

Ref. Dwg.: B1-081-P50-001
B1-083-P50-001
B1-016-P50-002
B1-028-P50-004
B1-044-P50-006
B1-046-P50-006

B1-011-P50-000
B4-534-P50-006
B4-535-P50-006
B7-059-P50-001

STEAM, CONDENSATE AND FEEDWATER SYSTEM DESCRIPTION

A. BOILER STEAM OUTLETS - NOS. 1, 2, 3, 4, and 5

Superheated steam at 1250 PSIG and 950°F leaves the boilers through the superheater outlet header via the boiler steam lead line which is connected directly to a common main steam header. Each lead line is equipped with a floating disc non-return valve which prevents reverse flow of steam from the main steam header back into the boiler. The boiler lead lines are of varying sizes consistent with their design load capacities. The size of the main steam header varies from 16" at Boilers 1 and 2 to 18" starting at Boiler 3. The original header at Boilers 1 and 2 is connected to the header for Boiler 3 via two 10" lines and one 4" expansion loop equipped with isolating valves. The header between Boilers 3 & 4, ~~and 5~~ are similarly connected via isolating valves. Expansion loops are provided between Boilers 3 & 4, ~~and 5~~ to prevent distortion of the header due to the high operating temperature of the steam.

The superheated steam passes through flow nozzles in each boiler lead line where the flow is measured for Control Room recorder indication and for feedwater-drum level control. This is described in detail in the "Three Element Feedwater Control" section. Pressure and temperature of the steam in each lead line is also measured for recorder indication and for steam temperature control on Boilers ~~3 & 4~~ 4, ~~and 5~~.

Direct-current motor-operated valves are provided on each lead line at the connection to the main steam header. The control switches for the MOV's are located on the Mechanical Console Boards and in addition the valves are equipped with local push-button stations and handwheels. The push-button station at each valve is interlocked with the control switch on the Console Board. This interlock circuit has been designed to prevent the switch on the board from operating against the push-button station while the valve is being operated locally. The control circuit of the valve can be disconnected by either pulling out the control switch on the Board or by opening the line switch at the valve starter, ~~thus avoiding~~ avoiding accidental operation of the valve during maintenance.

Between Boilers 1 and 2, two 8" lines from the 16" main steam header provide steam to a 475# Pressure Reducing and Desuperheating Station and a 235# Pressure Reducing and Desuperheating Station. These lines are equipped with manual isolation valves.

Between Boilers 3 and 4, a 10" line takes off from the 18" main steam header for No. 2-235# Pressure Reducing and Desuperheating Station. This line is equipped with a manual isolation valve adjacent to the main steam header and a direct-current motor-operated valve immediately upstream of the Pressure Reducing Valve. The Control Switch for this MOV is located on the Boiler 4 Console Board.

A 2" auxiliary steam header takes off from the 16" main steam header between Boilers 1 and 2 supplies high pressure-high temperature steam to the ~~hogging jet~~, hogging jet and to the steam driven auxiliary oil pump for Turbine 1. Also, a backup for Turbine 1 sealing steam is provided from the take-off to the hogging jet.

An electromagnetic relief valve (ERV-1) is installed on the 16" main steam header between Boilers 1 and 2 for automatic or remote controlled relief of the main steam header pressure. The remote-manual control switch for the valve is located on the Mechanical Console Board. Identical valves (except for relieving capacity) are installed on the boiler side of the non-return valves on Boilers 3, 4, ~~and 6~~. Their control switches are also located on the Mechanical Console. The popping pressure of these

The steam flow of each 10" line to the turbine is measured by a flow nozzle and is transmitted to a CRT in the control room. The flow from both 10" lines to the turbine is totalized through integrators.~~installed-in-the-~~ The pressure and temperature of the turbine steam is also indicated on

After expanding through the first six stages of the turbine, steam is automatically extracted at 475# for process use. After expanding through stages 7, 8 and 9 steam is automatically extracted at 235# for process use. 235# steam from process can also be admitted to the turbine at the maximum rate of 200,000 #/hr. After expanding through stages 10 and 11, there is a non-automatic uncontrolled extraction opening where steam is supplied to the Power Plant 30 psig header for deaerating and feedwater heating. The steam passing through the low pressure turbine is exhausted to the surface condenser where it is cooled and condensed by coming in contact with the tube bundles which have circulating water (untreated river water) flowing through them.

In the event of excessive condenser tube leakage, one side of the condenser can be isolated and still allow the turbine to continue operating, but at reduced load on the opposite half of the condenser. Contamination from the leakage is detected by two conductivity cells, one in each divi-

g CRT in the Control Room.
ded hotwell condensate outlet. The conductivity cells transmit a signal to ~~the recorder on the Process Auxiliary Board~~. High conductivity in the condensate is annunciated on the ~~Process Auxiliary Board~~. *Rel.*

The condenser is equipped with locally mounted level gauges in each half of the hotwell, locally mounted vacuum pressure gauge and temperature indicator. A pressure transmitter is used to transmit condenser back-pressure to a ~~recorder on the Mechanical Vertical Board and a pressure gauge on the Process Auxiliary Board~~. *CRT in the Control Room.*

Pressure is also indicated by a mercury manometer.
A constant water level of 7" in the hotwell is maintained by means of a level controller. The level controller delivers an air loading signal to throttle a 3" control valve located at the main condensate header. This control valve is equipped with a manual operator and has the lock-in position feature during control air failure. A 6" by-pass line with a 6" globe valve is provided. High or low water level (3 1/2" above or 4 1/2" below normal water level) in each half of the hotwell will be annunciated on the Mechanical Vertical Board.

A 6" manually operated globe valve, located at the side of the condenser with a 6" stack is used for breaking the condenser vacuum. A 1/2" seal water line is connected to the stack to detect any leakage of the normally closed 6" globe valve.

D. CONDENSATE PUMPS 1A AND 1B

Two 900 GPM full-capacity vertical pumps, one of which is a stand-by, with a differential head of 225 feet are used to take suction from the condenser hotwell and discharge condensate through a 6" condensate header to the air ejector, then to the turbine gland seal condenser, ~~the pressure station~~ and to the common condensate header connected to the Deaerators.

The suction line is 14" for each condensate pump with a valved 14" line interconnecting both condensate pump suction. The interconnecting line provides the flexibility of one pump normally taking suction from both halves of the hotwell ~~and the other pump taking suction from the contaminated half and discharging to the common header~~. The pump discharge connections are installed at the discharge outlet between the 6" check valve and the 6" gate valve. A closed and capped 2" globe valve is provided for the discharge of contaminated condensate to the condenser pit. In the event of a pump out, one condensate pump will be used for this purpose with the 6" gate valve at the discharge outlet and the 14" valve at the interconnecting suction line closed and the 3" globe valve open. The other condensate pump will be used to pump water in the normal manner from the uncontaminated condenser half.

The condensate pumps are directly connected to a vertical electric motor drive and can be started and stopped at a local push-button station. One pump is used during normal operation. A pressure switch is installed at the discharge header to start the standby pump upon low pressure. A low pressure alarm will be annunciated on both the Mechanical Vertical Board ~~and the Process Auxiliary Board~~. A locally mounted pressure gauge is provided at each pump discharge outlet.

A 3/4" seal water line tapped off from the condensate discharge header supplies condensate for condensate pump shaft packing gland sealing. A pressure gauge is installed at the seal water inlet on each pump for pressure indication which will be positive while the pump is in operation.

E. AIR EJECTORS NO. 1

A two-stage, ^{removing} twin-element air ejector with inter and after condensers is used for ~~removing~~ air from the condenser. A 2" steam line from the ~~main steam header~~ ^{475"} supplies steam for operating both ejectors.

~~1250 PSIG main steam pressure is reduced to 400 PSIG by means of a hand-operated valve for operating the air ejector.~~ ^{attention line supplies} Relief valves are provided with the air ejector to avoid over-pressure in the systems. The hogging ejector, used to evacuate the condenser during the start-up, discharges through a silencer to avoid excessively high noise level in the area surrounding the hogging ejector. ¹²⁵⁰ Steam to the hogging jet is reduced to 500 PSIG by a manually-operated throttling valve.

The vapor and operating steam condensed in the inter and after condenser of the air ejector is returned to the main condenser through trap drains. The air ejector rejects the non-condensable gases to the atmosphere through an air meter.

The condensate pump discharge header supplies condensate to the air ejector for condensing the steam vapor. A 6" by-pass line with a 6" globe valve is provided for the condensate to bypass the main air ejector.

F. GLAND SEAL CONDENSER NO. 1

Main condensate is ^{steam} supplied to the gland seal condenser to condense all the leak-off ~~water~~ from the turbine glands. The condensate of the gland seal condenser is returned to the main condenser through a trap drain system. ~~High water level of the gland seal condenser will be maintained on #1 Process Auxiliary Board.~~ The gland seal condenser is a shell-and-tube type heat exchanger and is furnished by the turbine manufacturer. A 6" bypass line with a 6" globe valve is installed for the main condensate to bypass the gland seal condenser.

~~A condensate recirculation control station is provided to maintain a minimum condensate flow of 200 gallons per minute through both the air ejector and the gland seal condenser while the turbine is generating minimum electric load and the condenser is operating at its minimum exhaust steam load.~~

~~The recirculation control station is installed in a 3" branch line tapped off from the main condensate header at downstream of the gland seal condenser. A 2" control valve is controlled from a flow orifice and a flow controller located at the condensate header after the low pressure heater. The control valve will be opened upon receiving a low flow signal from the flow controller and the condensate will be recirculated back to the main condenser through the control valve. A 3" globe valve is provided for the recirculation control valve by-pass.~~

G. LOW-PRESSURE HEATER NO. 1

A horizontal closed type heater with internal drain cooler welded in the main condenser transition piece receives extraction steam from the turbine low-pressure stages for main condensate heating. The extraction steam from the turbine low-pressure section is extracted through four 10" openings to two 16" headers connected to the heater shell. These extraction lines are located inside the condenser shell.

The extraction steam pressure, ranging from 4 psia to 18 psia, varies in proportion to the condenser steam loads. The extraction steam is condensed by the main condensate flowing through the heater tubes and the drain is connected to the suction of the low-pressure heater pump which discharges into the main condensate header. A level control valve in the discharge of the low-pressure heater pump is employed for controlling the normal drainage to the suction of the pump by receiving a signal from a level controller installed at the heater shell. In case of high level in the heater due to condensate tube leakage or outage of the pump, a 2" dump valve controlled by the same level controller will discharge the excess water through a separate 3" drain line to the condenser hotwell. High and low water levels in the heater will be annunciated both on the Electrical Board and the #1 Process Auxiliary Board. Temperature of the condensate is measured by locally mounted thermometers located before and after the low-pressure heater. A relief valve is installed on the water box of the heater to prevent overpressure in the heater. A 6" bypass line with a 6" globe valve is provided at the low-pressure heater for the main condensate to bypass the heater. Main condensate flow to the deaerators is recorded on the Process Auxiliary Board through flow transmitter.

H. STEAM TO TURBINE 2

Two 12" lines connected to the 18" main steam header near Boiler 3 supply steam through a 12" by 12" by 18" "Y" fitting to the Turbine 2 stop valve at ~~100~~ ¹²⁵ psig and 950°F. A 12" motor-operated gate valve is installed in each 12" line. The operation of these valves is the same as the MOV's to No. 1 Turbine.

The steam flow of each 12" line to the turbine is measured by a flow nozzle and is transmitted to a recorder on Turbine 2 Board. The flow from both 12" lines to the turbine is totalized through integrators. The temperature and pressure of the turbine steam is also recorded on the Turbine Board.

After expanding through Stages 1 through 6 in the high-pressure turbine, steam is automatically extracted from an opening controlled at 235 psig for process use. The turbine is designed to generate 60,000 KW with the automatic extraction supplying process steam of 1,000,000 #/hr. at 235 psig. Uncontrolled extraction openings (high pressure and low pressure) are provided between the seventh and eighth stages and the ninth and tenth stages to supply steam to the Power Plant 30 psig header for deaerating and feedwater heating. Normally the low-pressure opening is open with the high-pressure opening closed. Only one at a time can be used. ~~Steam is~~

~~also extracted (uncontrolled) from the low pressure turbine for condensate heating in the low pressure heater.~~

I. NO. 2 CONDENSER

The condensed exhaust flow from the turbine, the drains from the gland seal condenser, and the air ejector are accumulated in the hotwell of the condenser. ~~This unit also has an L.T. HEATER PUMP and its operation is identical to No. 1 Condenser.~~ The Worthington 40,000 sq. ft. condenser is a horizontal, two-pass unit with a divided 2800 gallon hotwell. At maximum electric generation of 60,000 KW, the condenser is designed to condense turbine exhaust steam of 400,000#/Hr. at zero-automatic extraction steam load and 280,000#/Hr. at full automatic extraction steam load.

In the event of excessive condenser tube leakage, one side of the condenser can be isolated and still allow the turbine to continue operating, but at reduced load, on the opposite half of the condenser. Contamination from the leakage is detected by two conductivity cells, one in each divided hotwell condensate outlet. The conductivity cells transmit a signal to a ~~recorder on the Process Auxiliary Board.~~ *on the C.R.T.* High conductivity in the condensate is annunciated ~~in the Process Auxiliary Board~~ *on the C.R.T.*

The condenser is equipped with locally mounted level gauges in each half of the hotwell, locally mounted vacuum pressure gauge and temperature indicator. A pressure transmitter is used to record condenser back-pressure ~~in the recorder on the Mechanical Control Board and to a draft gauge on the Process Auxiliary Board.~~ *Pressure is also indicated on a mercury manometer in the Control Room.*

A constant water level of 7" in the hotwell is maintained by means of a level controller. The level controller delivers an air loading signal to throttle a 2" control valve located at the main condensate header. This control valve is equipped with a manual operator and has the lock-in position feature during control air failure. A 6" bypass line with a 6" globe valve is provided. High or low water level (3 1/2" above or 4 1/2" below normal water level) in each half of the hotwell will be annunciated on the Mechanical Vertical Board.

A 6" manually operated globe valve, located at the side of the condenser with a 6" stack is used for breaking the condenser vacuum. A 1/2" seal water line is connected to the stack to detect any leakage of the normally closed 6" globe valve.

J. CONDENSATE PUMPS 2A AND 2B

Two 1030 GPM full-capacity vertical pumps, one of which is a standby with a differential head of 225 feet are used to take suction from the condenser hotwell and discharge condensate through a 6" condensate header to the air ejector then to the turbine gland seal condenser, ~~low pressure heater~~ and the common condensate header to the deaerator.

The suction line is 12" for each condensate pump with a line interconnecting both condensate pump sections. The interconnecting line provides the flexibility of one pump normally taking suction from both halves of the hotwell. ~~A pump-out discharge connection is installed at the discharge~~

~~outlet between the 4" check valve and the 4" gate valve to the circulating water outfall.~~

The condensate pumps are directly connected to a vertical electric motor drive and can be started and stopped at a local push-button station. One pump is used during normal operation. A pressure switch is installed at the discharge header to start the standby pump upon low pressure. A low pressure alarm will be annunciated on ~~the~~ the Mechanical Vertical Board ~~and the Process Auxiliary Board.~~ A locally mounted pressure gauge is provided at each pump discharge outlet.

K. AIR EJECTOR NO. 2

A two-stage, twin element Worthington air ejector with inter and after condensers is used for ~~purging~~ ^{relieving} the air from the condenser. Relief valves are provided with the air ejector to avoid over-pressure in the system. The hogging ejector used to evacuate the condenser during the startup, discharges through a silencer to avoid excessively high noise level in the area surrounding the hogging ejector. Steam for operating both ejectors is taken from an auxiliary line connected to the 235# process header.

The vapor and operating steam condensed in the inter and after condenser of the air ejector is returned to the main condenser through trap drains. The air ejector rejects the non-condensable gases to the atmosphere through an air meter.

The condensate pump discharge header supplies condensate to the air ejector for condensing the steam vapor. A 6" bypass line with a 6" globe valve is provided for the condensate to bypass the main air-ejector.

L. GLAND SEAL CONDENSER NO. 2

Main condensate ^{steam} is supplied to the gland seal condenser to condense all the leak-off ~~water~~ from the turbine glands. The condensate of the gland seal condenser is returned to the main condenser through a trap drain system. High water level of the gland seal condenser will be annunciated on the ~~Process Auxiliary Board.~~ The gland seal condenser is a shell-and-tube type heat exchanger and is furnished by the turbine manufacturer. A 6" bypass line with a 6" globe valve is installed for the main condensate to bypass the gland seal condenser.

~~A condensate recirculation control station is provided to maintain a minimum condensate flow of 200 gallons per minute through both the air ejector and the gland seal condenser while the turbine is generating minimum electric load and the condenser is operating at its minimum exhaust steam load.~~

~~The recirculation control station is installed in a branch line tapped off from the main condensate header downstream of the gland seal condenser. A control valve is controlled from a flow orifice and a flow controller located at the condensate header after the low pressure heater. The control valve will be opened upon receiving a low flow signal from the flow controller and the condensate will be recirculated back to the main condenser through the control valve. A globe valve is provided for the recirculation control valve bypass.~~

M. LOW-PRESSURE HEATER NO. 2

(Same as No. 1.)

N. STEAM TO TURBINE 3

A 16" line connected to the 18" main steam header near Boiler 4 supplies steam through a 16" by 18" reducer to the Turbine 3 stop valve at 1250 psig and 950°F. A 16" motor-operated valve is installed in the lead line. The operation of this valve is the same as the MOV's to the other Turbines.

Steam flow metering, flow through Turbine, process steam and 30% steam extraction, etc. are similar to that on Turbine 2.

and admission

O. NO. 3 CONDENSER

Manufactured by Ingersoll-Rand. Similar specifications to those on No. 2.

P. CONDENSATE PUMPS 3A AND 3B

Capacity 1000 GPM with a differential head of 195 feet. Otherwise, similar in operation to those on No. 2 Condenser.

Q. AIR EJECTOR NO. 3

Manufactured by Ingersoll-Rand. Otherwise, similar in operation to that on No. 2 Condenser.

R. GLAND SEAL CONDENSER NO. 3

Identical in design and operation to the one on No. 2 Turbine.

S. LOW PRESSURE HEATER NO. 3

Similar in operation to those on Turbines No. 1 and No. 2, except that it is a separate unit, removed from the Condenser transition piece, located on the Turbine level.

T. STEAM TO TURBINE 4

Steam lead line specifications are the same as those described for Turbine 3. Steam flow metering is also similar.

After expanding through the Turbine, process steam is extracted at 475 psig. The remainder of the steam exhausts into the ¹⁵⁰ psig system which supplies the ~~backstop~~. The turbine is rated at 50,000 KW with straight exhaust. ~~Higher loads can be attained as extraction load is applied.~~

U. GLAND SEAL CONDENSER NO. 4

Cooling and process water are supplied to the condenser to condense the leak-off vapor from turbine glands. The resulting condensate is piped to waste through a loop-seal. High level is annunciated.

July 1977

Page 222

DO 125343
CONFIDENTIAL

N. DEAERATORS NO. 1 AND 2

The two parallel operated Allis-Chalmers deaerators are installed to receive the main condensate from the condensate pump discharge and condensate make-up returned from the condensate storage tank.

Each deaerator is of spray, direct contact type equipped with a horizontal water storage tank and is designed to supply deaerated water at the storage tank outlet at any quantity up to 514,450 #/Hr. during normal operating conditions with a guaranteed oxygen content of not more than .005 cc per liter. For overload allowance each deaerator is capable of supplying deaerated water up to 625,000 #/Hr.

DEAERATOR NO. 3

No. 3 Deaerator is similar to Deaerators No. 1 and 2 except that it is designed to supply deaerated water at the storage tank outlet at any quantity up to 685,000 #/Hr. during normal operating conditions with a guaranteed oxygen content not to exceed .0005 cc per liter. For overload allowance this deaerator is capable of supplying deaerated water up to 800,000 #/Hr.

DEAERATOR NO. 4

This unit, manufactured by the Permutit Co., is of the vertical spray type mounted on a horizontal storage tank with a design outlet capacity of 1,100,000 #/Hr. The storage tank has an operating capacity of 91,700 pounds of condensate equal to five minutes at full load.

DEAERATOR NO. 5

Also manufactured by the Permutit Co., Deaerator No. 5 is identical to No. 4 except design outlet capacity is 1,800,000 #/Hr. The storage tank has an operating capacity of 17,160 gallons equal to five minutes at full load.

The deaerating sections of both 4 and 5 are quite different from the other three units. Refer to the Operating Manual for details.

The normal heating steam supply to the deaerators is supplied from the exhaust on Turbine 4.

Turbine cross-over extraction openings supply a back-up source for DA steam.

The use of cross-over extraction steam instead of automatic extraction steam for deaerators heating allows the steam to expand in the turbines to the cross-over point, thus improving the thermal efficiency and providing additional electrical power output.

Two deaerator heating steam back-up stations reducing process steam pressure are provided for primary back-up in case of loss of Turbine 4.

2

The No. 1 back-up heating steam station consists of a 6" pressure control valve and a bypass with a 6" globe valve. This control valve is equipped with manual operator and has the lock-in position feature for control air failure. The pressure control valve receives a pressure signal from a pressure controller located at the 18" deaerator heating steam supply header. Should the turbine stage pressure at the cross-over opening drop due to the increasing of process loads, the back-up station will supply steam to the deaerators. This back-up steam station ~~receives process steam from the 235 PSIG process steam header.~~ The back-up heating steam flow is measured through a flow nozzle, ~~and recorded on Process Auxiliary Board. Temperature and pressure of the heating steam to deaerators are recorded on a recorder on the Process Auxiliary Board.~~ Locally mounted pressure gauges and thermometer are installed at the header. Stage pressure of the cross-over extraction opening is indicated remotely on the Mechanical Vertical Board through a pressure transmitter to a draft gauge. Locally mounted pressure gauge and thermometer are also installed at the outlet of the extraction opening. Low and high pressures of the deaerator heating steam header will be annunciated ~~on the Mechanical Vertical Board and the Process Auxiliary Board.~~

WEST OF

The No. 2 back-up heating steam station (located ~~between~~ Boilers 4 ~~and 5~~) consists of two 8" pressure reducing valves and an 8" manual bypass tied into a 12" line taking off from the 30" 235 PSIG header running north and south across Block 28. ~~The line runs side (low pressure) into the 30 PSIG heating steam header near Deaerator 5.~~ Its operation is identical to that of the No. 1 Station.

Lines connected to the 18" steam header receive saturated vapor generated in the boiler continuous blowdown tanks. This arrangements recovers approximately 40% of the boiler blowdown quantity and returns it to the turbine cycles.

The deaerators collect a split flow of condensate from the condensate pump discharge header and split flow of make-up condensate from the condensate make-up pump discharge header. Each branch of the make-up condensate will pass through a control station before entering into the deaerator.

Each control station consists of a level control valve receiving a loading signal from a level controller for maintaining a constant and identical water level between the parallel operated deaerators. These control valves are equipped with manual operator and have the lock-in position feature for control air failure. A bypass valve for each control valve is provided. Normal water level is controlled at 7', 3" above the bottom of the deaerator water storage tank.

A high level alarm is set at a high water level of 8', 0" and is annunciated on ~~both~~ the Mechanical Vertical Board ~~and Process Auxiliary Board.~~ A low level alarm is set at a low water level of 4', 6" and is also annunciated on ~~both~~ the Mechanical Vertical Board ~~and Process Auxiliary Board.~~ A steel plate welded at one end of the storage tank forms a weir to discharge the overflow water. In case of system surge and the water level rises high enough, the water will overflow into the weir

space. A level controller sends an air loading signal to open an emergency dump valve when water level in the weir space exceeds 10". ~~The overflow water is sent to the 500,000 gallon condensate storage tank through a 10" header. A perforated pipe extends to the bottom of the storage tank is provided with a 1/2" hole. A mixture of the flow water and the condensate is discharged into the weir space.~~

The water level in the deaerator storage tank is indicated ~~on~~ on the Mechanical Vertical Board, ~~and Process Auxiliary Board~~. A level gauge is installed ~~on~~ the ~~deaerator~~ storage tank for local indication of the water level. Two thermometers are mounted at the deaerating section and at the storage tank for local temperature indication.

All the deaerator water storage tanks receive recirculation of feedwater from the boiler feed pumps.

The deaerators are connected on top of each storage tank by a 14" steam equalizing line. The function of this line is for equalizing the pressures between the deaerators. In order to attain an identical water level inside these parallel water storage tanks, a constant pressure must be maintained. A normally opened 14" gate valve is installed at the equalizing line for isolating the deaerators, if necessary. ~~From the 14" steam line supply steam from the 14" steam pressure equalizing line to various steam heating units for building steam heating.~~

0. BOILER FEED PUMPS 1, 2, 3, 4, 5, 6, ~~and 7~~

~~Six~~ ^{Six} motor-driven, barrel-type, multi-stage, centrifugal pumps are used to supply boiler feedwater. Three Allis-Chalmers units, (Nos. 1, 2 and 3) are driven by 1250 h.p. Allis-Chalmers motors and are designed to pump 1160 gpm against 4000 foot head at 3580 rpm. Allis-Chalmers Pump 4 is driven by a 1750 h.p. Allis-Chalmers motor and is designed to pump 1590 gpm against 4000 foot head at 3570 rpm. Pacific Pumps 5 and 6, driven by 1500 h.p. General Electric motors, are designed to pump 1344 gpm against a 4020 foot head at 3570 rpm. ~~Pacific Pump 7 and 8, driven by 2250 h.p. General Electric motors, are designed to pump 1954 gpm against a 4000 foot head at 3580 rpm.~~ The lubricating oil for the bearings of each pump is supplied normally by a gear-type oil pump from the pump shaft. There is a standby electric motor-driven auxiliary lube oil pump for each boiler feed pump that can be started by a two-position control switch on Boiler Feed Pump Board. The auxiliary lube oil pump control switches can be selected to be "TEST" or "AUTOMATIC". The switch should be selected on "AUTOMATIC" during normal operation. In case of low lube oil pressure, the "AUTOMATIC" position pressure switch will start the pump and sound an alarm. The pressure switch stops the auxiliary lube oil pump when the shaft driven pump has restored the oil pressure. The auxiliary lube oil pump can be started manually by putting the switch to "TEST" prior to the start-up of the boiler feed pump.

Also, the functioning of the auxiliary lube oil pump of a standby boiler feed pump can be tested. One red light for each auxiliary lube oil pump is installed on Boiler Feed Pump Board to give indication as to which and when the auxiliary lube oil pump is in operation.

The pumps are quipped with recirculation lines to provide protection against overheating during low pumping rates. When a pump requirement is less than 60,000#/Hr., the recirculation control valve will open, allowing the pump to stay above minimum flow by recirculating feedwater back to the deaerators. When pump requirement rises above 140,000#/Hr., the recirculation valve will close.

The pumps are equipped with water cooled stuffing boxes. Process water is piped to water jacket around the stuffing boxes for the purpose of keeping the packing cool and is discharged through piping to the plant drainage system. The discharge line has a thermometer for observing outlet temperature.

During a normal operation, feedwater passing through the BFP's is above the boiling point and leakage past the packing is prevented from flashing by mixing this leakage with cool water piped from the discharge of the condensate pumps to the packing retaining flanges. These snuffing water lines have throttle valves at each flange. Back-up snuffing water is provided by a tie-in to the make-up discharge line.

The discharge line from each pump is equipped with ^{TWO} non-return valves which prevents loss of pressure in the discharge header upon stopping a pump. *they also prevent back siphoning of the pumps.*

Necessary warm-up lines from the BFP discharge header bypasses the BFP non-returns and allows hot water from the header to back up through the BFP's keeping them at operating temperature when on standby.

Switches for starting or stopping the feed pumps 1, 2, 3, 4, 5, and 6 are located on the mechanical console and the boiler feed pump panels. Ammeters are also provided.

Boiler Feed Pumps 7 and 8 can only be started and stopped from the Process Auxiliary Board in No. 2 Auxiliary Control Room.

Condensate leaving the deaerator flows under pressure and force of gravity to the BFP suction header. Suction lines branch off of this header to supply condensate to the BFP's. A gauge is provided on each suction line just above the pumps for local pressure indication.

The BFP's discharge line supply 2000 PSI to the BFP discharge header. This header supplies high pressure feedwater to the boiler atomizer valves, the boiler's feedwater control valves, the desuperheating stations, and ~~the boiler's feedwater control valves.~~

Valves are provided in the discharge and suction lines to each pump for isolation purposes.

P. HIGH PRESSURE FEEDWATER HEATERS

Feedwater to Boilers #1, #2, and #3 is preheated before entering the economizers by the High Pressure Heaters, using 235 psi steam to raise the water temperature to approximately 390-400° F.

~~Steam flow to the heaters is adjusted manually from the main Control Room, with controllers for heaters #1 and #2, and a manual for #3.~~

Condensate level in each heater is maintained by a regulator which controls drainage of condensate from each heater to the flash-tank. High level alarms are provided for each heater, announced in the main Control Room.

Condensate from the three heaters flows into the flash-tank where a portion of it flashes to steam and is piped into the 30% system. Condensate which accumulates in the bottom of the tank is pumped through a regulator, which controls the level in the tank, into the make-up system.

High level and high pressure alarms on the flash-tank are announced in the main Control Room.

Q. SPRAY WATER PUMP

This motor-driven pump has the function of supplying hotwell condensate at sufficient pressure, to the attemperator spray water control valves on Boilers 3, 4, and 5 for superheat temperature control. It takes suction from the 8" condensate header near the southwest corner of Boiler 3 and discharges into the 6" spray water header. The header is reduced in size from 6" to 4" just downstream of the Boiler 4 take-off. The 4" take-offs to each Boiler are equipped with manual block valves and check valves, and are interconnected with lines from the boiler feed pump discharge header. Installed in each of these lines near the interconnection is a motor-operated valve and a check valve.

With proper valving arrangement, #5 boiler feed pump can also be used to pump condensate to the boiler sprays.

Q. AUTOMATIC EXTRACTION STEAM - NO. 1 TURBINE

The turbine is designed to supply process steam at two automatically controlled extraction openings. Each extraction opening is automatically controlled by a governor at a pressure of 475 PSIG and 235 PSIG, respectively, to deliver process steam varying from zero to 700,000 pounds per hour at 475# and 400,000 pounds per hour at 235#.

The system can also admit 700,000 lb. / hr. #
~~The flow, pressure and temperature of the extraction lines are recorded on the Mechanical Vertical Board.~~ *Steam back into*

~~Locally mounted pressure gauges are provided on the Turbine Start-up panel. In case of high temperature, an alarm will sound on both the Mechanical Vertical Board and process Auxiliary Board. Relief valves are installed upstream of the non-return valves for protection against over-pressure in the turbine.~~

These two groups of relief valves are installed to protect against over-pressure in the turbine under the following concurrent conditions.

1. Turbine operates at no process extraction with generator loaded between minimum to 50,000 KW.
2. The gate valves at each automatic extraction line being closed.
3. The extraction ~~governor mechanism~~ *central system* fails
4. The extraction valve gear fails closed forcing steam into the extraction lines under increasing pressure.

Two air-controlled, swing-check, non-return valves are installed in series in each of the automatic extraction lines to prevent re-entry of steam into the turbine from the process steam lines when the stop valve is tripped by relay action or by hand trip. Each is equipped with a side-mounted operating cylinder which encloses a spring-loaded piston connected by linkage to the non-return valve stem.

The inboard valves are controlled by an oil relay dump valve located on the turbine lube oil reservoir. The outboard valves are controlled by an air dump valve actuated by a cam installed on the lower inlet valve camshaft. In normal operation, air pressure is applied to the bottom of the piston, opposing the spring pressure, and the valve is free to operate as a swing check valve. When the stop valve trips, air pressure on the bottom of the spring loaded piston is dumped to atmosphere and the valve will close due to the stage pressure at the extraction opening dropping lower than line pressure and by the spring pressure in the operating cylinder.

The inboard non-return valves will close instantaneously upon tripping of the turbine stop valve, by reasons of:

1. 110% overspeed trip
2. Low vacuum trip
3. Hand trip
4. Generator differential trip

The outboard non-return valves will close when the lower inlet control valve camshaft rotates in a closed direction actuating the air dump valve to release air pressure on the bottom of the spring-loaded piston. The valves are closed completely by line pressure being higher than stage pressure and by spring pressure in the operating cylinder. The non-return valve in the uncontrolled extraction line operates in the same manner. Test valves are installed for each non-return valve for periodic operation to insure freedom of movement.

R. AUTOMATIC EXTRACTION STEAM - NO. 2 TURBINE

The turbine is designed to supply process steam at a single automatically controlled extraction opening. The extraction opening is controlled by a governor at a pressure of 235 PSIG to deliver process steam varying from zero to ~~1,000,000~~ ^{500,000} #/Hr.

This turbine has two extraction lines tied into a common extraction opening in the turbine. Each is equipped with a motor-operated shut-off valve and dual air-controlled non-return valve. Operation of these non-return valves is identical to No. 1 Turbine's.

~~Flow through the two lines is recorded on the turbine start-up panel. Pressure and temperature (common to both lines) is also recorded on the same instrument.~~

A locally mounted pressure gauge is provided also on the No. 2 Turbine Board. High temperature and high pressure annunciation is provided on the electrical board. Six (6) relief valves are installed upstream of the non-return valves for protection against over-pressure in the turbine which could occur for the same reasons as described for No. 1 machine.

NO. 3 TURBINE

No. 3 Turbine is the same as No. 2 except that it extracts through a single 24" line with a maximum design capacity of 1,100,000#/Hr. The extraction line ties into the 30" North-South header. *235# steam, can also be admitted to the turbine in up to a maximum of 500,000 #/hr*

NO. 4 TURBINE

500,000
This unit is equipped for single automatic extraction at 475 psig with maximum design capacity of ~~1,000,000~~ *500,000* #/hr. from a 24" opening in the turbine shell into a 20" line that ties into the 30" header to LHC II. From this 20" line, there is a 12" take-off increased to 16" that ties into the 18" east-west 235# process header. By use of a ~~control valve~~ *control valve*, we can bypass 475# extraction from this machine into the 235# process header *after being*

desuperheated
In addition to the 475# extraction, this unit exhausts (at ~~475~~ *can between 600 & 1500* psig) from a 42" opening in the turbine shell into ~~the 30" header~~

~~the 30" header~~ *a 36" line to the Caustic Plant.*
Steam can also be let down from the exhaust line into the 30" header through an 8" and a 16" control valves. A desuperheater is installed in the exhaust line to prevent ~~low~~ *excess* temperature in excess of 600°F during start-up.

S. PRESSURE REDUCING AND DESUPERHEATING STATIONS

Steam from the 16" main steam header (between Boilers 1 and 2) is supplied through two 8" lines to two pressure-reducing and desuperheating stations, each of which provides 475 PSIG and 235 PSIG process steam respectively.

Each pressure-reducing and desuperheating station consists of a pressure control valve, a remote controller, a pressure controller, ~~and a temperature control valve~~, a desuperheating water temperature control valve, a temperature controller, and desuperheating nozzles. These two desuperheating stations receive a common source of desuperheating water supplied through a pressure-reducing valve from the boiler feed pump discharge header.

High pressure, high temperature steam passes through the 8" pressure control valve controlled by a pressure controller which reduces its pressure from 1300 PSIG to the set pressure of 475 PSIG and 235 PSIG, respectively.

~~The system is controlled by the Fisher Video-Spec~~
~~pressure controller is provided on the No. 1 Process Auxiliary Board for remote control of the pressure of each station. A 6" bypass line with a globe valve is installed for bypassing each control valve. A desuperheating station is located downstream of each pressure reducing station. Two desuperheating nozzles are installed at the 475 PSIG steam line and three desuperheating nozzles are installed at the 235 PSIG steam line. The desuperheating nozzles of each station receive a small quantity of high pressure steam through a 6" pressure-reducing valve providing an atomizing effect to the incoming desuperheating water. The desuperheating water is supplied through a 2 1/2" pressure reducing valve controlled at 600 PSIG by a pressure controller from the feedwater discharge system. This water at 600 PSIG is common for both the 475 PSIG and 235 PSIG desuperheating station. A separate desuperheating water temperature control station receiving this 600 PSIG water is provided for regulating the desuperheating water quantity to each group of the desuperheating nozzles. This control station consists of a 1 1/2" temperature control valve and is regulated by a temperature controller. A remote manual controller is installed on the Process Auxiliary Board for each of the temperature control valves and atomizing control valve. Remote indications of temperature and pressure of the process steam from the stations are provided on the Process Auxiliary Board facilitating the manual operation of the stations.~~ *CRTS in the CRT (Certs)*

~~The feedwater reducing valve for the desuperheating water to the two temperature control valves is regulated by a pressure controller set at 600 PSIG. A remote manual controller for operating this valve is installed on the No. 1 Process Auxiliary Board. A pressure transmitter transmits the pressure of this supply header to a pressure indicator on the Process Auxiliary Board.~~

A restricting orifice installed at a 2" line tapped off from the desuperheating water supply header recirculates 5% of the water back to the deaerators, thus maintaining a minimum flow passing through the control valve to minimize the wire-drawing that causes the erosion of the

valve while the water demand from the desuperheating nozzles is at a minimum.

Both the process steam supply lines from the desuperheating stations are installed with high temperature alarms and the alarms will sound on both the Mechanical Vertical Board and Process Auxiliary Board.

The process steam supply lines are installed with relief valves for protection against over-pressure in the system. The desuperheating stations deliver back-up process steam to two 18" process steam headers at the east-west pipeway.

A second 235# Pressure Reducing and Desuperheating Station is located ~~near No. 4 Boiler Chemical Feed System~~. It is identical in operation to the No. 1 Station except that it has only one desuperheating nozzle, ~~and a different make of control is used~~. The remote manual controllers are located on No. 1 Process Auxiliary Board.

just west of #6 E. F. Pump -

T. PROCESS CONDENSATE RETURN SYSTEM (See Dwg. B1-046 P50-005)

Two 500,000-gallon capacity condensate storage tanks are located north of the boilers to serve as accumulators of all returning condensate and to insure continuity of condensate supply to the Power Plant.

Each tank is equipped with a level transmitter and level is indicated on two draft gauges on the mechanical vertical board in the main control room. No. 1 tank is provided with high- and low-water level alarms and will be annunciated on ~~both~~ the mechanical vertical board, ~~and the No. 1 process auxiliary board.~~ Level is also transmitted to the Water Treating control room. Overflow lines are installed on each tank to discharge the overflow to the ditch. However, this overflow should be kept minimal for energy conservation purposes.

No. 1 Condensate (East Tank)

Condensate is delivered into this tank from the East Return Line, The Caustic Plant and the Demin Plant. Whenever necessary, each plant on this system can close its appropriate condensate return block valve at their block line and remaining plants can continue to pump. This line has a flow orifice located in each line in the pipeway just north of the tank that transmits the rate of flow of each line to a CRT in the Control Room. A solenoid operated switch located on the dump valve determines which integrator is in service, either the "Dump" or "Take".

~~When the No. 1 process auxiliary board~~ Conductivity higher than 4 MMOHS will be annunciated on the process auxiliary board alarm panel by the recorder. Conductivity higher than 6 MMOHS (however, this is adjustable on the controller) will cause the two-way air-operated dump valve to change positions and dump the condensate to the ditch. The dump valve may also be operated manually by a switch on the No. 1 process auxiliary board or by lowering the "dump" set point on the automatic dump controller.

Because some condensate contaminants (mostly acids) cannot be detected by the two conductivity cells, two organic chloride detectors are also installed on this line. The first is located in the west pipeway opposite the demin plant at Water Treating and is connected to a recorder in the Water Treating control room. The second detector is located in the north pipeway just west of No. 1 condensate tank. ~~This detector is connected to the condensate conductivity recorder (point 8) in No. 1 auxiliary room and alarms at 2-1/2 MMOHS.~~ Organics in the condensate return are detected as follows: The sample from the condensate is pumped into an electrically heated preheater which brings the sample to the boiling point. The vapors then pass into the superheater, also electrically heated, which "cracks" the organic chlorides into acid (probably HCl). The gases then pass into the water-cooled condenser

T. PROCESS CONDENSATE RETURN SYSTEM (cont'd)

where the moisture condenses out as H₂O and acid. The sample then passes through two cells (dual, in event one fails) which measure the specific conductance of the liquid. If an organic is present, the recorder will give a higher than normal conductance reading.

A 10" line delivers demineralized water from the Water Treating Plant to the equalizing line between tanks 1 and 2. A flow orifice on the demin line transmits the rate of flow through a transmitter to a ~~condensate return flow recorder on the No. 1 process auxiliary board~~ *CR in the Control Room*. Flow through the orifice is also totalized by a DP cell and two integrators. A solenoid-operated switch located on the automatic two-way air-operated dump valve determines whether the "take" or "dump" integrator is in service. Two conductivity cells are located in the demin line. ~~The signal from one cell goes to the condensate conductivity recorder in the No. 1 auxiliary room.~~ Conductivity higher than 4 MMOHS will be alarmed on the alarm panel. ~~The other cell transmits a signal to the automatic demin dump controller, also on the No. 1 process auxiliary board.~~ Conductivity higher than 6 MMOHS (adjustable) causes two air-operated valves on the demin line to re-position. One of these valves is located on the line just inside the Power Block and when operated, opens and the demin water flows into the dump line to the ditch. The other valve is located at the tee where the demin line joins the condensate tank equalizing line. This valve simultaneously closes, thus forcing all demin flow through the dump line. When conductivity reaches an acceptable limit, demin dump controller can be manually reset and both air-operated valves will reposition to allow demin flow to be returned to the equalizing line.

~~In addition to the east return and demin lines, the condensate from the Caustic Plant can be put in this tank as well as No. 2 tank. Flow is transmitted from an orifice located in the north pipeway just behind the Power warehouse. Flow is indicated on the condensate return flow chart in No. 1 auxiliary room. Another orifice is located just north of No. 2 tank. Its installation flow is~~
~~"Small and Hard to see"~~

For water quality detection, there are three conductivity cells. One cell is located where the 10" Caustic return turns to leave the pipeway into #1 tank. The other two cells are located just east of the railroad track; two of these cells are for indication and alarm, the third is connected to the Dump controller. The dump controller conductivity cell operates both sets of dump valves on the Caustic return line; one set is located where the line enters the block at #2 Tank, the other set is just west of #1 tank.

~~When the controller opens both dump valves and~~
condensate goes to the ditch. The dump valve for No. 2 tank also activates the solenoid for putting the appropriate integrator in

T. PROCESS CONDENSATE RETURN SYSTEM (cont'd)

service. "Dump Valve Open" is alarmed in the main control room. When conductivity is again acceptable, dump controller can be manually reset to reposition both dump valves to normal. A manual "Dump-Tank" switch is located on No. 1 process auxiliary board for testing the dump valve to No. 1 tank. All dump valves are tested once each shift

No. 2 Tank (West Tank)

This tank is connected to No. 1 tank by a 12" underground equalizing line. For this reason, the two tanks will "float" on the line together with near equal levels. This tank receives condensate from several sources. One line from the Caustic plant, one line from Chlor-Alkali, Chlorinated Methanes and Glycol 11 plants and one from LHC 2. Metering orifices for all three of these lines are located in the pipeway just north of #2 tank. These lines also have two conductivity cells each for alarm indication and dump operation. In addition to the condensate sources listed above, an 8" demin line is connected to the suction header of make up pumps 8, 9 and 10.

Condensate Make-up System - Pumps 1, 2 and 3

Three Allis-Chalmers centrifugal, single-state pumps rated at 1750 gpm at 175 foot head are installed to take suction from No. 1 tank and to discharge the make-up into the parallel-operated deaerators. A low-pressure switch installed at the pump discharge header will start the standby pump(s) upon receiving a low-pressure signal due to failure of one of the operating pumps or load increase. A low-pressure alarm is also provided to annunciate on ~~both the process auxiliary board and~~ ^{the} mechanical vertical board. These three make-up pump motors receive power from two separate sources - 480V Bus 1 and 480V Bus 2 - thus preventing a significant reduction in condensate flow to the deaerators should any one of the buses fail. Locally mounted pressure gauges are installed at each pump discharge outlet. High conductivity will be annunciated on the No. 1 process auxiliary board.

No. 1 make-up pump also has block valve provisions for taking suction directly out of the demin line and discharging to a separate 4" line to each boiler for fill and washing purposes.

The condensate flow to the deaerators is measured through a flow orifice and is recorded on ~~the make-up flow recorder on No. 1 process auxiliary board~~ ^{4857 in the Control Room}. Locally mounted pressure gauges and thermometers are provided on the discharge header. The condensate (or make-up, as it is generally called at this point) passes through the control valves of the level control stations, thus completing the condensate return cycle to the deaerators.

T. PROCESS CONDENSATE RETURN SYSTEM (CONTD.)

Condensate Make-up Pumps 4, 5, 6, and 7

Three

~~Four~~ Ingersoll-Rand centrifugal, single-stage pumps rated at 2000 gpm at 175 foot head are installed to take suction from No. 2 tank via the 14" equalizing line between the two storage tanks. All four pumps discharge into the condensate make-up discharge header which is common to all deaerators. ~~These pumps also have automatic low pressure starting provisions and separate power supply sources (480V Bus 3 and 480V Bus 4).~~

Pumps

Power II Condensate Pumps 8, 9 and 10

These are Goulds centrifugal, single-stage pumps rated at 2000 gpm at 175 foot discharge head and are installed to take suction from the west side of 2 tank. They discharge into the condensate line to Power II.

The difference in these pumps is that 8 and 9 are 2400 volt, 125 h.p., while #10 (which was originally Power 1 #7) is 480 volt. Pumps 8 and 9 are powered from Power II, while #10 is powered from Power #1.

STEAM PRESSURE REDUCING AND DESUPERHEATING STATIONS

A. GENERAL

Under certain conditions, such as trip-out or un-availability of a turbine, it will be impossible for the process steam demands to be met by steam flow from the automatic extractions. Therefore it becomes necessary to provide a system by which 1250 psig steam at 950°F can be reduced in pressure and temperature down to 475 psig and 700°F and 235 psig and 600°F. This is accomplished by the use of pressure and desuperheating stations. The components of these systems are listed and described below.

B. 475 PSIG STATION NO. 1

Main Pressure Reducing Valve

This is an 8" 1500 lb. diaphragm operated control valve. Its purpose is to drop the steam pressure passing through it from 1250 psig to the set pressure of the controller (normally around 490 psig) by restricting the opening through which the steam must pass. The valve is so constructed that an increase in the air pressure exerted on the diaphragm will cause the valve to move toward the closed position while a decrease will tend to open the valve. The signal which "tells" the valve which position it should take comes from a pressure controller and is received by the positioner which then exerts the force necessary for the valve to reach this position. Upon air failure the control valve maintains its position due to the action of the air locking device which traps the last loading signal on the diaphragm of the control valve.

Steam Pressure Controller

The purpose of this instrument is to send a signal to the main pressure reducing valve so that a constant pressure equal to the set point of the controller is maintained downstream of the pressure control valve.

The controller senses the pressure in the header downstream of the pressure control valve through a "impulse" line. Through this line, the full pressure of the header is exerted on the mechanism of the controller. If this pressure varies from the set pressure of the controller, the controller will send a signal to the valve positioner which will adjust the valve to bring the header pressure back to set point.

The controller is tied into the steam line down stream of the pressure control valve (VPC-1A). Through this tie the full pressure inside the steam line is exerted on the mechanism of the controller. If this pressure varies from the set pressure of the controller (~~475 psig~~) the controller will send a signal (~~2 psig to 15 psig~~ ~~air pressure~~) to the valve positioner which will adjust the valve to bring the pressure back to ~~475 psig~~ as previously explained. ~~The controller is supplied with air at 20 psig with which it transmits its signal.~~

the set point

Remote Manual Station (RMC-1), (RMC-11), (RMC-3), & (RMC-9)

These stations are Copes-Vulcan model AM-4 Auto Manual Type. The purpose of this piece of equipment is to provide a means by which the operator can take over the control of the Control Valve from its controller.

It is located in the control line between the Controller and the Positioner on the Control Valve.

The station consists of 2 pressure gauges, one indicating manual loading and one indicating automatic loading, one pilot operated reducing valve, one cam operated two position transfer valve and the sub-panel on which these are mounted.

The station is switched to manual by turning the transfer valve from automatic to manual with the handle on the front of the panel. Now the controller is cut out and the control valve takes its signal from the pilot operated reducing valve which is located behind the panel and is operated by a handle on the front. The signal being sent to the control valve is now indicated on the manual loading pressure gauge and can be varied by hand from 3 psig for full open to 15 psig for full closed.

Pressure Reducing Valve (VPC-1B)

This valve is a 1½ inch, 1500 lb., type CV-D diaphragm operated control valve with a Mocre Positioner.

The purpose of this valve is to reduce the pressure of the atomizing steam from 1300 psig to 600 psig. The construction and operation of this valve is similar to valve (VPC-1A) which has been previously explained except that between the valve positioner and the diaphragm of the pressure reducing valve (VPC-1B) is a Taylor three way selector valve which causes control valve (VPC-1B) to close completely if valve VPC-1A closes completely.

Pressure Controller (PC-7)

This pressure controller is a Taylor falsecope pressure controller having full range sensitivity. The purpose of this controller is to send a signal to the control valve (VPC-1B) so that a constant pressure of 600 psig will be maintained downstream of the control valve (VPC-1B), and to indicate that pressure on the dial located on the face of the controller.

The construction and operation is similar to pressure controller (PC-1) which has been previously explained.

Temperature Control Valve (VTC-1)

Temperature Control Valve

This valve is a 1½ inch, 600 lb. diaphragm operated control valve.

The purpose of this valve is to allow the correct amount of desuperheating water to pass through it to the spray nozzles to lower the steam temperature from 950°F. to the temperature set point of the temperature controller (normally 700°F).

Temperature Controller

The purpose of this instrument is to send a signal to temperature control valve so that a constant temperature consistent with the set point (normally 700°F) will be maintained downstream of the control valve.

Desuperheating Water Pressure Control Valve

This is a 2", 900 lb. diaphragm operated control valve. Its purpose is to reduce the pressure of the desuperheating cooling water (boiler feedwater) going to the temperature control valves of both the 475 and 235 psig stations from approximately 1700 psig to 800 psig. It receives its signal from the desuperheating water pressure controller which has a variable set point.

Desuperheating Spray Nozzle Assemblies

The 475 psig stations incorporates two of these nozzles, installed downstream of the pressure control valve. Their function is to atomize the cooling water as it is injected into the steam flowing down the line.

C. 235 PSIG STATION NO. 1

The preceding description of the 475 station is almost identical to the 235 station except the 235 incorporates three spray nozzles since the temperature is dropped an additional 100°F.

All pressure and temperature controllers described for these stations and the automatic-manual functions for both stations is on the Foxboro Video-Spec system in the control room.

D. 235 PSIG STATION NO. 2

This system is almost identical in construction and operation to the #1 Station. An exception is that it incorporates only one spray nozzle. Desup water for this station can be from a line connected to the feedwater header just west of #6 boiler feed pump or from a line connected to the system that serves #1 station; the latter arrangement is normally used. The capacity of this station is 440,000 lb/hr. steam flow.

steam line.

4. Provide remote auto-manual control of 235 psi steam pressure and 600° F. temperature by using panel-mounted integral controllers and auto-manual stations (RMC-306 and RMC-307).
5. Provide control of atomizing steam pressure entering the desuperheater with a proportional, locally mounted pneumatic controller (PC-305).
6. Provide remote manual control of 235 psi pressure by means of a motor operated by-pass valve (MOV-324) around pressure reducing valve (VPC-301).

Pressure Reducing Valve (VPC-301)

This valve is an 8", 1500 psi, diaphragm operated, Copes-Vulcan Control Valve with positioner. The purpose of this valve is to drop the pressure of the steam passing through it from 1300 psig to 235 psig by restricting the opening through which the steam must pass. The valve is so constructed that an increase on the air pressure exerted on the diaphragm will cause the valve to move toward the open position while a decrease will tend to close the valve. The air pressure for operation comes from the positioner which is supplied with air at 30 psig. The signal (3 psig to open, 15 psig to close air pressure) which "tells" the valve which position it should take comes from a Remote Manual Station (RMC-306) and is received by the positioner which then exerts the force necessary for the valve to assume this position. Upon air failure the control valve maintains its position due to the action of the air locking valve near the control valve diaphragm.

Remote Manual Station (RMC-306)

This pressure controller is a Foxboro Model 52A-SM4, Pneumatic Pressure Indicating Receiver Controller with proportional-plus-reset control action and integral automatic manual station. By means of the automatic-manual station the operator can take over the control of the control valve from its controller. It is located in the control line between the pressure transmitter (PT-320) and the positioner on the control valve (VPC-301) and is mounted on the process auxiliary board in No. 1 Auxiliary Room.

The purpose of this controller is to send a signal (3 psig to open, 15 psig to close air pressure) to the control valve (VPC-301) so that a constant pressure of 235 psig will be maintained downstream of the control valve (VPC-301) and to indicate this pressure on the dial located on the face of the remote manual station (RMC-306).

Remote Manual Station (RMC-306) Cont'd.

The station consists of 2 pressure gauges, one indicating the line pressure (0-300 psig) downstream of the control valve (VPC-301) and one indicating signal output pressure (3-15 psig) to the control valve, one auto-manual transfer switch, one manual control knob, and one set-point control knob for automatic operation.

The station is switched from automatic to manual by lining up the transfer indicator (white pointer on the lower gauge - 3 -15 psig) to the center position on the gauge (9 psig) using the manual control knob and switching the auto-manual transfer switch to manual. To place the station back on automatic again, line the transfer indicator to the center position, this time using the set-point control knob, and switching the auto - manual transfer switch to auto.

Pressure Reducing Valve (VPC-302)

This valve is a 1-inch, 1500 lbs., diaphragm operated Copes-Vulcan Control Valve with positioner, cooling fins, and air locking valve.

The purpose of this valve is to reduce pressure of the atomizing steam from 1300 psig to 450 psig. The construction and operation of this valve is similar to valve (VPC-301) which has been previously explained except that between the valve positioner and the diaphragm of the pressure reducing valve (VPC-302) is a locking valve that vents control signal air to the diaphragm causing valve to close when control signal to diaphragm on pressure control valve (VPC-301) calls for this valve to close.

Pressure Controller (PV-305)

This pressure controller is a Foxboro Model 41A-A6 Pneumatic Pressure Indicating Controller, narrow band proportional control with 0-800 psi range. The purpose of this controller is to send a signal to control valve (VPC-302) so that a constant pressure of 450 psig will be maintained downstream of the control valve (VPC-302), and to indicate that pressure on the dial located on the face of the controller. This controller has a manual set point and is mounted locally to the pressure control valve (VPC-302).

Temperature Control Valve (VPC-305)

This valve is a 1½ inch, 1500 lb., diaphragm operated Republic Control Valve with positioner and air locking valve.

The purpose of this valve is to allow the correct amount of cooling water to pass through it to the spray nozzle to desuperheat the steam from 950°F. to 600°

The construction and operation of this valve is similar to pressure control valve (VPC-302) which has been previously explained.

E. 475 STATION NO. 2

This station is located on an elevated platform south of the extreme west end of the turbine deck. It is connected on the high pressure side to the 1250 psig steam header from Power II; the downstream or low pressure side is connected to the 475psig process header south of #4 turbine.

Desuperheating water for this station is from a connection on the extreme west end of the feedwater header. In addition to the desup cooling water pressure control valve, this station has a desup water over-pressure control valve. Its set point is usually a little higher than the set point for the pressure control valve.

This station uses only one spray nozzle and is rated 500,000 lb./hr. steam flow. ~~Unlike the other pressure reducing-desuperheating stations, this one is controlled by the Foxboro Spec 200 system.~~ Unlike the other pressure reducing-desuperheating stations, this one is controlled by the Foxboro Spec 200 system.

F. 475 PRESSURE REDUCING STATION NO. 3

This station is located near the pipeway south of #4 Turbine. It is actually a 235 psig station but for some strange, unknown reason it has been designated as a 475 station. The steam to the high pressure side of the station is the 475 psig steam from the low pressure side of 475 psig station no. 2. The down stream or 235 psig side is connected to the 235 psig header in the same location.

It is very similar in operation to the aforementioned station. The desup water for this station is the same source as no. 2 station. It has a capacity of 300,000 lb./hr. steam flow.