes.

For pump shut down, the valve control circuit shall be first actuated causing the valve to move toward the closed position. When the valve has reached the practically closed position, the pump motor circuit shall be interrupted by a momentary break limit switch (furnished with and mounted on the valve) and the pump motor shall stop. In the event the valve has not reached the fully closed position within a preset time after initiation of the close signal, the motor shall be stopped and locked out similar to the incomplete sequence shut down during starting.

The equipment furnished shall be such that when a pump starts the two three-way solenoids are energized to position the four-way valve. The equipment furnished shall include limit switches, solenoids, and all control devices (except the electrical time delay relays). Limit switches shall function as described under Section 23.0 - CONTROLS AND INSTRUMENTATION.

Manual control of the hydraulic valve shall be provided as indicated on the piping schematic. It shall consist of a four-way manual valve for open/close control in the circuit bypassing the solenoid controlled four-way main control valve. Isolating valves (normally kept closed ball valves) shall be provided in this circuit, as shown on the schematic.

c. Butterfly valve for isolation (with gear operators for valves 8-inches and larger).

2. Venturi Meter, Influent Line, Reservoir, Etc.

Butterfly valves at appropriate locations shall be used for isolation of the Venturi meter, influent line, and/or reservoir.

3. Reservoir Fill Valve

In the case of "booster stations with pumped storage", a reservoir fill valve is needed in the fill line to open and refill the reservoir when the water level drops and to close when the reservoir is full and prevent overflow.

This valve shall be a motorized cone valve complete with limit switches for open and closed indications as well as pump start permissives. For control schematic, see Drawing DG-02-14. In general, the functional requirements of the reservoir fill valve control system shall be as follows:

a. Local open-close.

b. Remote manual open-close from Hyattsville Control Room when the Selector Switch is in the Auto mode.

c. In the auto position, it shall be possible to open the valve remotely only if the reservoir is not full, there is no overflow, the valve has not closed because of low pressure at control points, and pumps are not called to run automatically.

d. Once opened, the valve shall continue to fill the tank and automatically close if the center frequency is lost (after a time delay), if low pressure exists at any control point (after a time delay), when the tank is full, if the reservoir overflows, or if pumps are called to run.

The amount of opening of the valve and thus the filling rate will be set by adjustment of the "open" limit switch position, based on operating experience.

If cavitation in the fill line is a potential predictable problem, cavitation control measures shall be adopted. See Section 8.3 - Cavitation. The control of the reservoir fill valve, however, shall remain essentially the same.

4. Other isolating valves, pressure control valves, etc., shall be provided, as required, with all necessary accessories, depending upon the function of the pumping station in the system and the connection to the system. Requirement of such valves shall be decided on case-by-case basis.

8.3 Cavitation

Possible cavitation problems in the fill line to the reservoir down stream from the reservoir fill valve during reservoir filling shall be investigated and if cavitation is a potential predictable problem, cavitation control measures shall be incorporated in the design to eliminate or reduce significantly cavitation and its attendant effects - slow destruction and high noise levels.

Cavitation charts of valve manufacturers also may be used to check if cavitation can occur under the inlet and outlet pressure conditions during maximum flows that can occur through the valve size chosen.

Of the different methods currently utilized for cavitation control, viz:

butterfly valves with expansion chamber

cone valve with energy dissipation assembly

Roto-disc valve with pressure reducer (HITCO)

multiple valves in series to step down pressure in stages, etc.

a cone valve with energy dissipation assembly is preferred.

9.0 ORIENTATION OF VALVES

The following criteria shall be applied for the orientation of plug valves, and shall be clearly indicated on drawings and specified.

1. The rotation of the plug shall be about a horizontal axis.
2. The plug shall store in the top when the valve is open.
3. The valve shall be oriented such that the seat is opposite the high pressure side; that is, towards the pumps.

10.0 FLOW METERING

In the case of "in-line booster stations", the station discharge flow shall be metered with a one-way Venturi type flow meter; and in the case of "booster stations with pumped storage", both influent and discharge flows shall be metered with a two-way Venturi type flowmeter. The influent flow indication would be helpful in positioning inlet control valve on the fill line to the reservoir to get any desired rate of flow.

Station discharge flow indication is required at the pumping station and also at the Hyattsville Control Room. For transmission to Hyattsville, the flow element shall be connected to a flow transmitter (non-mercury type) capable of producing a time pulse signal proportional to the flow, and compatible with the receiver.

For flow instrumentation and control requirements, see Section 23.0 - CONTROLS AND INSTRUMENTATION.

11.0 CHLORINATION FACILITIES

11.1 GENERAL

Chlorination facilities for disinfection, when required, shall be located in a separate room adjoining the pump operating room.

For "in-line booster stations", the chlorination shall be automatic; and for "booster stations with pumped storage", a manual system is considered adequate. However, the need for chlorination facilities and mode of operation shall be checked with WSSC, before start of design.

For layout of the chlorination facility, mode of operation, controls, major components, heating and ventilation, safety requirements, etc. refer to Mechanical and Electrical Design Guidelines for Chlorination Facilities (under preparation at this time).

12.0 STATION DRAINAGE

All station interior and footing drains shall be drained to natural drainage. If there is a reservoir and if elevations permit, these drains shall connect to the reservoir overflow for discharge to the storm drains.

If gravity drainage is not feasible from the pumping station because of the location and elevations, the pumping station drains shall be led to an adequately sized drain sump and pumped out. There shall be two close-coupled, submersible sump pumps. One of the pumps shall be sized for the normal expected drainage flows and shall have built-in float switch for on-off control. The other pump shall be sized for four or five times the normal flow.

A pressure tube type flood sensor - Vigiltrol by Autocon or equal - shall be located at a suitable point near the sump, on the pump floor to start the large sump pump, to transmit station flooding alarm via telemetering to the Hyattsville Control Room, and to stop all pumps (if considered necessary).

In the case of "booster stations with pumped storage", reservoir overflow shall also be annunciated at Hyattsville Control Room as an alarm.

13.0 RESTROOM FACILITIES AND WASTEWATER

A toilet consisting of a water closet, tissue dispenser, lavatory and a combined towel dispenser and waste receiver shall be provided. Hot water is not considered necessary.

Toilet and other sanitary drain wastes shall be separately piped to local sewers if they exist, or to a small septic tank to be constructed near the pumping station.

14.0 SECURITY

All door locks are to be keyed to the WSSC system. Fencing is to be limited to the net area that requires security.

15.0 SAFETY

15.1 Fire Extinguishers

Fire extinguishers of 20 lbs. capacity, suitable for Class A, B and C fires and U/L listed shall be wall mounted at strategic and easily accessible locations (near doors) in the following areas:

Pump Room-upper level	2 nos.
Generator Room (as applicable)	1 no.
Chlorine Room (as applicable)	1 no.

15.2 First Aid Kit

One first aid kit each (10 unit) in a prefinished steel cabinet wall mounted shall be provided in the pump room - upper level, in the generator room (as applicable) and in the chlorination facility (as applicable). The items in the kit shall be as follows:

2 Units	Adhesive Bandage 1"
1 Unit	Bandage Compress 4"
1 Unit	Bandage Compress 2"
1 Unit	Plain Absorbent Gauze 2"x2"
1 Unit	Eye Dressing (no ointment)
1 Unit	Zephiran Swabs or Methiolate Swabs
1 Unit	Triangular Bandage
1 Unit	Ammonia Inhalants
1	Tweezer

16.0 PAINTING

Painting inside the pumping station - pumps, pipes, conduits, etc. - shall conform to the Standard Specifications Section 09900 and Standard Procedure "Pumping Station Water Oper. 82-05".

17.0 MISCELLANEOUS

Hose bibs shall be provided on the interior of the station for cleaning, and wall hydrants (3/4-inch freeze-proof type) shall be provided on exterior walls, one on each side, for maintenance of landscaping.

A regular business phone shall be provided for Operations and Maintenance use.

18.0 HEATING AND VENTILATION

Adequate heating and ventilation for the comfort of operating personnel and for the safety of the equipment shall be provided.

18.1 Ventilation

For the pump room, storage area and toilet, forced ventilation of at least six air changes per hour shall be provided (from "Recommended Standards for Water Works" - A report of the Committee of the Great Lakes - Upper Mississippi River Board of State Sanitary Engineers - 2003 edition).

Air intake shall not be near the chlorine room exhaust, if there is a chlorination facility attached to the pumping station.

For storage and toilet areas, separate intake louvers for outside air may not be needed; infiltration and pull air from pump room may be adequate.

A small centrifugal exhauster fan shall be installed in the restroom area.

For the generator room (as applicable), in addition to the normal ventilation, ample flow of air to support combustion and to dissipate the heat produced in the combustion process of the diesel engine shall be provided. Design shall be based on air requirements for the size of generator set being used.

Ventilation system noise levels shall be taken into account in determining the overall property line noise levels.

18.2 Heating

Electric heat is preferred. Heating design shall be based on ASHRAE HANDBOOK - 2005 Fundamentals. Use winter outside temperature of 10°F and winter inside design conditions of 50°F. Heating load for each area shall be arrived at by a space load analysis.

18.3 Chlorine Room Ventilation

See Mechanical and Electrical Design Guidelines for Chlorination Facilities (under preparation at this time).

19.0 EXTERIOR PIPING AND VALVES

The piping configuration and valving required will depend upon the location and connection of the pumping station to the water supply system and has to be determined on case-by-case basis.

Buried valves or fittings shall not have flanged ends.

20.0 NOISE CONTROL

Guidelines for the Design of Noise Control in Facilities of the Washington Suburban Sanitary Commission, revised July 1977, establish the property line goals to "ensure compliance with applicable regulations and to minimize the impact on existing noise environment where such impact could affect the public health and general welfare". Goals related to achieving this compliance are given in the following table:

WSSC PROPERTY LINE NOISE CONTROL GOALS

Zone	Maximum Daytime Levels (7am to 10 pm)	Maximum Nighttime Levels (10 pm to 7 am)*
Residential	55 dBA	50 dBA
Commercial	62 dBA	62 dBA
Industrial	62 dBA	62 dBA

Note: Ambient conditions may require more stringent goals.

*Maximum levels for noise containing pure tones, hums, whines, or impulses of a periodic character shall be 5 dBA below values listed in the table.

Workplace noise control goals were established to ensure that WSSC personnel are not subjected to hearing damage risk and that noise levels in work environments are compatible with work activities. Goals related to achieving workplace compliance are given in the following table:

WSSC WORKPLACE NOISE CONTROL GOALS

Workplace Activity Description	Noise Goal	PSIL*
Machinery operation and maintenance	85 dBA	----
Noisy environment with speech communications required	85 dBA	72 dB

*PSIL is speech interference level equal to the average of the noise levels in the 500, 1000 and 2000 hertz octave bands.

Source of noise for exterior control are the air intake and exhaust louver systems, generator exhaust, influent control assembly and pump operations. Noise control worksheets shall be completed and submitted for review documenting noise control design data and calculations.

Twenty-four hour ambient sound level recordings shall be specified to be made at the site prior to starting construction to document existing noise levels, and following construction when the station is operating.

21.0 ELECTRICAL SERVICE AND DISTRIBUTION

21.1 Utilization Voltage

Selection of the utilization voltage shall be made based on economical considerations taking into account the horsepower of motors, total load, future growth, and the class of service available from the power company.

Assuming that a pumping station may consist of three or four pumps, as a general guidance, for a station with motors up to 200 HP, a 480V system may be used; and for stations with motors over 200 HP, a 2400V system or a 4160V system may be used. Consideration has to be given to reduced voltage starting of motors to reduce inrush currents to levels acceptable to the power company or to limit the size of standby emergency power generator as the case may be.

21.2 Power Supply Reliability

If power failure would result in cessation of minimum essential service, power supply reliability shall be assured by either a second reliable power feed from the power company or by the installation of an on-site standby generator. Whether minimum essential service can be maintained in the area served by the pumping station during the length of time normally associated with power outages from other sources would depend on system interconnections, available storage, etc. These factors shall be analyzed to determine if standby power is essential.

<u>Dual Feeders</u>

For dual feeders from the power company, the following criteria shall apply:

> The two feeders shall be from non-adjacent bays at the power company's substation. The two feeders shall follow separate routes so that chances of simultaneous disruption of power will be minimized.
>
> The feasibility, reliability, and cost of a second feed shall be carefully evaluated and compared with the cost of on-site generation and the better alternate shall be chosen, with the concurrence of WSSC.

21.3 Standby Generator

The generator shall be sized to start and operate the pumps required for firm capacity plus the miscellaneous station loads. Lock-out of the last or standby pump shall be provided in the control system, if other pumps required for firm capacity are running, when on generator power. The interlock shall allow the last or standby to run if any other pump should fail.

The standby generator shall be diesel-driven. The engine shall be of the general purpose, stationary solid injection 4 cycle, compression ignition type. Radiator cooling is preferred as opposed to city water cooling.

Maximum speed of the engine shall not exceed 1800 RPM. The generator shall be of the self regulated type utilizing a brushless excitation system. All accessories needed for proper operation of the set shall be provided. These shall include a hospital type muffler, flexible exhaust connection, vibration isolators, starting battery, battery charger, day tank fuel transfer system, gauges, jacket water heater, antifreeze, underground fuel storage tank with a capacity to sustain full load operation of the generator for two (2) days, engine generator control panel, generator output circuit breaker and automatic transfer switch.

Engine generator control panel shall include automatic-manual-off switch to permit testing of engine, voltmeter and ammeter with selector switches, frequency meter and running time meter, exciter circuit breaker, automatic voltage regulator, oil pressure gage, coolant temperature gage, solid state engine monitor with fault lights to indicate engine shutdown for overcrank, overspeed, high coolant temperature and low oil pressure.

The day tank shall include a hand operated pump in addition to the standard electrically operated pumps.

The transfer switch controls shall be solid state, mounted on keyed, plug-in printed circuit boards.

Accessories shall include:

- adjustable close differential voltage sensing on all phases of normal source
- adjustable time delay (0-5 min) on engine starting
- adjustable time delay (0-5 min) on transfer to emergency source
- adjustable time delay (0-30 min) on transfer to normal source

Adjustable time delay (0-5 min.) unloaded running time delay for cooldown

Normal and emergency position indicating lights.

The transfer switch shall conform to NEMA and UL 1008 and shall be inherently double-throw and mechanically interlocked so that it is either in a normal or emergency position; no neutral position shall be possible.

For heating and ventilation, see Section 18.0 – HEATING AND VENTILATION.

Noise criteria given in Section 20.0 – NOISE CONTROL shall be considered in sizing and selecting air intake and exhaust louvers.

Spare Parts and Special Tools

The following spare parts and tools shall be specified to be furnished with the standby generator set:

One set of special engine tools

Two spare lube oil filters

One spare filter (if dry type)

Acceptable Manufacturers

Generator Set – Caterpillar, Kohler, or Onan

Auto Transfer Switch – Onan or Russelectric

21.4 Power Company Metering

The power company billing metering shall be located outside of the pumping station, in a tamperproof and weatherproof enclosure as required by the power company, to facilitate meter reading. Location of the C.T.s and P.T.s when required shall be as per power company requirements and shall be coordinated with the power company.

21.5 Interphasing with the Power Company

All necessary interphasing with the power company serving the area shall be done by the Consultant, from the start of the job. The final submission of construction documents shall include a letter from the power company that they have reviewed the portions of the electrical service of interest to them and that it meets with their approval. A detailed cost estimate for the service shall also be obtained from the power company.

The Consultant shall keep the WSSC advised of the progress of their interphasing with the power company by copies of letters, minutes of meetings, etc.

21.6 Power Distribution

1. Utilization Voltage of 480V

Power distribution within the station shall be through a double ended motor control center. Pumps and other loads shall be divided as equally as possible between the two sections of the motor control center. Vital loads like lighting and control power shall be capable of being connected automatically through an auto-transfer switch to either half of the motor control center. Bus shall be copper.

For one-line diagram with one feed from the power company and standby emergency generator see Diagram 1 on Drawing DG-02-3. The tie breaker in this arrangement will be normally kept open.

For one-line diagram with two feeds from the power company, see Diagram 2 on Drawing DG-02-3. The tie breaker, in this arrangement, will be normally closed and one of the two incoming line main circuit breakers (selected as the normal or preferred source) will be closed. The two main circuit breakers shall be electrically operated and an automatic throw-over control shall be provided for automatic transfer to the second source, if the preferred source fails and for automatic return to the preferred source on restoration of the preferred source.

Generally, it is difficult to get two services at 480 Volts which can be paralleled from power companies, especially for small loads, and hence the above arrangement is suggested.

It shall be possible by means of a selector switch to select either of the two lines as the preferred source.

The compartment for power company metering shall comply with the power company requirements.

A preferred motor control center layout is shown in Diagram 3 on Drawing DG-02-3. This layout will generally be the same for one feed from the power company and a standby generator or for two feeds from the power company, except for differences in the width and depth of the incoming sections because of the location of the power company metering C.Ts and P.Ts at the motor control center. (The meters are to be located outside the pumping station in both cases.)

The main incoming line circuit breakers shall be of the insulated case type with current monitors and solid state tripping devices with adjustable settings for continuous current, long time delay, short time delay, ground fault trip, and fixed instantaneous trip. All trip devices shall have trip indicators.

All circuit breakers shall have external handles which clearly indicate when breaker is 'ON', 'OFF', or 'TRIPPED' and lockable in the 'OFF' position.

The interrupting rating of all circuit breakers and bus bracing shall be adequate for the available fault currents.

For the pumps, one separate vertical section per pump, housing the branch circuit breaker, starter, individual pump controls, indicating lights, etc. is preferred. All indicating lights shall be of the push-to-test type.

The pump motor branch circuit breakers shall have auxiliary contacts for use in the control circuitry (see pump control schematics).

The lock-out relay (device 86) shall be of the hand reset type.

Size of the control power transformer in starter shall be coordinated with control power requirements, heaters, etc.

Spare Parts and Special Tools

The following spare parts and tools shall be specified to be furnished with the motor control center:

one spare closing device for electrically operated breakers (spring charging motor, solenoid, etc)

one manual closing handle

one standard carton of indicating lamps

two spare indicating lamp assemblies

six spare fuses of each amperage used

one spare relay of each type used.

one coil for contactor of motor starter of each size

one set of contactors for motor starter of each size

Acceptable Manufacturers: Square D, Autocon, Allen-Bradley.

2. Utilization Voltage of 2400V or 4160V

If the horsepower of the motors, total load and future possible growth indicate the need for 2400V or 4160V as the utilization voltage, a substation to step down the power company's distribution voltage available in the area to the utilization voltage would be needed.

A power distribution one-line diagram of a 13.8KV-2400V or 4160V substation and motor control center is shown in Drawing DG-02-4. One-line diagram of a substation with a primary voltage of 13.8KV is included here, as a distribution voltage of 13.8KV appears to be more common especially in areas where booster pumping stations are likely to be built.

The substation is to be located outside the pumping station at the most suitable location. Metalclad switchgear with drawout type power circuit breakers in outdoor walk-in enclosures is preferred as they are easy to install, are less susceptible to problems due to bad weather, and for aesthetic reasons.

The one-line diagram and the protective relaying scheme shown represents the preferred arrangement from a reliability point of view. This scheme assumes that two feeders can be paralleled on the secondary side of the transformers. Normal operation would be with both the primary breakers, both the secondary breakers and the secondary tie breaker closed and the automatic reclosing scheme in service. The tie switch on the primary side would be open.

In the one-line diagram, the transformer secondary main breakers and secondary tie breaker are shown to be located in the outdoor metalclad switchgear. This arrangement has two main advantages.
1) The width of the balcony area for the motor control center can be considerably reduced - by approximately five (5) feet.
2) Control and protective relay wiring for the substation can be confined to the outdoor switchgear and need not run back and forth between the switchgear and the motor control center and the entire switchgear can be factory wired and tested for proper operation at the factory before shipment.

However, other physical arrangements like locating the secondary breakers at the motor control center have to be considered and the best arrangement depending on site conditions shall be chosen on a case-by-case basis.

The power company serving the area is to be consulted to ascertain if paralleling on the secondary side would be permitted. If paralleling will not be permitted, the scheme shown on Drawing DG-02-4 has to be suitably modified, incorporating an automatic transfer scheme satisfactory to the power company.

The power circuit breakers shall be D.C. close and D.C. trip. The primary breakers shall be provided with D.C. undervoltage release, so that in case D.C. voltage fails or falls below a safe value while the breaker is closed, the breakers would open. This coil should have as low a VA burden as possible.

An emergency trip pushbutton shall be provided at the motor control center inside the pumping station for remotely tripping both the incoming primary breakers. This trip pushbutton shall be protected from accidental operation, preferably by installing it in a recessed pocket.

The switchgear for each incoming line shall be in a separate enclosure and each line up shall be separated at least by six feet to minimize chances of a common mode failure. The front isle space in the walk-in enclosures shall provide sufficient space to permit the passage of two breakers side by side (not less than six (6) feet).

The surface of the concrete pad for the switchgear and transformers shall be so sloped that water does not stagnate and cause deterioration of the bottom plates. Also, as the actual pad sizes and reinforcement (to some extent) may vary with the equipment actually furnished, coordination of pad sizes and design have to be done by the Contractor before pads are poured. These shall be clearly indicated on the drawings.

Automatic Reclosing Scheme

An automatic reclosing scheme (if permitted by the power company) shall be designed to automatically reclose the incoming primary and the secondary breakers of either line up, on restoration of power in either line after the secondary and primary breakers trip on reverse power for a fault in the power company line. Reclosing shall take place only after a time delay (adjustable) after the power company successfully re-energizes the line. Reclosing shall be inhibited for any fault within the substation. Operation of any lock-out relay shall automatically change the control transfer device 43 to the manual position to prevent auto-reclosing when lock-out relays are reset. Auto reclosing shall also be inhibited if breakers are tripped manually.

D.C. Battery System

The battery shall be properly sized based on the continuous load current (indicating lights, relays, annunciator, etc.) and the largest instantaneous current to be supplied. Battery discharge time shall be 24 hours. The battery charger shall be sized to recharge a completely discharged battery within 24 hours. The battery charger shall be of the two rate (float and high rate) constant potential type, with automatic charging control, D.C.

voltmeter, D.C. Ammeter, AC-On and High Rate indicating lamps, A.C. input breaker, D.C. output breaker and other standard features. In addition, the charger shall be provided with the following, plug-in, failsafe accessory circuits:

1. A.C. failure alarm relay
2. D.C. low voltage alarm relay
3. D.C. high voltage alarm relay
4. Rectifier failure alarm relay
5. High rate charging alarm relay
6. Ground detector alarm relay.

All these alarms should have local visual indications.

The battery shall be located in a well ventilated area inside the outdoor switchgear enclosure away from the front isle space. Equipment should not be located on the rear wall space occupied by the length of the battery rack. The battery should be so placed that there is free access to any battery cell.

Alarm circuits are to be provided for signalling to Hyattsville the following abnormal conditions:

Any abnormality in the D.C. system, listed under battery charger (D.C. Trouble)

Open position indications for the two incoming line breakers and secondary tie breaker

Motor Control Center

The motor control center line up shall include incoming disconnect switches (quick make, quick break, load interruptor type) (or circuit breakers), bus tie switch (or circuit breaker), high voltage starters with draw-out type contactors and current limiting power fuses (or circuit breakers), relays, metering, etc., as indicated on the one-line diagram. Bus bars shall be copper.

The step-down transformer for station auxiliaries shall be capable of being fed from either side of the motor control center. The contactors shall be electrically interlocked so that only one contactor can be closed at one time. Controls shall provide for automatic transfer of the transformer feeder from one bus to the other, if voltage fails on the bus to which it is connected normally. Indicating lights for open (green) and closed (red) positions and open-close switches shall be provided for each contactor.

Motor protection shall include as a minimum, thermal overcurrent, with instantaneous unit (49/50) ground overcurrent (50G) and phase sequence and undervoltage (47). Bearing temperature protection shall be included for motors 500 HP and above. Medium voltage motors rated 500 HP and above shall also be provided with lightning and surge protection. The surge arrestors and capacitors shall be located as close to the motor as possible, preferably in the terminal box, which has to be adequately sized for this purpose. Single phasing protection and mechanical interlocks to prevent the opening of the isolating switch when the contactor is closed and other required safety interlocks shall be incorporated in the contactor. Provision shall be made for plugging in an auxiliary test source for checking the operation of the contactor and the low voltage pilot circuits, when the contactor is in the test or drawn out position.

Sufficient space shall be provided in front of the motor control center for taking out the contactors.

One vertical section per pump housing the contactor, fuses, individual pump controls, indication lights, etc., is preferred. The common pump control and telemetering panels in free standing unitized sections shall form an integral part of the motor control center.

3. Short Circuit and Protective Device Coordination Study

Fault current calculations shall be made by the Consultant to arrive at the proper ratings for the sensing and interrupting devices used in the electrical system. This shall be done for low voltage and medium voltage systems as applicable and shall be submitted for review.

In addition, for medium voltage installations and for low voltage installations where power circuit breakers with relaying is used, a short circuit and protective device coordination study shall be specified to be done by the Contractor through an engineering firm specializing in such work. Changes and additions to devices and equipment characteristics suggested by the results of the study and recommended have to be incorporated in the electrical equipment to be furnished at no additional cost to WSSC. Therefore, it is important that the study be done and approved before shop drawings for electrical equipment are submitted.

For low voltage installations with molded case circuit breakers only, this short circuit and protective device coordination study is not required.

4. Power Factor Improvement

The average power factor at full load of motors 75 HP and above (1200 RPM) is around 85 percent. Therefore, power factor correction, generally may not be necessary.

However, current data on power factor shall be obtained from motor manufacturers and the need for power factor correction looked into. Should power factor correction be considered necessary to avoid KVAR demand penalty charged by power companies, power factor improvement shall be limited to 95 percent lagging at full load.

5. Identification of Equipment, Devices, and Wiring

All equipment, devices, and wiring in the motor control center and pump control panel (and substation where applicable) shall be specified to be suitably identified.

Engraved nameplates shall be provided for each vertical section, for each device mounted on the front and for each relay, control device, etc. mounted inside for easy identification of all components.

Each control and instrumentation wire and cable should have a unique identification number. This number shall be assigned to all conductors having common terminals and shall be specified to be shown on shop drawings. These numbers shall appear within three inches of the conductor terminals. Pump No. 1 shall have 100 series number, Pump No. 2, 200 series numbers, etc. The method of identification shall be either imprinted plastic coated cloth by Brady or Thomas and Betts, imprinted heat shrink tubing or imprinted split sleeve markers cemented in place.

Multiconductor cables shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub up locations beneath free standing equipment. The cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall all be identified at pull points as described above.

6. Conduits, Wiring, Etc. - General

Embedded conduits for pump motor branch circuits shall be oversized so that conductors two sizes bigger can be used later for limited upgrading of pumps.

Conduits inside the chlorine room shall be PVC coated rigid galvanized steel.

Empty conduits for future use in floors shall be terminated in a conduit coupling with threaded plug flush with the finished floor. See conduit termination detail for future equipment on Drawing DG-02-13.

22.0 STATION LIGHTING

Station lighting shall be designed for sufficient levels of illumination for the various areas. The following illumination levels are recommended:

Storage and Rest Rooms	20 fc
Pump Room	30 fc
Chlorine Room	
Storage Areas	30 fc
Chlorine Panel/Feed Area	50 fc
Motor Control Center Area	50 fc
Generator Room	30 fc
Building Entrance	5 fc

Lighting fixtures shall be located to facilitate relamping and maintenance.

Energy efficient light sources shall be used.

Switching shall enable sectional control for partial illumination.

Exterior lighting shall be designed to provide adequate lighting at doorways and substation/transformer areas. Control shall be automatic with manual override. Fixtures shall be vandalproof.

Battery operated emergency lights shall be provided for safe egress at strategic places in the station. As a minimum there shall be at least one at the pump floor, two at the pump room upper level near the exits, one in the generator room (and one in the chlorine room).

Exit lights shall be provided as required.

23.0 CONTROLS AND INSTRUMENTATION

23.1 General

The booster pumping stations will normally be unattended and shall operate automatically to maintain distribution system pressure, flow or level or a combination of these as the case may be depending upon the function of the pumping station in the system.

The station operation is to be monitored at and controlled from the Hyattsville Control Room through a supervisory control system, using telemetering over leased telephone lines.

23.2 In-Line Booster Stations

As these types of stations pump into a distribution system with elevated storage tanks, the primary control shall be level control. Levels in elevated storage tanks shall be transmitted by telemetering to the pumping station. If level sensing (primary control) is lost due to communications failure, the pumping station shall operate on local pressure sensing point at the pumping station discharge line which is not dependent on telemetering (secondary control). Level control schematic is shown on Drawing DG-02-7.

23.3 Booster Stations with Pumped Storage

As these types of stations pump into the distribution system when the pressure in the distribution system, normally fed from the system main falls, the primary control shall be pressure control. From remote pressure sensing locations, system pressure shall be transmitted by telemetering to the pumping station. If remote pressure sensing (primary control) is lost due to communications failure, the pump station shall operate on local pressure sensing point at the station discharge line which is not dependent on telemetering. Pressure control schematic is shown on Drawing DG-02-8.

In some cases, where the pumps are of different capacities, it may be necessary to use pressure control to start the first pump and then resort to flow control to call in subsequent pumps.

23.4 Pressure Sensor Locations and Vault

System pressure sensor locations shall be chosen such that localized transient gradient fluctuations which are not reflective of the overall system hydraulic gradient condition are avoided. Choice of the best location may have to be made based on hydraulic analysis results.

Easy accessibility to the pressure sensor vault location is also an important consideration. The vaults shall be located near existing roadways (away from residential front yards) or suitable access road shall be provided.

Where possible the vault should be built with the top of the slab slightly above grade.

The vault shall be of reinforced concrete construction complete with access hatch, vent pipes, ladder, sump, etc., and shall be sized to house all the components required viz:

1. Circuit breaker load center (240/120V, 1Ø, 3W with main breaker and six 1P, 15 Amps branch circuit breakers in NEMA 3R enclosure).

2. Telemetering cabinet (with power supply, line protector and three FS transmitters - one transmitter for pressure to the pump station, and one transmitter for pressure and one transmitter for flood alarm to the Hyattsville Control Room).

3. Pressure gauge and pressure transmitter.

4. Sump pump with union, check valve and gate valve.

5. Flood alarm switch.

6. Ventilating fan.

7. Lights (wall mounted).

The vault shall be membrane waterproofed. Pressure sensor vault details are shown in Drawing DG-02-12.

Meterbase and service disconnect (circuit breaker) shall be mounted on service pole in case of overhead electrical service and on a pedestal in case of underground electrical service. The service disconnect circuit breaker shall be mounted in a lockable NEMA 4 stainless steel enclosure. Service pole or service pedestal shall be located approximately 10 feet from the vault. Location and other requirements shall be coordinated with the power company. The same pole or pedestal shall also be used for telephone service. Service conduit to the load center inside the vault, telephone service conduit to the telemetering cabinet, and all conduit inside vault shall be PVC coated rigid galvanized steel.

Freezing of water in the sump discharge pipe is to be prevented. The sump pump discharge shall be taken through the side of the vault to a suitable nearby location so that discharge is free and flows toward drainage. If this is not feasible, pump discharge shall be terminated in a perforated drain tile in a gravel pocket. A small hole drilled in the discharge pipe, above the gate valve, will also be helpful in preventing freezing.

23.5 Communications

Communications failure for both types of stations shall be indicated at the pumping station and telemetered to and annunciated at the main Control Room at Hyattsville as an alarm.

An indicating light for communication failure and manual reset button to reset the primary control shall be provided at the pumping station pump control panel.

23.6 Control Functional Requirements

In general, the functional requirements of the pump control system shall be as listed below and shall be provided through a completely integrated control system, including all power, control and protection items which form part of the individual pump units, the pump control system and the telemetering system. The complete integrated power and control system shall be the responsibility of one manufacturer and shall be so spelled out in the specifications.

The control system shall provide for

1. Automatic start-stop of all pump motors.

2. Manual local start-stop control of all pump motors.

3. Remote manual start-stop of all pump motors (when selector switch of pump is in the Auto Mode).

The local controls for the pump motors are to be located at the individual pump motor control cubicles. The common pump control system and the telemetering system shall be installed in free standing unitized sections forming an integral part of the motor control center.

It shall be possible to override the automatic system and start and stop any pump from Control Room when the selector switch of the pump is in the Auto Mode. In the case of booster pumping station switch pumped storage, it shall be possible to control the reservoir fill valve also from Laurel .

The pushbutton and indicating lights for remote control and indication to be installed at the Control Room have to match the existing equipment, for similar control and shall be square type Cutler Hammer E-30 series.

23.7 Sequence of Operation

The starting and stopping sequences of pump operation shall be as follows:

After a start signal is initiated from the first step of the control system, after a predetermined time delay, (on-delay timer adjustable 0-60 sec.), the starter of the lead pump motor shall be energized provided the following permissives (as applicable depending on the function of the pumping station in the system) are met.

1. In-Line Booster Stations

a. Pump control valve on discharge side is closed as sensed by limit switch (as applicable).

b. There is no pump lock-out due to overload, valve failure, high bearing temperature or other abnormalities, as sensed by the lock-out relay (device 86).

c. There is sufficient water available on the suction side, as sensed by an electrode type water sensor.

2. Booster Stations with Pumped Storage

a. Pump control valve on discharge side is closed as sensed by limit switch (as applicable).

b. There is no pump lock-out due to abnormalities as sensed by the lock-out relay.

c. There is sufficient water available in the reservoir.

d. The altitude or reservoir fill valve is closed as sensed by limit switch on the altitude valve. (If the reservoir fill valve is open, closing of the reservoir fill valve shall be initiated when any pump is called to start.)

In the case of pumps with automatic pump control valves, after the motor has started, the associated discharge valve shall open and reset the overall sequence timer if the pump is operating satisfactorily and the discharge valve has fully opened within a predetermined time period. When a stop signal is initiated from the control system, after a predetermined time delay, the solenoid operated discharge valve shall be caused to close. When the valve has reached the nearly closed position, a limit switch mounted on the valve shall open momentarily to stop the motor. (This limit switch does not open on the opening cycle of the valve).

If the system demand (pressure, flow or level as the case may be) cannot be satisfied by the first pump, the second step in the control system shall cause a second pump to start as outlined above, and shall continue to operate until system demand can be satisfied by the lead pump alone at which time the second pump shall be stopped as outlined above. If the lead pump and the first lag pump are not able to meet the system demand, the second lag pump shall start, etc.

23.8 Pump Sequence Selection

The number of steps in the control system shall match the number of pumps. It shall be possible to select any pump as lead, lag, or standby.

A plug arrangement for pump selection is preferred. See schematic on Drawing DG-02-9.

The pump sequence control plugs shall be located in the common pump control panel in a recessed compartment of adequate size with hinged door flush with the panel front. All wiring to the sequence control plugs shall be from terminal blocks inside the cabinet and all wiring shall be accessible from the front by opening the hinged door of the cabinet.

23.9 Protection

The pumps shall be shutdown for any of the following abnormalities and locked out:

1. Failure of discharge valve to open or to close within predetermined time (incomplete sequence) - applicable if there is an automatic pump control valve.

2. Motor overload (for medium voltage motors, thermal overcurrent, ground fault and phase sequence/undervoltage).

3. High bearing temperature (applicable for pumps 500 HP and above).

4. No discharge flow (pump failure, sensed by flow switch on discharge side) (if considered necessary).

5. Excessive vibration (if considered necessary).

6. High pressure (in the event the system pressure should exceed a predetermined maximum level).

7. Pump floor flooding (if considered necessary).

The pumps shall also be shutdown, but not locked out, in case of low suction, as sensed by the reservoir low level sensor or electrode type water sensor in the suction line.

23.10 Control Voltage

A.C. control voltage for individual pump control shall be 120V obtained from the control power transformer with isolated fused secondary, in the pump motor starter, with provisions for connecting an auxiliary test source for testing the control circuits without actually running the pump. Adequate safety interlocks shall be provided to ensure that the auxiliary source can be connected only if the pump motor circuit breaker is open (in low voltage systems) or only if the draw-out type contactor or circuit breaker is in the test or drawn out position (in medium voltage systems).

23.11 Indications - Status and Abnormalities

At Pumping Station

It shall be possible for the operator to check status or find out which abnormality caused a pump to shutdown. Indicating lights for status and abnormalities with suitable nameplates and reset buttons shall be provided for this purpose.

Listed below are the required indicating lights (push-to-test):

1. At individual pump control panel for each pump:

   Status

   1. Discharge Valve -closed (amber) -open (blue) - as applicable
   2. Pump -off (green) -running (red)

   Abnormalities

   1. Discharge Valve Failure (white) - as applicable
   2. High Bearing Temperature (red) (for each bearing as applicable)
   3. No Discharge Flow (white) (if considered necessary)
   4. Excessive Vibration (white) (if considered necessary)

2. At the common pump control panel:

   Abnormalities

   1. Communications failure from remote sensors (white)
   2. Remote sensor in service/failure (red)
   3. High pressure shutdown of pumps (white)

For booster stations with pumped storage, the following additional indications shall also be provided:

1. Reservoir Fill Valve

   Fully Open (red)

   Closed (green)

   Open (amber)

2. Reservoir Low Level (amber)
3. Reservoir Overflow (amber)

Status indication for any other important valve which will affect the operation of the station shall also be provided.

Graphic Panel

If the piping and valving connecting the pumping station to the distribution system is complicated, a graphic panel (approximately 24" x 48") shall be provided at a suitable location near the motor control center, depicting the main piping layout and location of valves, and incorporating status indication of valves (position indicating lights) and remote control switches for the valves, where required.

A sketch showing general requirements for the graphic panel is shown in Drawing DG-02-13. (The piping configuration and type and location of valves will vary and has to be adapted suitably to suit the pumping station under design.)

At Hyattsville Control Room

The following status shall be indicated and alarms annunciated at the Control Room:

Status

In-Line Booster Stations

1. Each Pump

Running (red)

Off (green)

2. Altitude Valve at Tanks

Fully Open (red)

Closed (green)

Open (amber)

Booster Stations with Pumped Storage

1. Each Pump

Running (red)

Off (green)

2. Reservoir Fill Valve

Fully Open (red)

Closed (green)

Open (amber)

The above indicating lights shall be part of pushbutton control stations (combination pushbutton and indicating light operators to be located at the existing control consoles).

Only indications (no control) are required for altitude valves at tanks served by in-line booster stations.

Alarms

1. Pump Malfunction - for each pump.

2. Telemetering Failure

3. One of the following three groups of alarms as applicable:

Generator running Both feeder breakers open Tie breaker open	for stations with dual feeds at 480V and automatic throw over scheme
Substation Line #1 breaker open Substation Line #2 breaker open Secondary Tie breaker open	for stations with dual feeds at medium voltage and substations D.C. Trouble

4. Pump Room Flooded

5. Chlorine Leak (as applicable)

6. Low Temperature

For booster stations with pumped storage, the following additional alarms shall be provided:

1. Reservoir Overflow
2. High/Low Discharge Pressure
3. Pressure sensor vault flooding, power failure and telemetering failure - combined as Trouble Alarm.

For in-line booster stations, the following additional alarms shall be provided:

High/Low levels at tank locations.

An annunciator panel with eighteen windows (three across and six vertical) 2-inches wide and 3-inches long, with milk-white plexiglass annunciator indication plates engraved with station name and alarm legend shall be furnished for installation in the existing vertical panels at the control room. The overall dimensions, appearance and finish have to match the existing annunciators. Existing annunciators are Edward, 14½ inches wide and 14-5/8 inches high and 12-1/8 inches deep with black finish.

Normal: Lamp and Audible Signal - "Off"

Alarm: Lamp "Flashes" and Audible Signal "On". (Alarm to be activated by closure of a contact.)

Acknowledge: Lamp "Steady" and Audible Signal "Off".

Return to

Normal: Lamp and Audible Signal - "Off".

23.12 Instrumentation

At Pumping Station

Instrumentation at the pumping station shall be provided to indicate the following variables:

In-Line Booster Stations	Booster Stations with Pumped Storage
1. Primary Control Levels	1. Primary Control Pressures
2. Station Discharge Flow	2. Station Discharge Flow
3. Discharge Pressure	3. Reservoir Influent Flow
4. Suction Pressure	4. Discharge Pressure
5. Chlorine Residual (as applicable)	5. Reservoir Level
	6. Chlorine Residual (as applicable)

The above indicating instruments (except the chlorine residual indicator) shall be located at the common pump control and telemetering panels.

At Hyattsville Control Room

The following variables shall be telemetered to the control room. Instrumentation shall be as indicated against each item.

In-Line Booster Stations	Booster Stations with Pumped Storage
1. Station Discharge Flow	1. Station Discharge Flow and 2. Reservoir Influent Flow
indicator recorder totalizer	indicator recorder (two pen) totalizer (for discharge flow only)
2. Discharge Pressure	3. Discharge Pressure
indicator recorder	indicator recorder

3. Remote Level

   indicator
   recorder (two pen)

4. Remote Pressure

   indicator
   recorder (two pen)

4. Suction Pressure

   indicator
   recorder

5. Reservoir Level

   indicator
   recorder

The overall dimensions, appearance and finish of the recorders shall match the existing recorders at the control room. Existing recorders are Bristol and B.I.F. approximately 15-inches wide and 21-inches high with 12-inch nominal diameter charts and with black finish.

(Because of space limitations - available vertical panel spaces - at the control room, instrumentation as described above may not be feasible for all future stations. Methods for accommodating the required instrumentation in the space available, like combining more functions in one gauge have to be considered.)

23.13 Telemetering System

The telemetering system shall be suitable for operation on 120 Volts, single phase 60 cycles.

A scanner system may be used for transmitting from the pumping station and receiving at the Hyattsville Control Room, status indications and alarms. But for all control functions, individual frequency shift transmitters and receivers shall be used. For transmission of levels or pressures to the control room, from remote sensing points where no control is involved AM transmitters and receivers may be used.

Pressure and level indicating transmitters shall have a time cycle of 15 seconds.

Leased telephone lines shall be used for signal transmission between the pumping station and remote control points and between pumping station and Hyattsville Control Room. A telephone terminal cabinet of adequate size, surface mounted shall be provided on the wall near the motor control center close to the telemetering cabinet.

All equipment for telemetering, control and indications, alarms and instrumentation to be installed at the Hyattsville Control Room has to be furnished by the Contractor, but installation will be done by WSSC.

Location of all equipment needed for control, indication, alarms, instrumentation etc., shall be clearly indicated in the schematic drawings and coordinated with floor plans. All conduits and wiring needed for a functioning system shall be clearly indicated on floor plans and all field mounted devices like limit switches, auxiliary contacts, and solenoid valves shall be specified with the associated major equipment and indicated on plans.

ATTACHMENTS

A. Standard Procedure - Pumping Station Water Oper. 82-05

B. Drawings

1.	Preferred Pumping Station Plan	
	Piping Schematic for Pumping Stations with Pumped Storage	DG-02-1
	Piping Schematic for In-Line Booster Pumping Stations	
2.	Pump Discharge Valve Controls	DG-02-2
3.	Power Distribution (480V) One-Line Diagram Single Feeder and Emergency Generator	
	Power Distribution (480V) One-Line Diagram Dual Feeders	DG-02-3
	Motor Control Center Layout	
4.	Power Distribution - One-Line Diagram 13.8KV-2400V or 4160V Substation and Motor Control Center	DG-02-4
5.	Elementary Breaker Control Schematics	DG-02-5
6.	Pump Control Schematic - For Pumps with Hydraulic Pump Control Valve	DG-02-6
6A.	Pump Control Schematic - For Pumps without Hydraulic Pump Control Valve	DG-02-6A
7.	Level Control Schematic (In-Line Booster Stations)	DG-02-7
8.	Pressure Control Schematic (Booster Stations with Pumped Storage	DG-02-8
9.	Pump Sequence Selection Schematic	DG-02-9
10.	Instrumentation and Control Schematic - In-Line Booster Station	DG-02-10
11.	Instrumentation and Control Schematic - Booster Stations with Pumped Storage	DG-02-11

STANDARD PROCEDURES

OF

THE WASHINGTON SUBURBAN SANITARY COMMISSION

ORIGINATOR	DEPT. & NUMBER	APPROVED BY/DATE	EFFECTIVE DATE	PAGE
Jeff Asner Senior Civil Engineer	Pumping Station Water Oper. 82- 05	Wayne W. Fallin Water Operations Div. May 6, 1982	May 6, 1982	1 OF 2

SUBJECT

WATER PUMPING STATION PIPING COLOR CODE

PURPOSE: To provide a standard piping color code to be used in all water pumping station.

To provide quick and easy identification of all lines.

To provide a guideline whenever station piping is repainted, replaced or added.

COLOR CODE: Only the pipe lines listed in the following table will be color coded. Bare copper, stainless steel, and PVC lines will not be painted. If these pipe lines carry potable water, no markings will be made. If they carry other process water (except chlorine) they whall be appropriately labeled. If they carry chlorine gas or solution, they shall be painted yellow except that flexible connectors, flexible vacuum tubing, and all chlorine valves and appurtenances shall not be painted.

When labels on pipelines are required (check with the Water Operations Division) they should be the plastic wrap-around type, or self sticking type, which are commercially available. Arrows indicating the direction of flow should be of the same color as the lettering. In most cases, lettering and/or arrows will not be required.

Pipeline	Pipe Color	Lettering Color	Background Color
Potable Water	Lt. Blue	Black	Green *
Chlorine Gas	Yellow	Red	
Chlorine Solution	Yellow	Black	Yellow *
Drainage	Lt. Gray	Black	Green *
Wastewater	Dk. Gray	Black	Green *
Fuel Oil (Diesel)	Burgundy	Black	Yellow *
Natural Gas	Red	Black	Yellow *

200-1 (3/79)

All pumps and valves shall be painted the same color as the pipeline. Exceptions are that brass, bronze, copper, stainless steel, PVC and any flexible portions of these pumps or valves shall not be painted. If these items have been previously painted, then they should be repainted according to the above schedule.

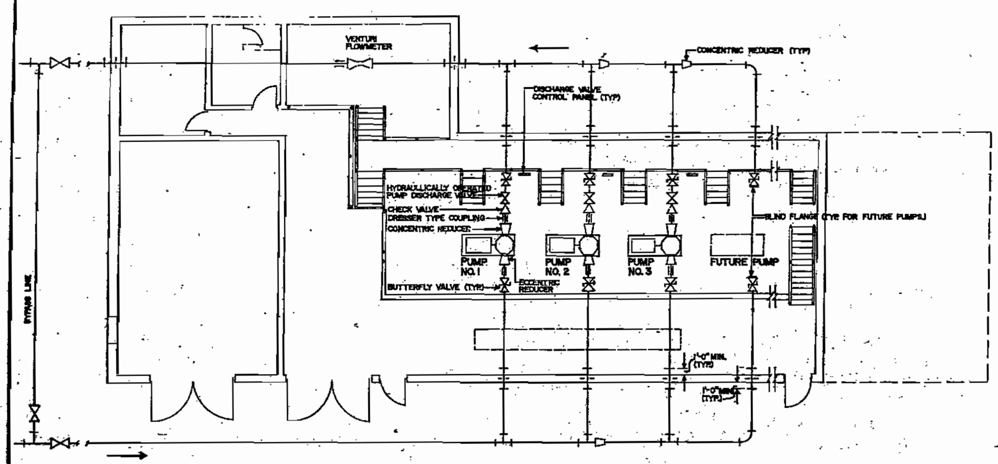
CLEANUP: Cleanup and retouch as necessary all affected work. Leave all glass areas, unpainted fittings, plaster surfaces, floors and walks, hardware and other surfaces clean and free from any paint, stain, smears, spatterings or smudges.

Do not paint over equipment identification tags.

* Indicates standard, commercially available labels.

DISTRIBUTION LIST:

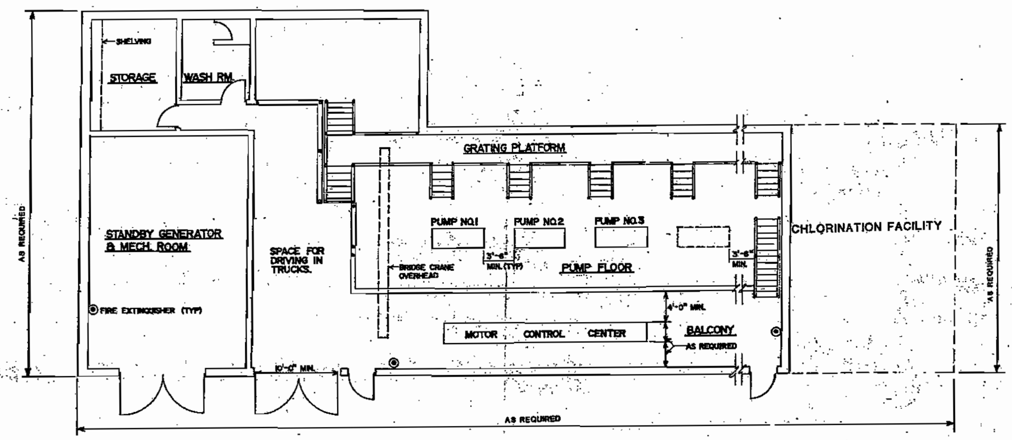
- Department of Maintenance & Operations
- Operations Bureau
- Water Operations Division
- Facilities Maintenance Division
- Design Bureau



PIPING SCHEMATIC—IN LINE BOOSTER STATIONS

NO SCALE

2



PREFERRED PUMP STATION PLAN

NO SCALE

1

NOTES:

1 —

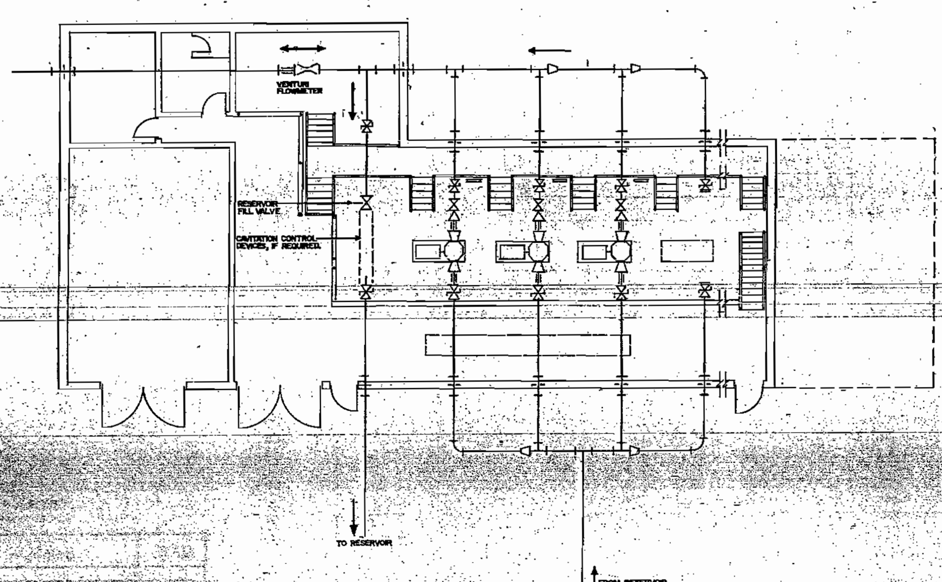
1. GENERATOR ROOM AND CHLORINE ROOM LOCATIONS MAY BE SWITCHED.
2. IF STANDBY GENERATOR IS NOT REQUIRED, BECAUSE STANDBY POWER IS NOT CONSIDERED ESSENTIAL OR BECAUSE DUAL POWER FEEDS ARE AVAILABLE, THE CHLORINE ROOM MAY BE SWITCHED TO THE GENERATOR ROOM LOCATION.
3. FOR CHLORINATION FACILITY LAYOUT SEE M/E DESIGN GUIDELINES ON CHLORINATION FACILITIES.

2 —

1. PIPING AND VALVES SHOWN OUTSIDE THE STATION ARE VERY GENERAL. ACTUAL REQUIREMENTS WILL VARY DEPENDING UPON EXISTING LINES, LOCATION AND FUNCTION OF THE STATION, ETC., AND WILL HAVE TO BE DECIDED ON A CASE BY CASE BASIS.
2. ISOLATING VALVES ON SUCTION AND DISCHARGE SHALL NOT BE LOCATED UNDERNEATH WALKWAYS, OR MEZZANINE FLOORS WHERE HEAD ROOM IS LIMITED.

3 —

3. BURIED VALVES OR ANY FITTINGS SHALL NOT HAVE FLANGED ENDS.



PIPING SCHEMATIC—BOOSTER STATIONS WITH PUMPED STORAGE

NO SCALE

3

TECHNICAL SERVICES GROUP

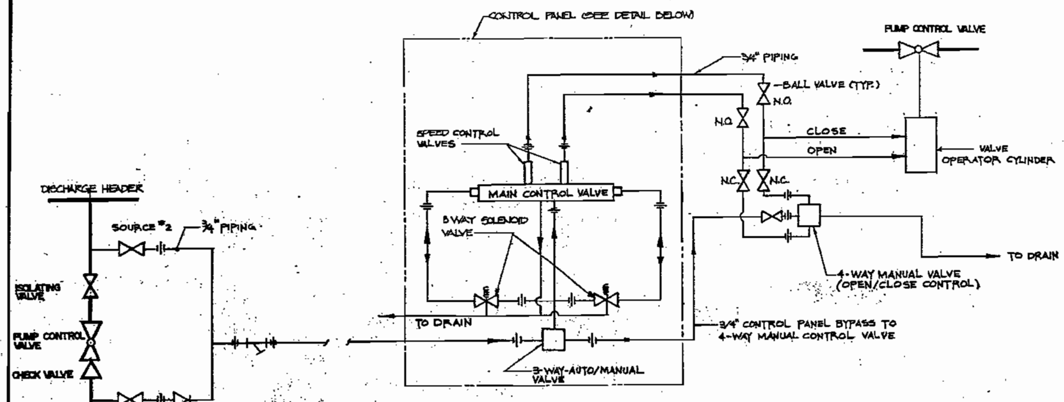
DATE	REVISION

DG-02-1

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

PREFERRED PUMPING STATION PLAN AND PIPING SCHEMATIC



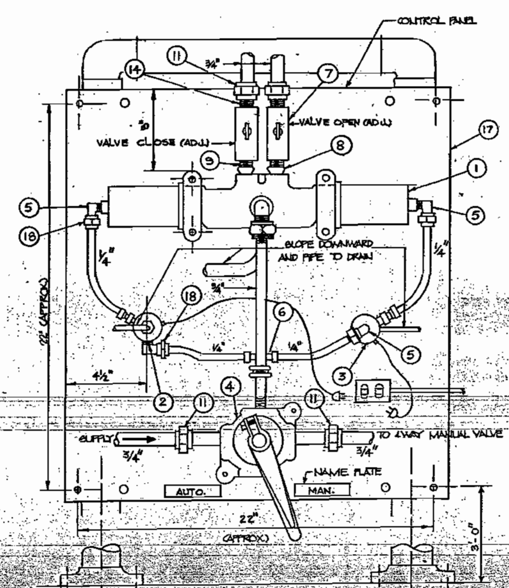
SLOW OPENING PUMP DISCHARGE VALVE CONTROL SCHEMATIC

NO SCALE

NOTES:

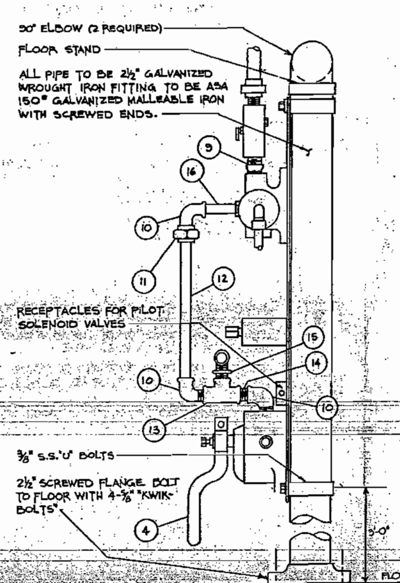
1. ALL PIPING SHALL BE 3/4" HARD TEMPER COPPER EXCEPT PIPING CONNECTED TO THE SOLENOID VALVES WHICH SHALL BE SOFT TEMPER 1/4" COPPER TUBING WITH BRASS FITTINGS.
2. ALL VALVES, EXCEPT SOLENOID VALVES, SHALL HAVE 3/4" FEMALE NPT CONNECTIONS.
3. UNIONS SHALL BE PROVIDED TO ALLOW REMOVAL OF ALL COMPONENTS.
4. SOLENOID VALVES SHALL BE PIPED AND WIRED SO THAT BOTH VALVES ARE ENERGIZED UPON INITIATING PUMP SEQUENCE AND REMAIN ENERGIZED WHEN THE PUMP'S POWERED CHECK VALVE IS TO REMAIN OPEN.
5. ALL PIPING TO DRAIN SHALL BE SLOPED DOWNWARD.

PART NO.	DESCRIPTION	QTY.
1	VALVAIR M-119-C46-R-4 WAY 3/4"	1
2	SKINNER V53 DB 2150 1/4 NO 120V-AC	1
3	SKINNER V53 DB 2150 1/4 NC 120V-AC	1
4	HALINA NO. 15500C (3/4")	1
5	1/4" N.P.T. x 90° ELBOW	6
6	1/4" N.P.T. TEE	1
7	SPEED CONTROL - 3/4" PNEUTROL	2
8	3/4" N.P.T. x 1/4" BUSHINGS	2
9	3/4" NIPPLE	2
10	3/4" STREET EL.	3
11	3/4" UNION	AS REQ'D.
12	3/4" x 8" NIPPLE	1
13	3/4" x 1/2" TEE, BR.	1
14	3/4" CLOSE NIPPLE	3
15	1/2" x 1/4" BR BUSHING	1
16	3/4" x 2" NIPPLE	1
17	PANEL - 24" x 24" x 3/16" ALUM.	1
18	1/4" UNION	AS REQ'D



VALVE CONTROL PANEL – FRONT VIEW

NOT TO SCALE



VALVE CONTROL PANEL – SIDE VIEW

NOT TO SCALE

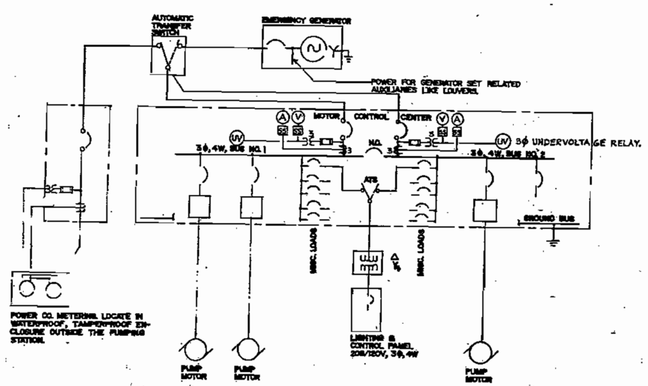
TECHNICAL SERVICES GROUP

DATE	REVISION

DG-02-2

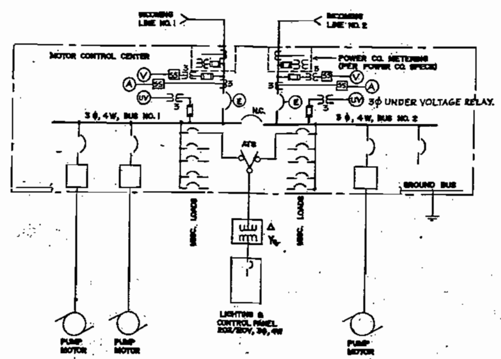
WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS.
PUMP DISCHARGE VALVE CONTROLS



ONE-LINE DIAGRAM-ONE FEED FROM POWER CO. AND EMERGENCY GENERATOR
NO SCALE

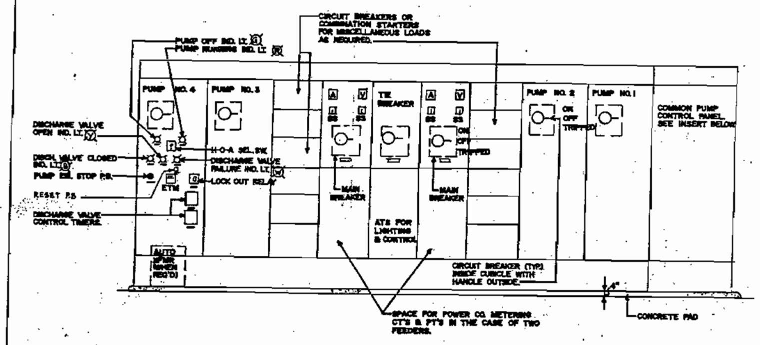
1



ONE-LINE DIAGRAM-TWO FEEDS FROM POWER CO.
NO SCALE

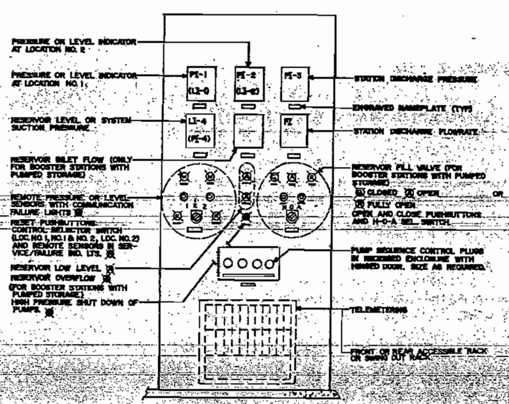
NOTES:
1. TIE BREAKER NORMALLY CLOSED.
2. MAIN CIRCUIT BREAKERS TO BE ELECTRICALLY OPERATED WITH AUTOMATIC THROWOVER SCHEME.
3. UNDER NORMAL CONDITIONS, MAIN C.B. NO. 1 WILL BE CLOSED AND MAIN C.B. NO. 2 WILL BE OPEN. UPON FAILURE OF INCOMING LINE NO. 1, MAIN C.B. NO. 1 SHALL TRIP, AND MAIN C.B. NO. 2 SHALL CLOSE. UPON RESTORATION OF POWER ON INCOMING LINE NO. 1, THE CONTROL SHALL TRIP MAIN C.B: NO. 2 AND CLOSE MAIN C.B. NO. 1.
4. SEQUENCE SELECTOR SWITCH TO PERMIT SELECTION OF EITHER LINE AS THE PREFERRED SOURCE.
5. POWER COMPANY METERS TO BE LOCATED OUTSIDE THE PUMPING STATION IN WATERPROOF, TAMPERPROOF ENCLOSURE.

2



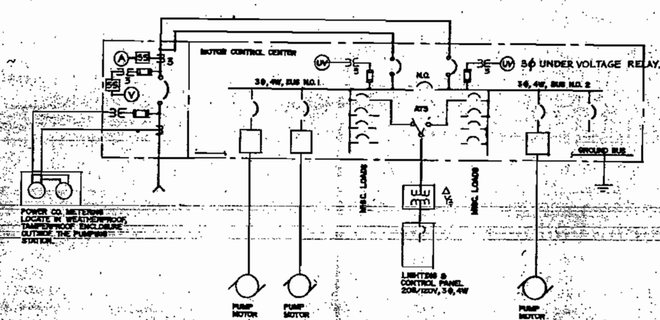
MOTOR CONTROL CENTER LAYOUT
NOT TO SCALE

3



COMMON PUMP CONTROL PANEL
NOT TO SCALE

4



ONE-LINE DIAGRAM - ONE FEED FROM POWER CO.
NO SCALE

5

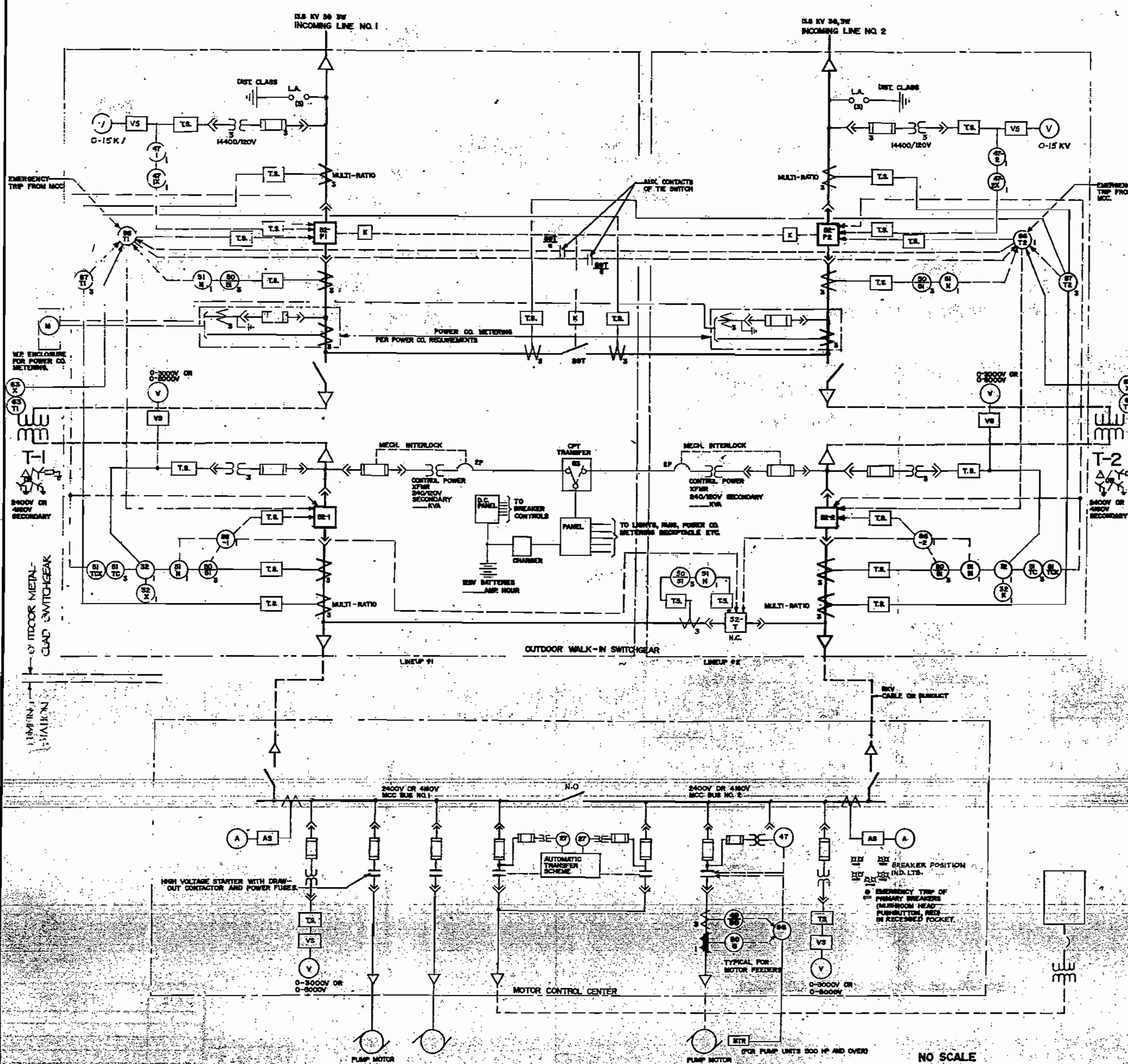
TECHNICAL SERVICES GROUP

DATE	REVISION

DG-02-3

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
POWER DISTRIBUTION (480V) ONE-LINE DIAGRAMS & MOTOR CONTROL CENTER LAYOUT



LEGEND

52	POWER CIRCUIT BREAKER DRAW-OUT TYPE
K	KIRK KEY INTERLOCK
	POWER TRANSFORMER
	POTENTIAL TRANSFORMER
	CURRENT TRANSFORMER
	LIGHTNING ARRESTER
	GROUND
	FUSE

50/51	PHASE TIME OVERCURRENT RELAY W/ INST. ATTACHMENT	GE TYPE IAC OR WESTINGHOUSE TYPE CO
51N	RESIDUAL TIME OVERCURRENT RELAY	GE TYPE IAC OR WESTINGHOUSE TYPE CO.
50G	GROUND OVERCURRENT RELAY	
87	DIFFERENTIAL RELAY	GE TYPE SDD OR WESTINGHOUSE TYPE [illegible]
86	LOCKING OUT RELAY. HAND RESET	GE TYPE HEA
63	GAS PRESSURE RELAY	WESTINGHOUSE TYPE SPR
63X	AUXILIARY RELAY FOR 63	
32	DIRECTIONAL POWER RELAY	WESTINGHOUSE TYPE [illegible] THREE PHASE
52X	AUXILIARY RELAY FOR 52	GE TYPE HFA OR WESTINGHOUSE TYPE MG-6.
51TC	TORQUE CONTROLLED OVER CURRENT RELAY	WESTINGHOUSE CO OR GE IAC WITH EXTERNAL STUDS FOR SHADING COIL
47	PHASE SEQUENCE AND UNDER VOLTAGE RELAY	GE TYPE ICR OR WESTINGHOUSE TYPE CP.
47X	AUXILIARY RELAY FOR 47	
27	UNDER VOLTAGE RELAY	GE TYPE PCV
49/50	THERMAL OVERCURRENT RELAY WITH INSTANTANEOUS UNIT	GE TYPE THC
V	VOLTMETER	
VS	VOLTMETER SELECTOR SWITCH	
A	AMMETER	
AS	AMMETER SELECTOR SWITCH	
TS	TEST SWITCH	
BTR	BEARING TEMPERATURE RELAY	

NOTES:

1. THE ONE-LINE DIAGRAM AND PROTECTIVE RELAYING SCHEME SHOWN REPRESENTS THE PREFERRED ARRANGEMENT FROM A RELIABILITY POINT OF VIEW. THIS SCHEME ASSUMES THAT THE POWER CO. WILL PERMIT PARALLELING OF THE TWO FEEDERS ON THE SECONDARY SIDE OF THE TRANSFORMERS (THE TRANSFORMERS MAY HAVE TO BE Y/Y IN SOME CASES, THOUGH Δ/Y IS COMMONLY USED.)
   NORMAL OPERATION WOULD BE WITH BOTH THE PRIMARY BREAKERS, BOTH THE SECONDARY BREAKERS, AND THE SECONDARY TIE BREAKER CLOSED, THE TIE SWITCH ON THE PRIMARY SIDE OPEN AND THE AUTO RECLOSING SCHEME IN SERVICE.
2. CONSULT THE POWER CO. TO ASCERTAIN IF PARALLELING ON THE SECONDARY SIDE WILL BE PERMITTED, BEFORE GOING AHEAD WITH THE SCHEME SHOWN. MODIFY THE SCHEME SUITABLY IF THE TWO FEEDERS CANNOT BE PARALLELED.
3. PROTECTIVE RELAYING TO THE POWER COMPANY'S SATISFACTION HAS TO BE PROVIDED.
4. THE POWER CIRCUIT BREAKERS SHALL BE D.C. CLOSE AND D.C. TRIP. THE PRIMARY BREAKERS SHALL BE PROVIDED WITH D.C. UNDERVOLTAGE RELEASE.
5. POWER COMPANY METERING BAY SHALL BE PER POWER COMPANY SPECIFICATIONS CONTAINING PROVISIONS FOR FUSE ASSEMBLIES, POTENTIAL TRANSFORMERS AND CURRENT TRANSFORMERS.
6. FOR ELEMENTARY BREAKER CONTROL SCHEMATICS, SEE DG-02-5.

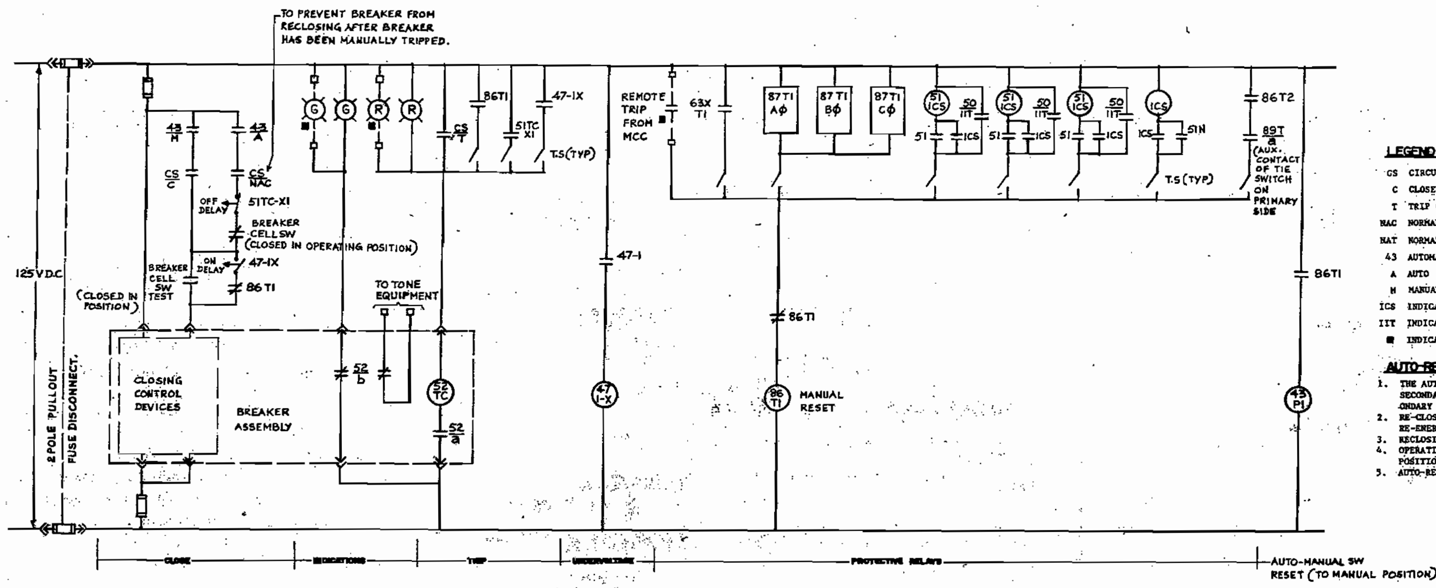
TECHNICAL SERVICES GROUP

DATE	REVISION

DG-02-4

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
POWER DISTRIBUTION ONE-LINE DIAGRAM, 13.8KV - 2400V OR 4160V SUBSTATION AND MCC



PRIMARY BREAKER 52P1 CONTROL SCHEMATIC (52P2 SIMILAR)

LEGEND

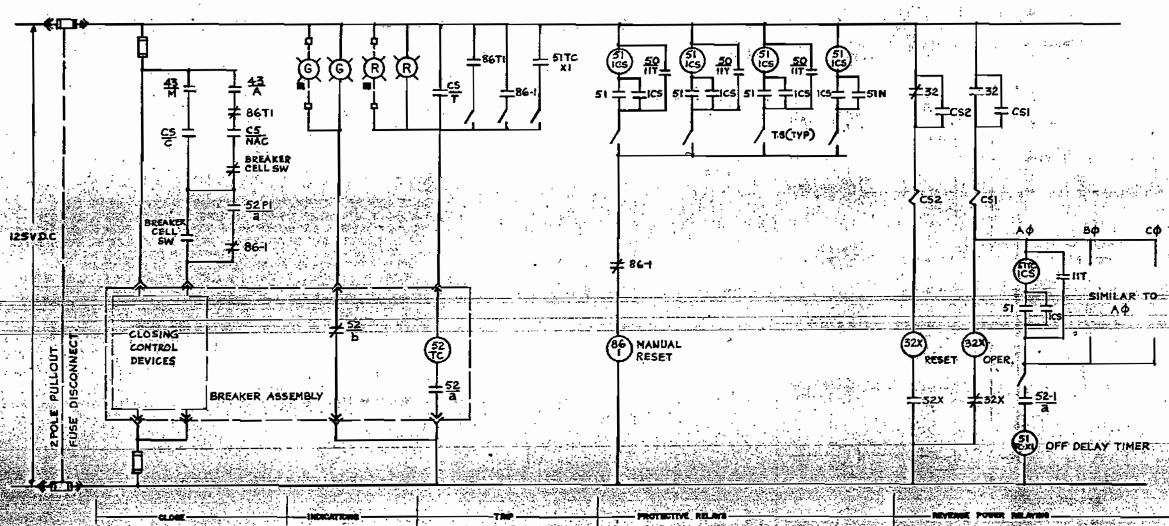
- CS CIRCUIT BREAKER CONTROL SWITCH
- C CLOSE CONTACT
- T TRIP CONTACT
- NAC NORMAL AFTER CLOSE CONTACT
- NAT NORMAL AFTER TRIP CONTACT
- 43 AUTOMATIC-MANUAL SELECTOR SWITCH
- A AUTO
- M MANUAL
- ICS INDICATING CONTACTOR SWITCH
- IIT INDICATING INSTANTANEOUS TRIP
- ■ INDICATES DEVICE REMOTELY MOUNTED AT THE MOTOR CONTROL CENTER INSIDE THE PUMPING STATION

$\frac{52}{a}$ BREAKER AUX. SWITCH CONTACTS - OPEN WHEN BREAKER IS IN THE TRIPPED (OPEN) POSITION. CLOSED WHEN BREAKER IS IN THE CLOSED POSITION.

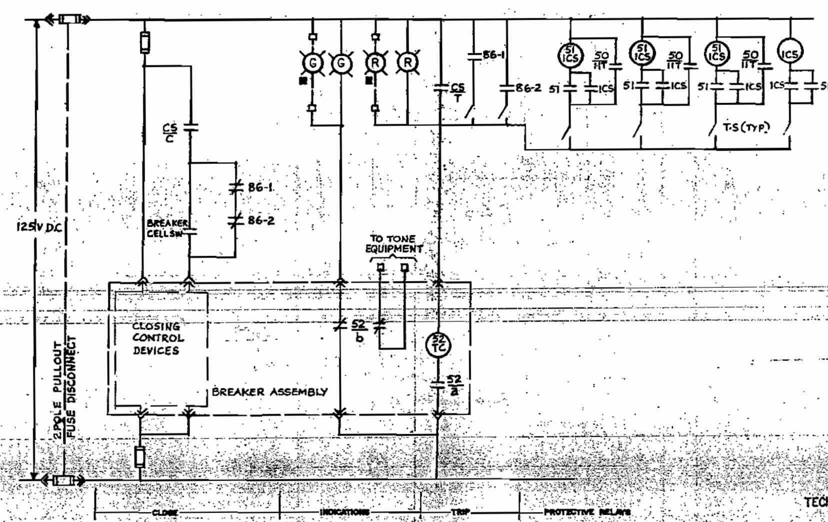
$\frac{52}{b}$ BREAKER AUX. SWITCH CONTACTS - CLOSED WHEN THE BREAKER IS IN THE TRIPPED (OPEN) POSITION. OPEN WHEN BREAKER IS IN THE CLOSED POSITION.

AUTO-RECLOSING SCHEME NOTES

1. THE AUTOMATIC RE-CLOSING SCHEME SHALL BE DESIGNED TO AUTOMATICALLY CLOSE THE INCOMING PRIMARY AND THE SECONDARY BREAKERS OF EITHER LINE-UP, ON RESTORATION OF POWER IN EITHER LINE AFTER THE PRIMARY AND SECONDARY BREAKERS TRIP ON REVERSE POWER FOR A FAULT IN THE POWER COMPANY LINE.
2. RE-CLOSING SHALL TAKE PLACE ONLY AFTER A TIME DELAY (ADJUSTABLE) AFTER THE POWER COMPANY SUCCESSFULLY RE-ENERGIZES THE LINE.
3. RECLOSING SHALL BE INHIBITED FOR ANY FAULT WITHIN THE SUBSTATION.
4. OPERATION OF ANY LOCK-OUT RELAY SHALL AUTOMATICALLY CHANGE THE CONTROL TRANSFER DEVICE 43 TO THE MANUAL POSITION - TO PREVENT AUTO-RECLOSING WHEN LOCK-OUT RELAYS ARE RESET.
5. AUTO-RECLOSING SHALL BE INHIBITED IF BREAKERS ARE TRIPPED MANUALLY.



SECONDARY BREAKER 52-1 CONTROL SCHEMATIC (52-2 SIMILAR)



SECONDARY TIE BREAKER 52-T CONTROL SCHEMATIC

TECHNICAL SERVICES GROUP

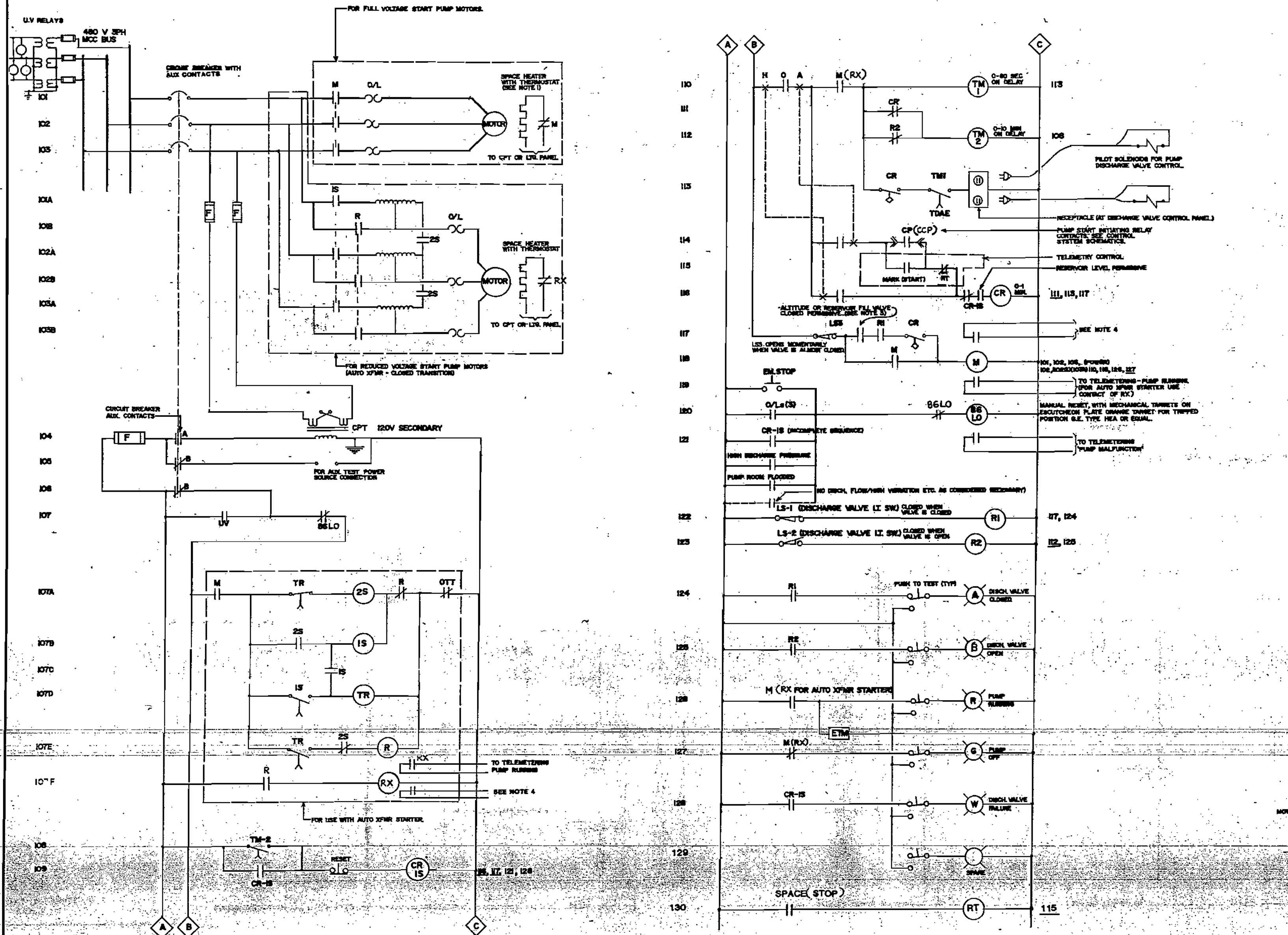
DATE	REVISION

NO SCALE

DG-02-5

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
ELEMENTARY CONTROL DIAGRAMS FOR BREAKERS (13.8 KV-2400V OR 4160V SUBSTATIONS)



LEGEND

- SWITCH CONTACT CLOSED IN "A" POSITION OF SWITCH
- SWITCH CONTACT CLOSED IN "H" POSITION OF SWITCH (BOTH CONTACTS OPEN IN "O" POSITION OF SWITCH)
- RELAY COIL
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- INDICATING LIGHT - LETTER DENOTES COLOR
- NORMALLY OPEN PUSHBUTTON
- NORMALLY CLOSED PUSHBUTTON
- LIMIT SWITCH, NORMALLY CLOSED (UN-OPERATED)
- LIMIT SWITCH, NORMALLY CLOSED (OPERATED)
- LIMIT SWITCH, NORMALLY OPEN (UN-OPERATED)
- LIMIT SWITCH, NORMALLY OPEN (OPERATED)

CONTACT ACTION - TIME DELAY AFTER ENERGIZATION

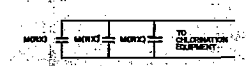
- NORMALLY OPEN CONTACT (RELEASED)
- NORMALLY OPEN CONTACT (OPERATED)
- NORMALLY CLOSED CONTACT (RELEASED)
- NORMALLY CLOSED CONTACT (OPERATED)
- IMPLIES CONTACT ACTION TIME DELAYED BOTH UPON ENERGIZATION AND DE-ENERGIZATION

CONTACT ACTION - TIME DELAY AFTER DE-ENERGIZATION

- NORMALLY OPEN CONTACT (RELEASED)
- NORMALLY OPEN CONTACT (OPERATED)
- NORMALLY CLOSED CONTACT (RELEASED)
- NORMALLY CLOSED CONTACT (OPERATED)
- IMPLIES CONTACT ACTION TIME DELAYED BOTH UPON ENERGIZATION AND DE-ENERGIZATION
- PRESSURE SWITCH CLOSES ON FALLING PRESSURE
- PRESSURE SWITCH CLOSES ON RISING PRESSURE
- L I C LEVEL INDICATING CONTROL
- P I C PRESSURE INDICATING CONTROL
- LEVEL SWITCH CLOSES ON FALLING LEVEL
- LEVEL SWITCH CLOSES ON RISING LEVEL
- E T M ELAPSED TIME METER
- F FUSE

NOTES

1. SPACE HEATER IS REQUIRED FOR MOTORS 50 HP AND ABOVE ONLY.
2. ALL RELAY AND OTHER DEVICE NUMBERS SHALL BE PREFIXED WITH THE PUMP NUMBER. EX: 1M FOR PUMP NO.1, 2M FOR PUMP NO. 2, ETC.
3. THE RESERVOIR FILL VALVE CLOSED AND RESERVOIR LEVEL PERMISSIVES ARE FOR BOOSTER STATIONS WITH PUMPED STORAGE. FOR IN LINE BOOSTER STATIONS, USE OTHER PERMISSIVES AS APPLICABLE.
4. IF THERE IS CHLORINATION FACILITY AND IF OPERATION IS TO BE AUTOMATIC (THAT IS IF CHLORINATION HAS TO START WHEN ANY OF THE PUMPS RUN, AND STOP WHEN PUMPS STOP) CONNECT AUX. CONTACT OF M (OR R AS APPLICABLE) OF ALL THE PUMPS, IN PARALLEL FOR INTERCONNECTION TO THE CHLORINATION EQUIPMENT.



TECHNICAL SERVICES GROUP

DATE	REVISION

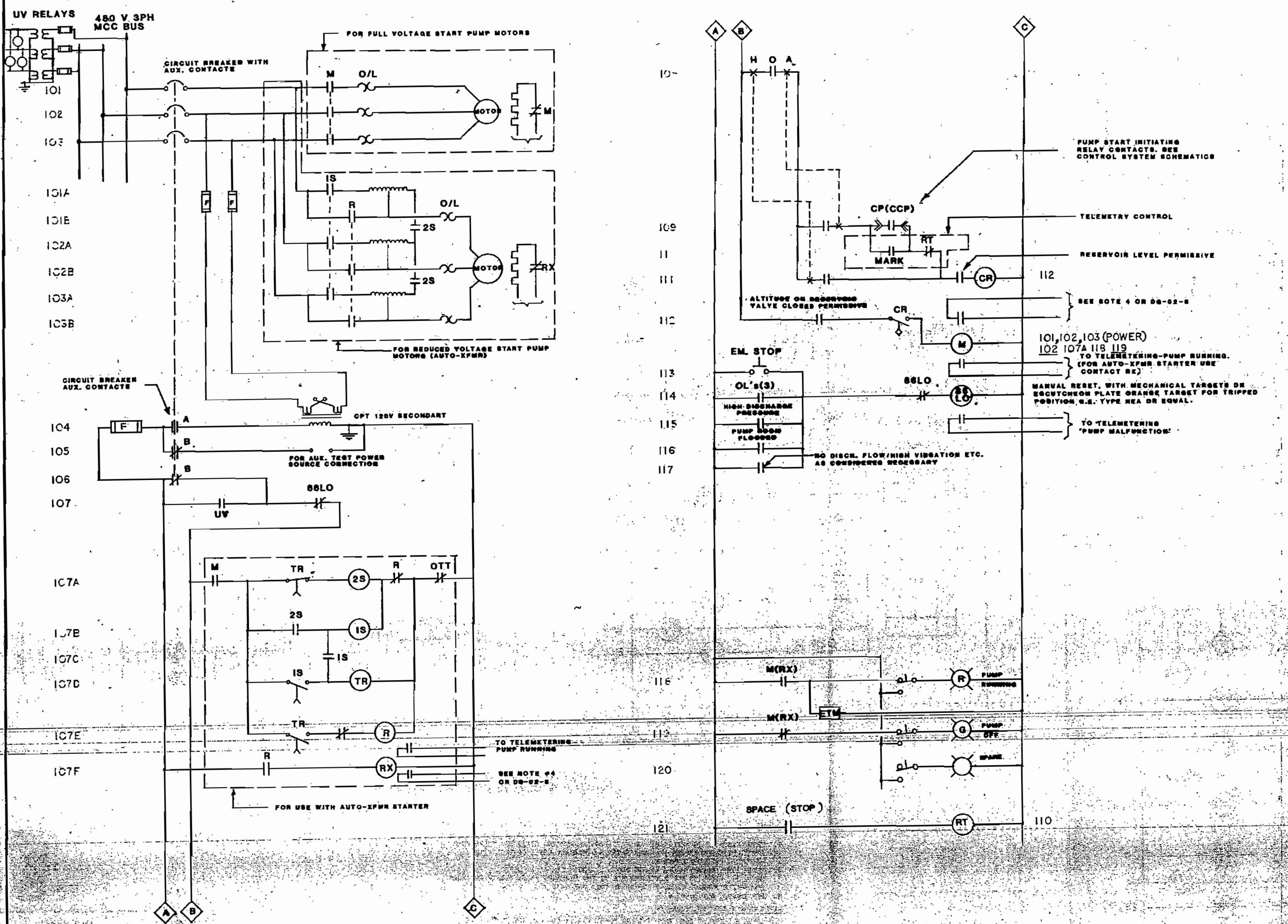
NO SCALE

DG-02-6

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

PUMP MOTOR CONTROL SCHEMATIC (480V, 3φ SYSTEM) FOR PUMPS WITH HYDRAULIC CONTROL VALVE



TECHNICAL SERVICES GROUP

DATE	REVISION

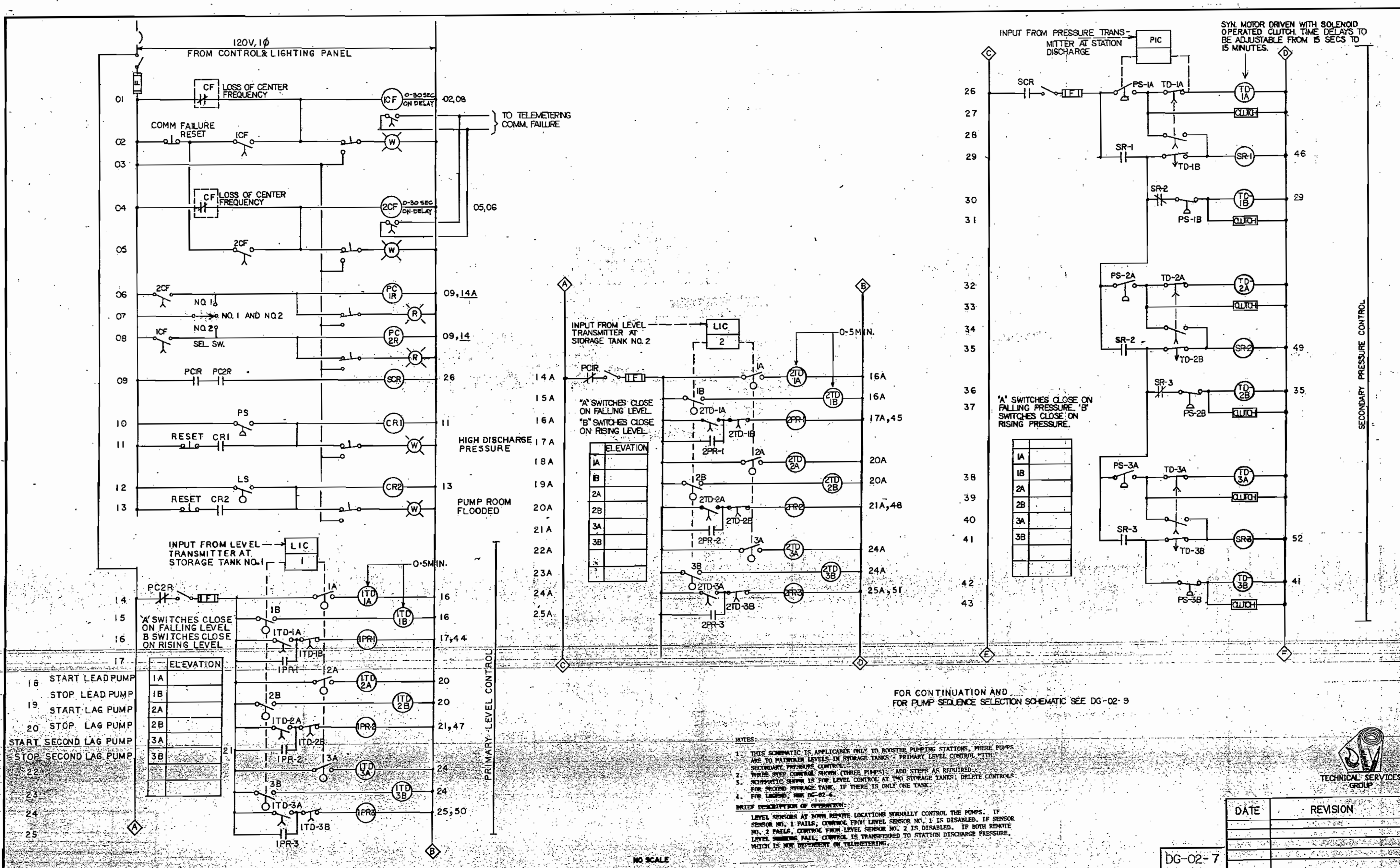
DG-02-6A

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

PUMP MOTOR CONTROL SCHEMATIC (480 V, 3 Φ SYSTEM)

FOR PUMPS WITHOUT HYDRAULIC PUMP CONTROL VALVE



FOR CONTINUATION AND
FOR PUMP SEQUENCE SELECTION SCHEMATIC SEE DG-02-9

NOTES:

1. THIS SCHEMATIC IS APPLICABLE ONLY TO BOOSTER PUMPING STATIONS, WHERE PUMPS ARE TO MAINTAIN LEVELS IN STORAGE TANKS - PRIMARY LEVEL CONTROL WITH SECONDARY PRESSURE CONTROL.
2. THREE STEP CONTROL SHOWN (THREE PUMPS). ADD STEPS AS REQUIRED.
3. SCHEMATIC SHOWN IS FOR LEVEL CONTROL AT TWO STORAGE TANKS. DELETE CONTROLS FOR SECOND STORAGE TANK, IF THERE IS ONLY ONE TANK.
4. FOR LEGEND, SEE DG-02-6.

BRIEF DESCRIPTION OF OPERATION:

LEVEL SENSORS AT BOTH REMOTE LOCATIONS NORMALLY CONTROL THE PUMPS. IF SENSOR NO. 1 FAILS, CONTROL FROM LEVEL SENSOR NO. 1 IS DISABLED. IF SENSOR NO. 2 FAILS, CONTROL FROM LEVEL SENSOR NO. 2 IS DISABLED. IF BOTH REMOTE LEVEL SENSORS FAIL, CONTROL IS TRANSFERRED TO STATION DISCHARGE PRESSURE, WHICH IS NOT DEPENDENT ON TELEMETERING.

NO SCALE

TECHNICAL SERVICES GROUP

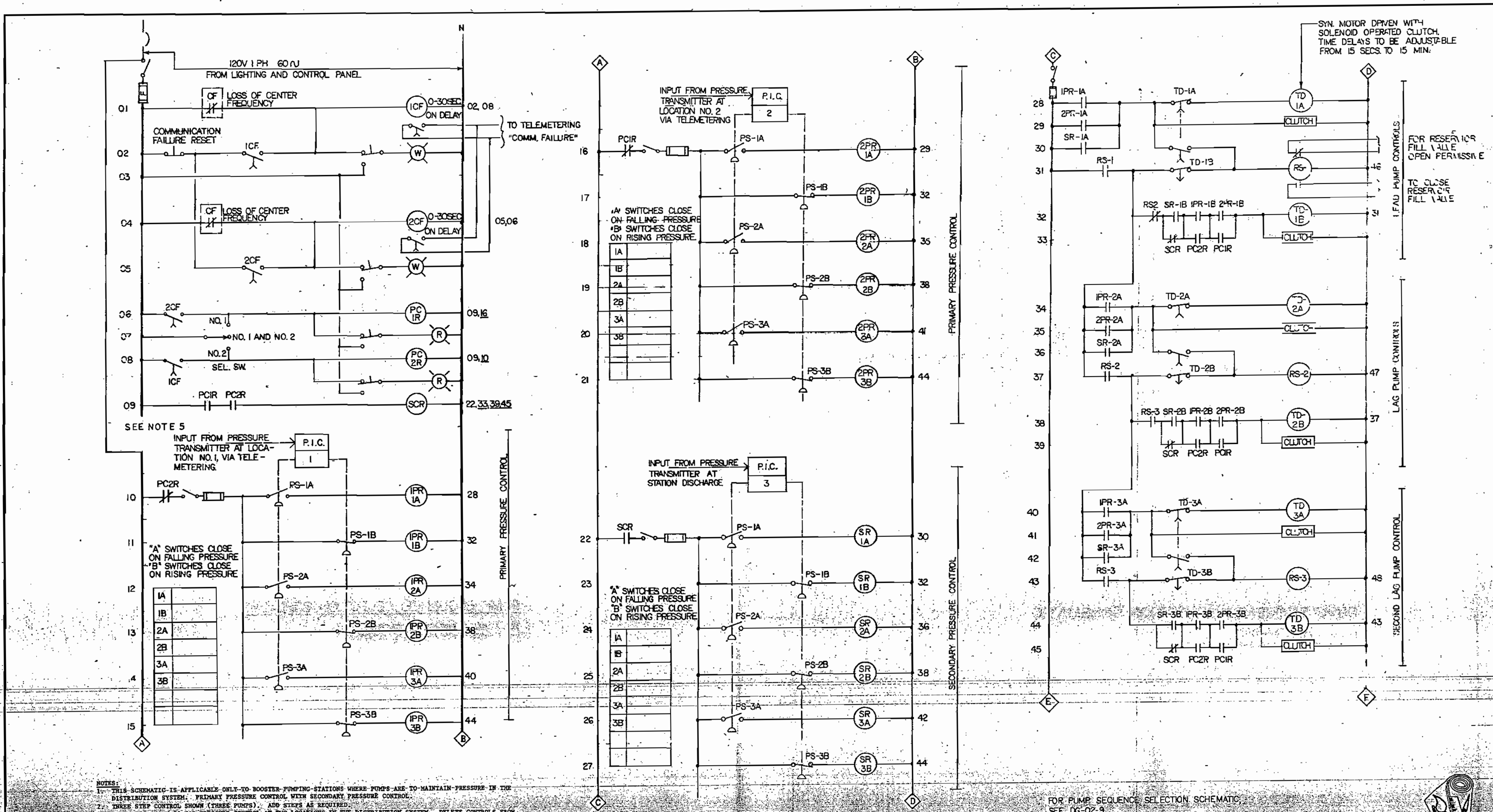
DATE	REVISION

DG-02-7

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

LEVEL CONTROL SCHEMATIC (IN-LINE BOOSTER STATIONS)



NOTES:

1. THIS SCHEMATIC IS APPLICABLE ONLY TO BOOSTER PUMPING STATIONS WHERE PUMPS ARE TO MAINTAIN PRESSURE IN THE DISTRIBUTION SYSTEM. PRIMARY PRESSURE CONTROL WITH SECONDARY PRESSURE CONTROL.
2. THREE STEP CONTROL SHOWN (THREE PUMPS). ADD STEPS AS REQUIRED.
3. SCHEMATIC SHOWN IS FOR PRESSURE CONTROL AT TWO LOCATIONS IN THE DISTRIBUTION SYSTEM. DELETE CONTROLS FROM SECOND LOCATION IF PRESSURE IS TO BE MAINTAINED AT ONLY ONE LOCATION.
4. FOR LEGEND, SEE DG-02-6.

BRIEF DESCRIPTION OF OPERATION

PRESSURE SENSORS AT BOTH REMOTE LOCATIONS NORMALLY CONTROL THE PUMPS. IF SENSOR NO. 1 FAILS, CONTROL FROM SENSOR NO. 1 IS DISABLED. IF SENSOR NO. 2 FAILS, CONTROL FROM SENSOR NO. 2 IS DISABLED. IF BOTH REMOTE PRESSURE SENSORS FAIL, CONTROL IS TRANSFERRED TO STATION DISCHARGE PRESSURE, WHICH IS NOT DEPENDENT ON TELEMETERING.

SELECTOR SWITCH ALLOWS EITHER OR BOTH REMOTE PRESSURE SENSORS TO BE SELECTED FOR CONTROL.

LEAD PUMP MUST START BEFORE LAG PUMP MAY START, AND LAG PUMP MUST START BEFORE SECOND LAG PUMP MAY START, ETC. THE LAST PUMP TO START IS THE FIRST TO STOP.

NOTES (CONTINUED)

INCLUDE RELAYS AND INDICATIONS WITH RESET FOR HIGH DISCHARGE PRESSURE AND PUMP ROOM FLOODING SIMILAR TO WHAT IS SHOWN ON DG-02-7.

NO SCALE

TECHNICAL SERVICES GROUP

DATE	REVISION

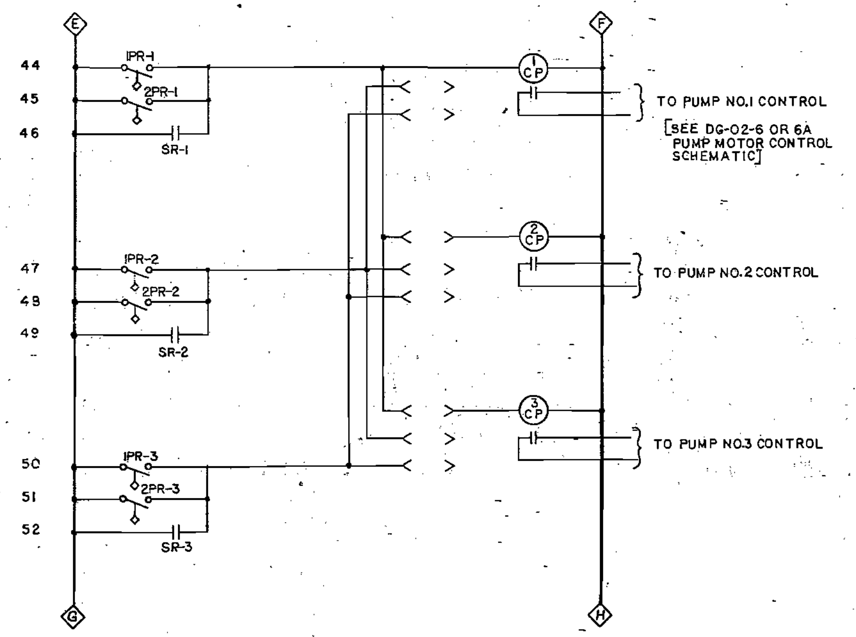
DG-02-8

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

PRESSURE CONTROL SCHEMATIC (BOOSTER STATIONS WITH PUMPED STORAGE)

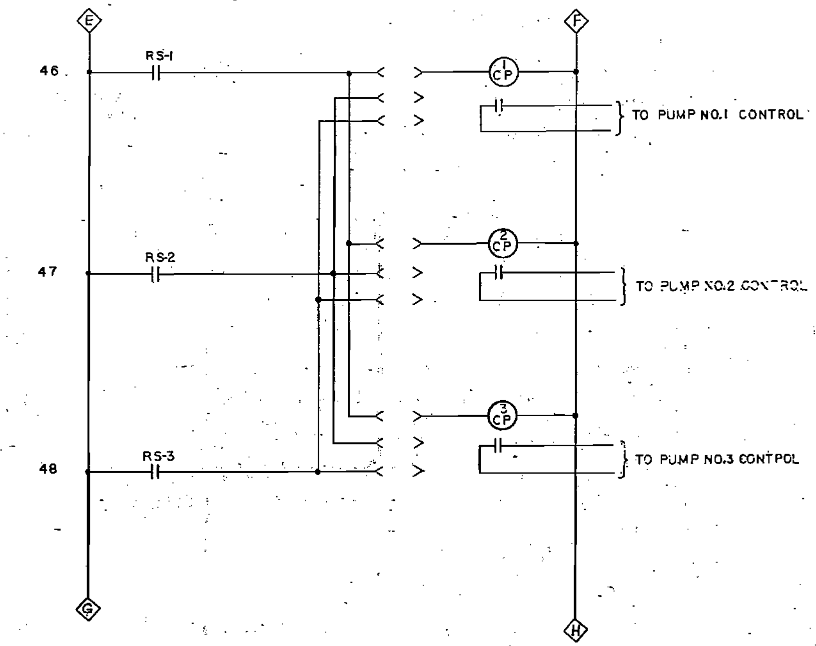
CONTINUED FROM DG-02-7



PUMP SEQUENCE SELECTION SCHEMATIC

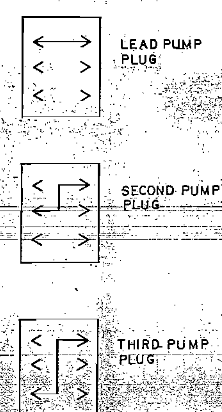
PRIMARY LEVEL CONTROL
WITH SECONDARY PRESSURE CONTROL

CONTINUED FROM DG-02-8



PUMP SEQUENCE SELECTION SCHEMATIC

FOR PRIMARY PRESSURE CONTROL
WITH SECONDARY PRESSURE CONTROL



NOTE:
IF STANDBY GENERATOR IS USED AND IF THE LAST OR STANDBY PUMP IS TO BE PREVENTED FROM STARTING AND RUNNING WHEN ON GENERATOR POWER, SEE CONTINUATION AND INTERLOCK SCHEMATIC ON DG-02-14.

TECHNICAL SERVICES GROUP

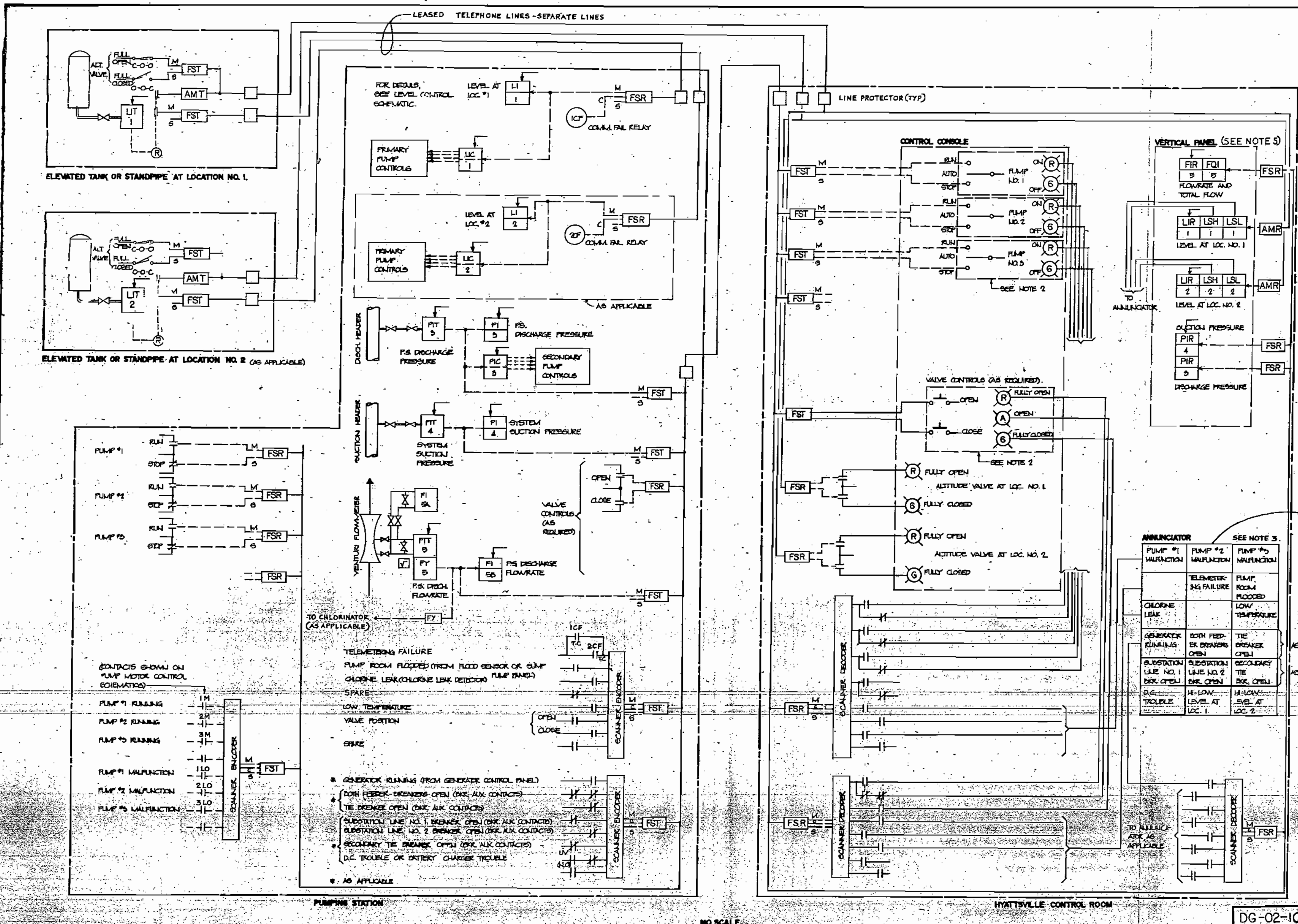
DATE	REVISION

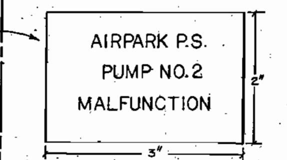
NO SCALE

DG-02-9

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
PUMP SEQUENCE SELECTION SCHEMATIC





-ANNUNCIATOR INDICATION PLATE
BLACK LETTERS ENGRAVED ON MILKWHITE PLEXIGLASS

NOTES:

1. FOR LEGEND, SEE DG-02-11.
2. COMBINATION PUSH BUTTON AND INDICATOR LIGHT OPERATORS - SQUARE TYPE CUTLER HAMMER E-30 SERIES (TO MATCH EXISTING).
3. ANNUNCIATOR LEGENDS ARE TO BE PRECEDED BY STATION NAME.
4. ALL EQUIPMENT FOR TELEMETERING, CONTROL AND INDICATIONS, ALARMS, AND INSTRUMENTATION TO BE INSTALLED AT HYATTSVILLE CONTROL ROOM HAVE TO BE FURNISHED BY CONTRACTOR, BUT INSTALLATION WILL BE DONE BY WSSC.
5. BECAUSE OF SPACE LIMITATIONS, METHODS FOR ACCOMMODATING THE REQUIRED INSTRUMENTATION IN THE SPACE AVAILABLE, LIKE COMBINING MORE FUNCTIONS IN ONE GAUGE HAVE TO BE CONSIDERED.

TECHNICAL SERVICES GROUP

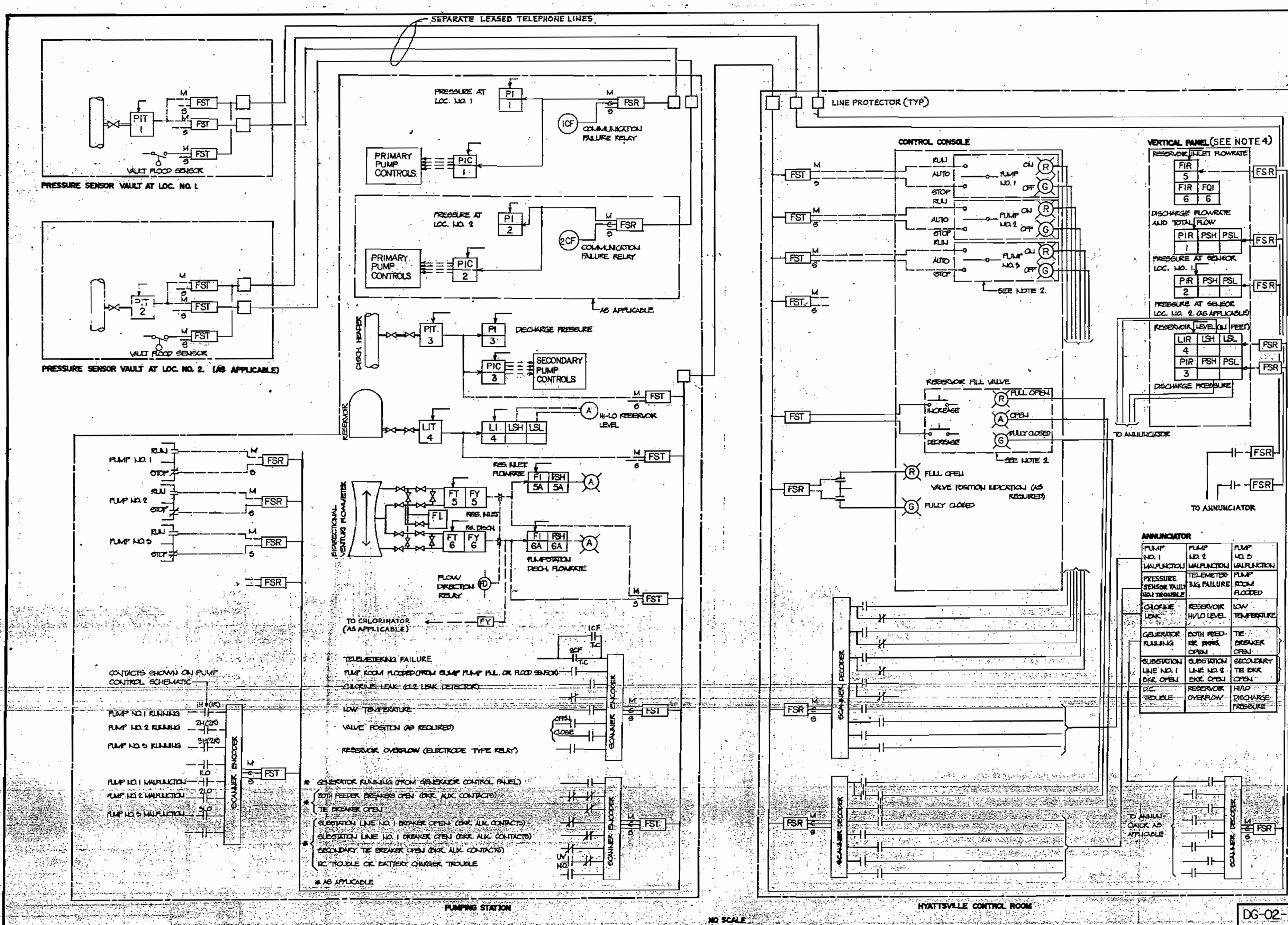
DATE	REVISION

DG-02-10

NO SCALE

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
INSTRUMENTATION AND CONTROL SCHEMATIC (IN LINE BOOSTER STATIONS)



ANNUNCIATOR

PUMP NO. 1 MALFUNCTION	PUMP NO. 2 MALFUNCTION	PUMP NO. 3 MALFUNCTION
PRESSURE SENSOR VAULT NO. 1 TROUBLE	TELEMETERING FAILURE	PUMP ROOM FLOODED
CHLORINE LEAK	RESERVOIR HI/LO LEVEL	LOW TEMPERATURE
GENERATOR RUNNING	BOTH FEEDER BKRS. OPEN	TIE BREAKER OPEN
SUBSTATION LINE NO. 1 BKR. OPEN	SUBSTATION LINE NO. 2 BKR. OPEN	SECONDARY TIE BKR. OPEN
D.C. TROUBLE	RESERVOIR OVERFLOW	HI/LO DISCHARGE PRESSURE

AS APPLICABLE

AS APPLICABLE

LEGEND

- FST — FREQUENCY SHIFT TRANSMITTER
- FSR — FREQUENCY SHIFT RECEIVER
- ELECTRONIC INSTRUMENT SIGNAL
- POWER SUPPLY
- (R) INDICATING LIGHT R-RED, G-GREEN, A-AMBER
- C — CARRIER
- M — MARK
- S — SPACE
- FI — FLOW RATE INDICATOR
- FIC — FLOW RATE INDICATING CONTROLLER
- FIR — FLOW RATE INDICATOR-RECORDER
- FT — FLOW RATE TRANSMITTER
- FQI — FLOW INTEGRATING TOTALIZER
- LI — LEVEL INDICATOR
- LIR — LEVEL INDICATING RECORDER
- LIT — LEVEL INDICATING TRANSMITTER
- LSL(H) — LEVEL SWITCH LOW (HIGH)
- PSL(H) — PRESSURE SWITCH LOW (HIGH)
- PI — PRESSURE INDICATOR
- PIR — PRESSURE INDICATING RECORDER
- PIT — PRESSURE INDICATING TRANSMITTER
- INSTRUMENT OR OTHER COMPONENT TO BE FIELD MOUNTED (SHOW LOCATION ON PLANS)
- INSTRUMENT OR OTHER COMPONENT TO BE MOUNTED INSIDE PANELS
- INSTRUMENT OR OTHER COMPONENT TO BE MOUNTED ON PANEL FRONT.

NOTES

1. ALL EQUIPMENT FOR TELEMETERING, CONTROL AND INDICATION, ALARMS AND INSTRUMENTATION TO BE INSTALLED AT HYATTSVILLE CONTROL ROOM HAVE TO BE FURNISHED BY CONTRACTOR, BUT INSTALLATION WILL BE DONE BY WSSC.
2. COMBINATION PUSHBUTTON AND IND. LIGHT OPERATORS - SQUARE TYPE CUTLER HAMMER E-30 SERIES (TO MATCH EXISTING)
3. ANNUNCIATOR LEGENDS SHOWN ARE TO BE PRECEDED BY STATION NAME.
4. BECAUSE OF SPACE LIMITATIONS, METHODS FOR ACCOMMODATING THE REQUIRED INSTRUMENTATION IN THE SPACE AVAILABLE, LIKE COMBINING MORE FUNCTIONS IN ONE GAUGE HAVE TO BE CONSIDERED.

- AMT — AM TONE TRANSMITTER
- AMR — AM TONE RECEIVER

TECHNICAL SERVICES GROUP

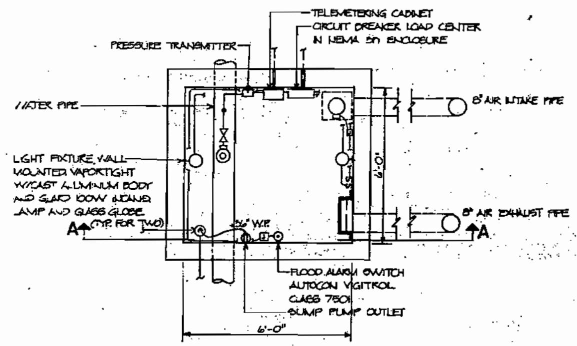
DATE	REVISION

DG-02-11

WASHINGTON SUBURBAN SANITARY COMMISSION

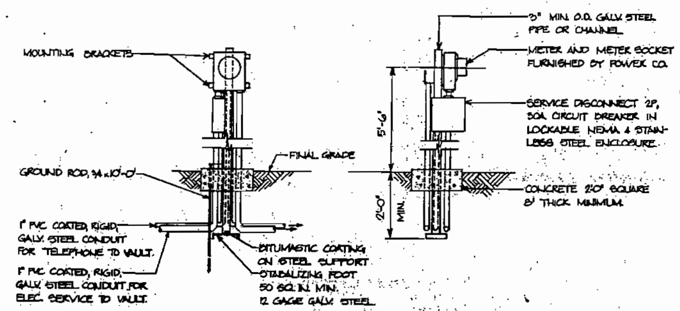
DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

INSTRUMENTATION AND CONTROL SCHEMATIC (BOOSTER STATIONS WITH PUMPED STORAGE)



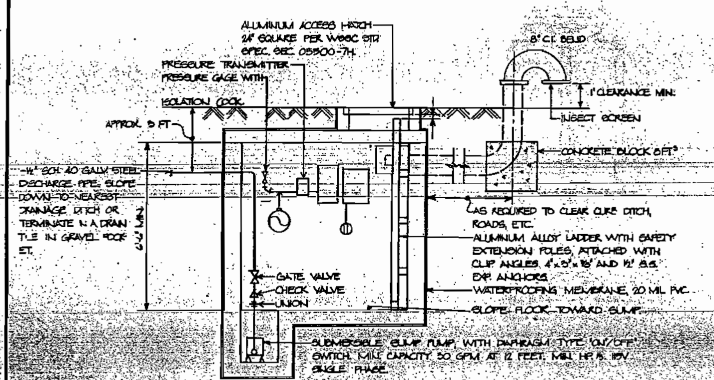
PRESSURE SENSOR VAULT PLAN
NOT TO SCALE

VAULT SHALL BE CAST-IN-PLACE CONCRETE PER WSSC STANDARD DETAILS W/5.2, W/5.21, W/5.3, W/5.5 COMPLETE WITH ALUMINUM ACCESS HATCH, VENT PIPES, LADDER, SUMP, ETC. TOP SLAB SHALL BE PRE-CAST PER WSSC STD. DETAIL W/5.21

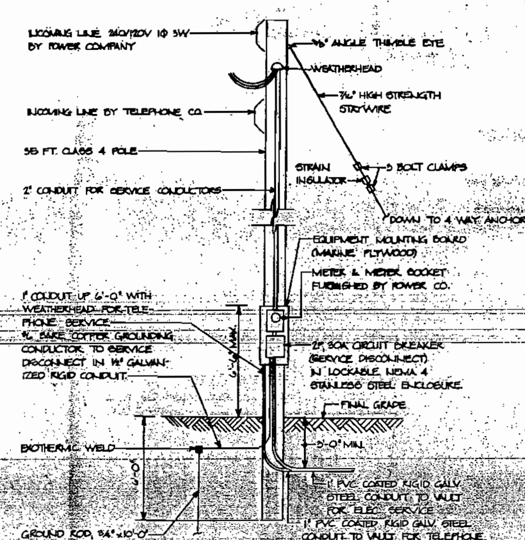


SERVICE PEDESTAL DETAIL (FOR UNDERGROUND SERVICE)
NOT TO SCALE

1. INSTALL SERVICE PEDESTAL OR SERVICE POLE APPROXIMATELY 10 FEET FROM THE VAULT CO-ORDINATE LOCATION WITH POWER COMPANY.
2. MATERIAL OF CONDUIT FOR INCOMING SERVICE SHALL BE AS REQUIRED BY POWER CO. AND TELEPHONE CO.
3. STAY WIRE FOR SERVICE POLE NOT NEEDED FOR SHORT, LOOSELY STRUNG SPANS.



SECTION AA
NOT TO SCALE



SERVICE POLE DETAIL (FOR OVERHEAD SERVICE)
NOT TO SCALE

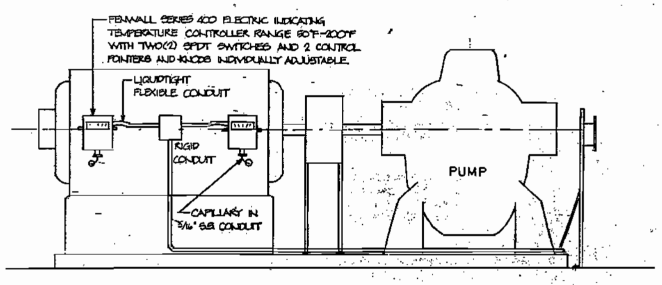
TECHNICAL SERVICES GROUP

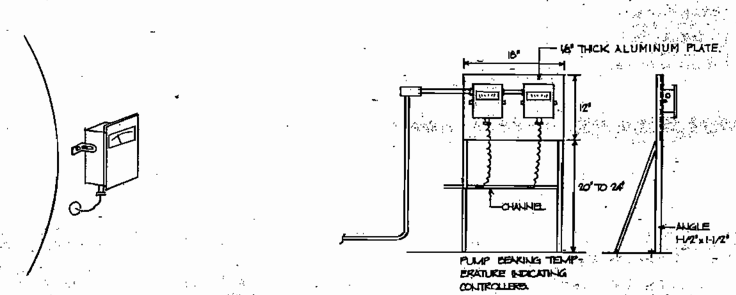
DATE	REVISION

DG-02-12

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS
REMOTE PRESSURE SENSOR VAULT DETAILS (FOR BOOSTER STATIONS WITH PUMPED STORAGE)



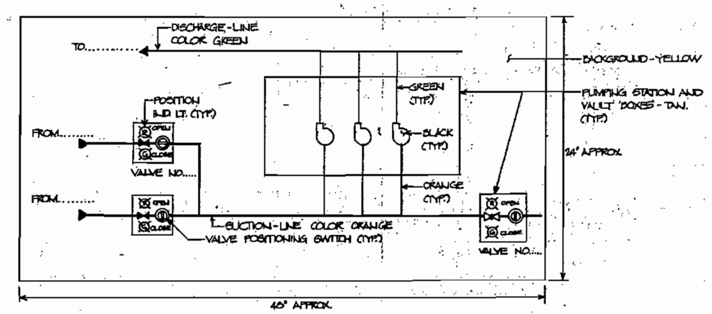


INSTALLATION DETAILS FOR BEARING TEMPERATURE INDICATING CONTROLLERS

(FOR PUMP UNITS 500 HP AND ABOVE)

NOT TO SCALE

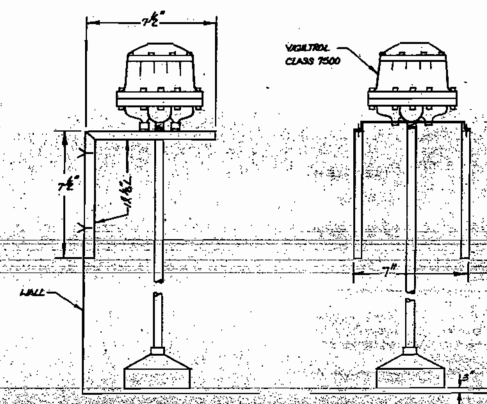
1. MOUNT INDICATING TEMPERATURE CONTROLLERS FOR MOTOR BEARINGS ON THE MOTOR ITSELF.
2. MOUNT PUMP BEARING TEMPERATURE INDICATING CONTROLLERS ON A PANEL, NEAR THE PUMP, PREFERABLY PARALLEL TO THE SUCTION PIPE.



MIMIC OR GRAPHIC DISPLAY PANEL

NOT TO SCALE

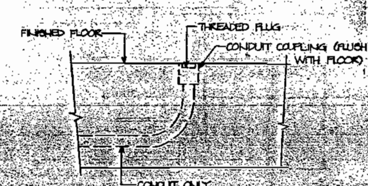
THE ABOVE SKETCH IS SHOWN JUST TO INDICATE THE GENERAL REQUIREMENTS. THE GRAPHIC DISPLAY PANEL SHALL REPRESENT THE HYDRAULIC SCHEME OF THE PUMPING STATION DEPICTING EACH MAJOR STRUCTURE AND COMPONENT. LETTERING TO BE BLACK.



NOTE: LOCATE ON WALL NEAR EMERGENCY SUMP PUMP.

FLOOD SENSOR MOUNTING DETAILS

NOT TO SCALE



CONDUIT TERMINATION FOR FUTURE EQUIPMENT

NO SCALE

TECHNICAL SERVICES GROUP

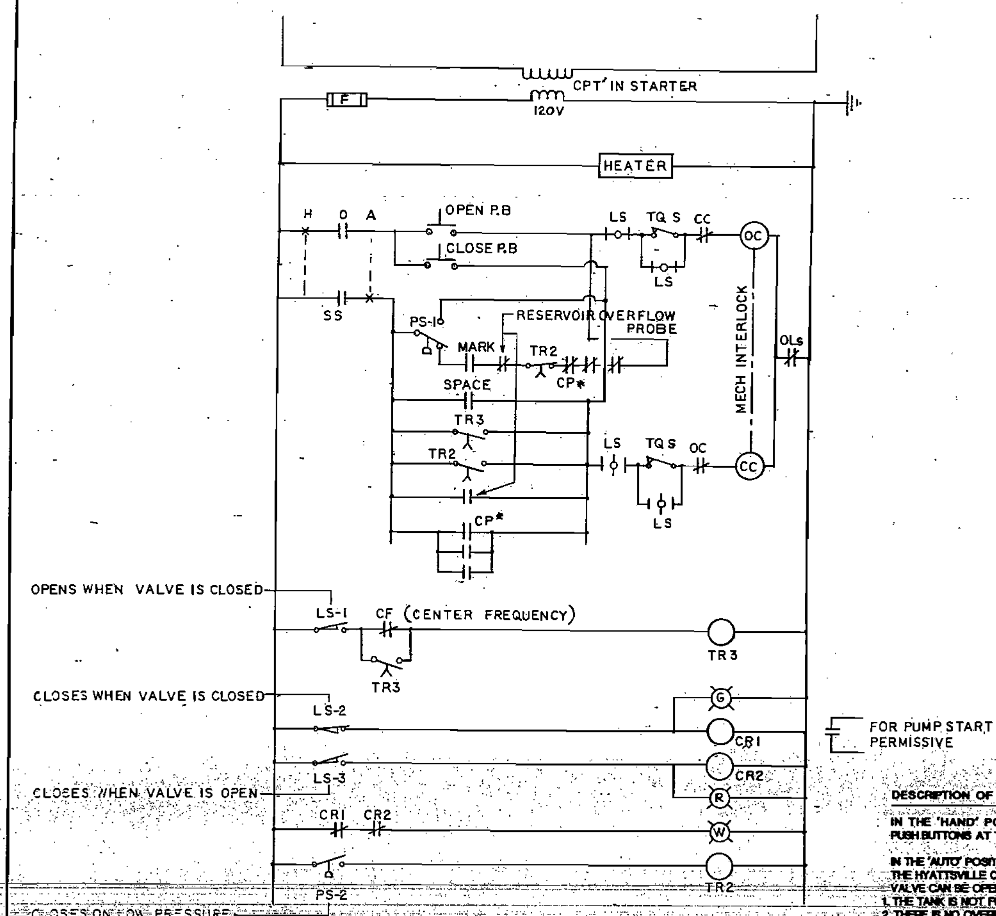
DATE	REVISION

DG-02-13

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

MISCELLANEOUS DETAILS



RESERVOIR FILL VALVE CONTROL SCHEMATIC

NO SCALE

* NUMBER OF CONTACTS DEPENDS ON NUMBER OF PUMPS

DESCRIPTION OF OPERATION

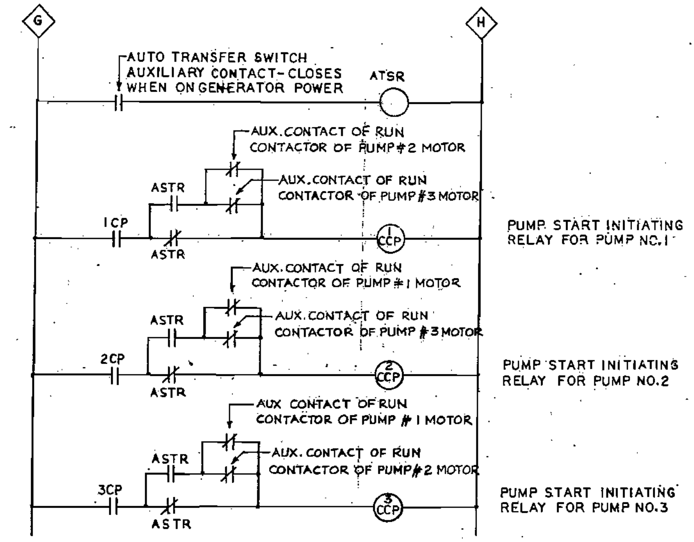
IN THE 'HAND' POSITION VALVE IS CONTROLLED BY THE OPEN AND CLOSE PUSH BUTTONS AT THE PUMP STATION CONTROL PANEL

IN THE 'AUTO' POSITION, THE VALVE CAN BE OPENED OR CLOSED REMOTELY FROM THE HYATTSVILLE CONTROL ROOM VIA TONE.
VALVE CAN BE OPENED BY REMOTE CONTROL ONLY IF
1. THE TANK IS NOT FULL (AS SENSED BY PRESSURE SWITCH PS-1)
2. THERE IS NO OVERFLOW (AS SENSED BY OVERFLOW PROBE)
3. THE VALVE HAS NOT BEEN CLOSED BY LOW PRESSURE AT ANY CONTROL POINT AND
4. PUMPS ARE NOT AUTOMATICALLY CALLED TO RUN.

THE VALVE WILL CLOSE IF
1. CENTER FREQUENCY IS LOST (AFTER A TIME DELAY)
2. LOW PRESSURE EXISTS AT ANY CONTROL POINT (AFTER A TIME DELAY)
3. RESERVOIR OVERFLOWS OR
4. PUMPS ARE CALLED TO RUN.

NOTE: OPENING OF THE VALVE IS NOT AUTOMATIC— HAS TO BE DONE BY REMOTE CONTROL FROM HYATTSVILLE CONTROL ROOM

CONTINUED FROM DG-02-9



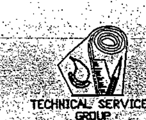
INTERLOCK SCHEMATIC

NO SCALE

TO PREVENT STANDBY PUMP FROM STARTING WHEN ON GENERATOR POWER

SCHEMATIC SHOWN IS FOR THREE PUMPS. MODIFY AS REQIRED DEPENDING ON NUMBER OF PUMPS.

IF THIS INTERLOCK SCHEME IS USED, USE CONTACT OF CCP INSTEAD OF CP FOR INITIATING PUMP START IN PUMP CONTROL SCHEMATIC SHOWN ON DG-02-6



DATE	REVISION

DG-02-14

WASHINGTON SUBURBAN SANITARY COMMISSION

DESIGN GUIDELINES FOR WATER BOOSTER PUMPING STATIONS

CONTROL SCHEMATIC FOR RESERVOIR FILL VALVE ETC.