FINAL

SYSTEM DESCRIPTION
(Index No. 17)

REACTOR COOLANT MAKE-UP AND PURIFICATION SYSTEM
(B&R Dwg. No. 2024, Rev. 11)

JERSEY CENTRAL POWER AND LIGHT COMPANY

THREE MILE ISLAND NUCLEAR STATION

UNIT NO. 2

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REACTOR COOLANT MAKEUP AND PURIFICATION SYSTEM

1.0 INTRODUCTION

1.1 System Functions

The makeup and purification system provides a means for controlling reactor coolant inventory during reactor power operations as well as maintaining the water quality and chemistry of the coolant within prescribed specifications. The system also serves to accomplish the following:

a. provides seal injection water to the reactor coolant pumps to establish a primary coolant pressure boundary and to supply pump cooling water;

b. provides a means of venting radioactive and flammable gases from the reactor coolant system;

c. adds makeup water to the core flooding tanks;

d. serves a safety features function by injecting high pressure water into the reactor coolant system in the event of a LOCA;

e. provides an indication of failed fuel.

The makeup and purification system has an interface with the following auxiliary systems and in conjunction with these systems, performs its primary and secondary functions.

(Drawing numbers refer to Burns and Roe, Inc. flow diagrams):

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a. Intermediate Closed Cooling Water System (Dwg. No. 2029)

b. Nuclear Services Closed Cooling Water System (Dwg. No. 2030)

c. Chemical Addition System (Dwg. No. 2025)

d. Radioactive Waste Disposal Systems (Liquid, Gas & Solid) (Dwg. Nos. 2027, 2028, 2039)

e. Core Flooding System (Dwg. No. 2026)

f. Decay Heat Removal System (Dwg. No. 2026)

g. Radwaste Disposal - Misc. Liquids (Dwg. No. 2045)

h. Nitrogen for Nuclear and Radwaste System (Dwg. No. 2036)

i. Demineralized Service Water (Dwg. No. 2007)

1.2 Summary Description of System (Refer to B&R Dwg. No. 2024, Rev.11)

During reactor power operations, reactor coolant flow is confined to a closed loop, i.e., through the reactor core, to the steam generators, and back to the reactor. In order to maintain the high degree of water quality required for operation of a nuclear reactor, it is necessary to continuously pass a portion of the coolant flow through a purification system to remove contaminants which have been picked up in the system. These contaminants are the result of corrosion of the reactor coolant system materials, leakage of fission products from fuel cladding defects, and other impurities that may be introduced into the reactor coolant with makeup water. The corrosion products tend to foul the heat transfer surfaces in the reactor core and steam generators, while the fission products and the corrosion products which have become irradiated, increase the background radiation levels of the plant and create problems relative to equipment accessibility. Other impurities such as chloride, oxygen, etc., tend to accelerate the rate of material corrosion, and in this manner, have a deleterious effect on the system. Purification of the reactor coolant is accomplished by continuously passing a portion of the coolant through a demineralizer and filter arrangement after it has been cooled and depressurized to avoid damage to the demineralizer resins. The purified water is then directed into the makeup tank from where it is returned

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to the reactor coolant system by high pressure makeup pumps. A portion of the purified water is also directed to the reactor coolant pumps for seal injection and serves to cool the pump seals which operate at very close tolerances.

The system also serves to provide a means of detecting failed fuel. This is accomplished by passing a portion of the letdown coolant after it has been cooled and depressurized through a radiation monitor to detect abnormal levels of radioactivity. (Refer to Radiation Monitoring System Description, Index #52).

Since the system is basically low pressure at the makeup pump suction and returns water to the high pressure reactor system, it affords a method for the introduction of makeup water to the reactor to replenish that which is lost through system leakage. Makeup water is added to the system downstream of the demineralizers and upstream of the makeup filters and is supplied from either the demineralized service water system, the bleed holdup tanks or from the deborating demineralizers. Provision is also made at this point for the addition of boric acid and other chemicals. The system also serves to permit dilution of the coolant boron concentration. This is accomplished by bleeding the reactor coolant from the system after it has passed through the demineralizer, and replacing it with deborated water from the sources previously mentioned.

A makeup tank serves as a reservoir for the coolant which is let down from the reactor system and provides the suction and NPSH required for the high pressure makeup pumps. It further serves as a surge tank during changes in reactor coolant inventory and provides a place for the introduction of hydrogen gas into the reactor coolant for oxygen control. During normal

operation, a specified hydrogen overpuressure is maintained in the tank. Hydrogen, in a gamma radiation field, will combine with free oxygen in the reactor coolant to form water, and thereby prevent the corrosive effects which are caused by the oxygen. When it becomes necessary to degas the reactor coolant of hydrogen, e.g. in preparation for refueling or reactor coolant system maintenance, the makeup tank and the pressurizer act as collection chambers from which the hydrogen gas can be vented and replaced with inert nitrogen which prevents corrosion and replaces the potentially explosive hydrogen. The tank is also utilized to vent radioactive gases which have been expelled from the reactor coolant and have collected in the gas space of the tank. These gases are vented to the radioactive gaseous waste disposal system where they are processed before being released to the atmosphere through the station vent.

During reactor shutdowns, the high pressure pumps in the makeup and purification system are used to fill the core flooding tanks with borated water at the refueling concentration by taking suction from either the makeup tank, MU-T-1, or the borated water storage tank, DH-T-1. The borated water is pumped to each core flooding tank through a line which is provided from the discharge header of the makeup pumps. During reactor operation, however, any makeup to the core flooding tanks is provided by a positive displacement pump in the chemical addition system since the amount of makeup would be minimal and the boron concentration in the makeup and purification loop is lower than the refueling water concentration.

The safety features function of the system is provided by the injection of high pressure water from the borated water storage

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tank into the reactor coolant system immediately following a rupture in the system piping. Because of the high discharge pressure capability of the makeup pumps, the borated water can be supplied to the reactor while the reactor pressure is high and before operation of the decay heat removal system for low pressure injection. In the event of a small reactor coolant system leak where the reactor pressure decreases slowly and the supply of water in the borated water storage tank has been exhausted before the decay heat removal system pumps can overcome the reactor pressure to provide low pressure recirculation from the reactor building sump, the makeup pumps function to recirculate the spilled coolant by taking suction from the outlet of the DHR coolers. In this case, the DHR pumps provide the required NPSH for operation of the makeup pumps.

1.3 System Design Requirements

The makeup and purification system is designed to receive reactor coolant at normal operating conditions, cool and depressurize the water so that it can be purified, and return the purified water to the reactor. The piping design conditions (pressure and temperature) are varied throughout the system, as follows: from the steam generator outlet to the letdown cooler inlet valve, 2500 psig and 650°F; the cooler is designed for 2500 psig and 600°F on the tube side; from the cooler outlet valve to the block orifice, 2500 psig and 300°F; from the block orifice to the makeup tank, 150 psig and 200°F; the tank is designed for 100 psig and 200°F; from the tank to the makeup pumps suction header 350 psig and 300°F; from the makeup pumps

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to the check valves inside the secondary shielding, 3050 psig and 200°F; and from the check valves to the reactor coolant piping, 2500 psig and 650°F. The seal return piping from the reactor coolant pumps to the internal building isolation valve is designed for 2500 psig and 650°F; between the internal and external building isolation valves, 2500 psig and 300°F; while the downstream of the external isolation valve to the makeup tank, including the seal return coolers, the design conditions are 150 psig and 200°F.

During normal steady state power operation, one of the two parallel arranged letdown coolers, purification filters, purification demineralizers and makeup filters is in operation for flow rates up to 70 gpm. For higher flow rates, up to the maximum capacity of the system (140 gpm), two letdown coolers as well as both demineralizers and both sets of filters upstream and downstream of the demineralizers, are required to be in service. The reactor coolant in passing through the letdown cooler is cooled from approximately 555°F to 120°F with the inlet temperature of the intermediate closed cooling water system at 95°F. The pressure of the coolant is reduced from approximately 2155 psig to 100 psig by the block orifice. At low pressure and if a flow rate in excess of 45 gpm is required, the letdown flow control valve, MU-V5, must be placed in service. This valve is sized to handle the maximum system flow; however, for normal system operation, only the block orifice is necessary. One purification demineralizer is required for flows to 70 gpm; the second demineralizer must be placed in service for higher letdown flow rates or when No. 1 resin is exhausted. The demineralizers contain a 2:1 mixture of cation and anion resins and are 99% efficient in removing all fission isotopes except xenon, krypton, yttrium, molybdenum, cesium and tellurium.

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Chlorides and sodium are also removed, and a small percentage of suspended corrosion products is collected in the resins by a filtration effect. Provisions are incorporated for changing the demineralizer resins by sluicing. Two sets of multi-element type filters, each set consisting of two filters arranged in parallel, are provided in the letdown flow path. The first set is upstream of the demineralizers and capable of removing particulate matter greater than 1 micron with 98% retention while the second set is downstream of the makeup addition lines to the letfown flow, with the same removal rating of 1 micron at 98% retention. Normally, one filter in each set is in service for flow rates up to 80 gpm. The alternate filters are used when the normal filter becomes clogged and requires changing of the elements, or when higher flow rates are required. The makeup tank acts as a system surge tank, and is stainless steel clad with a capacity of approximately 4500 gallons. A ring header in the tank's water space is provided for the introduction of hydrogen and nitrogen to the system. Three makeup pumps, arranged in parallel with common suction and discharge headers, take suction from the makeup tank. The pumps are multi-stage centrifugal and are rated at 300 gpm at 3000 psi One makeup pump is in service for normal operations; the second is utilized as a standby backup for the operating pump while the third is normally idle. This provision ensures a separate source of suction from the borated water storage tank and path for discharge to the emergency injection lines to provide redundant high pressure injection in the event of an emergency. Two straight-tube design coolers, arranged in parallel, are provided to remove the heat from the reactor coolant pumps seal water return and the controlled

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bleedoff, before the water is returned to the makeup tank. One cooler is normally in service with the second maintained as a spare. The cooling water flow to these coolers is supplied from the nuclear services closed cooling water system.

There are several interlocks and automatic controls incorporated into the design of the system to prevent damage to equipment and to provide automatic flow and pressure regulation. Relief valves are installed on system equipment and piping where overpressurization could result in damage. The interlocks and controls are discussed in greater detail in Section 2.2.

2.0 DETAILED DESCRIPTION OF SYSTEM

2.1 Components

Since a portion of the makeup and purification system serves a safety features function, redundant equipment has been provided for emergency operation. This equipment includes the makeup pumps, the emergency high pressure injection makeup valves, and the normal makeup and purification system process isolation valves to and from the reactor coolant system. In order not to degrade the adequacy of the system for emergency use, only one of the three makeup pumps may normally be out-of-service at any given time, and at least one of the two emergency injection valves to each loop must be operable at all times.

2.1.1 Letdown Coolers, MU-C-1A and MU-C-1B

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The letdown coolers (see Table 1) transfer the heat from the letdown water to the intermediate closed cooling water system. The coolers are arranged in parallel with remotely controlled, electric motor operated stop valves at the inlet and outlet of each cooler. The cooler inlet valves are interlocked with the corresponding intermediate cooling water inlet valves to ensure a supply of cooling water prior to placing the cooler in service. The cooler outlet valves also serve as reactor building isolation valves. The tube side through which the reactor coolant flows, is formed by a series of 30 parallel tubes which are spiraled around the major axis of the shell. Cooling water from the intermediate closed cooling water system is directed through the shell in a counterflow to the reactor coolant. The tubes are designed in accordance with the ASME code classification III-C lethal, and the shell conforms with ASME VIII. The design temperature and pressure of the coolers are 600°F and 2500 psig (tube side) and 350°F and 200 psig (shell side).

2.1.2 Reactor Coolant Pump Seal Return Coolers, MU-C-2A and MU-C-2B

The seal return coolers (see Table 2) dissipate the heat picked up by the reactor coolant pumps' seal injection water in passing through the pumps. The heat is transferred to the nuclear services closed cooling water system which supplies the cooling water. The units are of straight-tube design with the seal return water passing through the tubes. The tube side is designed in accordance with the ASME code classification III-C lethal and the shell side complies with classification VIII. Remotely controlled electric motor operated gate valves are provided on the tube side and manual gate valves on the shell side for isolation purposes. A relief valve on the cooler shell prevents

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an inadvertent pressure buildup resulting from an increase in the ambient temperature in the event the cooler is isolated. The design temperature and pressure of the coolers is 250°F and 150 psig for the shell side and 200°F and 150 psig for the tube side.

2.1.3 Seal Injection and Seal Return Filters, MU-F-4A, MU-F-4B, and MU-F-3

Two filters are provided upstream and one filter is provided downstream (see Table 3) of the reactor coolant pump seals. The two upstream filters are provided to protect the reactor coolant pump seals from particulate matter. The filter vessels are designed for a flow rate of 50gpm borated water with a 6.5 psi pressure differential across the filter. The filter elements are rated at 3 microns nomimal and 23 microns absolute. Manual isolation and bypass valves are provided to permit selection of the standby (alternate) filter for isolation purposes during cartridge replacement. The downstream filter is provided to keep particulate matter from entering the makeup tank. The filter vessel is designed for a flow rate of 20 gpm borated water with a 1 psi pressure differential across the filter. The filter elements are rated at 20 microns absolute. Manual isolation and bypass valves are provided for isolation purposes during cartridge replacement.

2.1.4 Make-Up and Purification Demineralizer Filters

Filters are provided upstream of the demineralizers to keep active particulate corrosion products from being deposited in the demineralizer beds (see Table 4). The filter vessels conform to ASME code classification III-C lethal and are

designed for a flow rate of 80 gpm with a 5 psi pressure differential across the filter. The outside diameter of the vessel is 12 3/4 inches and the overall length envelope is approximately 71 inches. The renewable cartridge envelope size is 6 inches in diameter by 24.72 inches long. The filters are fitted with a hinged cover for replacement of the filtering elements. Drain lines from each filter are directed to the auxiliary building sump. A spring is provided for each element to force a seal at the top of the element. The elements are depth-type design affording excellent particulate retention capability and are made of epoxy impregnated organic media with 304 stainless steel core. The filter elements are rated at 1 micron nominal with 98% retention. A remotely controlled air cylinder operated stop valve (MU-V224A/B) is provided at the inlet to each filter to permit selection of this standby (alternate) filter from the Control Room Auxiliary Systems Control Panel Number 3. A manually operated stop valve is installed in the outlet from each filter for isolation purposes during cartridge replacement.

2.1.5 Makeup and Purification Demineralizers, MU-K-1A and MU-K-1B

The letdown demineralizers (see Table 5) purify the reactor

coolant after it has been cooled, depressurized and filtered. Each demineralizer is designed for a flow rate of 70 gpm and complies with the ASME code Classification III-C lethal. The shell diameter is 48 inches and its overall height is 100 inches. Fifty cubic feet of mixed bed (2:1 ratio of cation-anion) resin is filled to a depth of approximately 4 feet. The inlet flow is distributed by a header consisting of twelve 3/4 x 18 inch pipes, each having one end plugged. Each pipe has twenty-one 3/16 inch holes. The outlet header is similar, except that the pipes are 3/4 x 20 inches and a 110 mesh stainless steel screen is wrapped around each pipe to prevent resin break through. A fill and removal connection is provided for replacement of depleted resin. The spent resin is directed to the spent resin storage tank in the solid waste disposal system. A sampling line leading to the Unit 1 Radio Chemistry Laboratory is provided with a remotely controlled diaphragm operated valve at the common inlet and outlet of the demineralizers for influent and effluent sampling. In the letdown line upstream of the demineralizers, a temperature alarm, set at 135°F actuates an annunciator and operates a switch which closes the external building isolation valve, MU-V376, thereby protecting the resins from exposure to excessive temperature. The design pressure of the demineralizers is 150 psig.

2.1.6 Makeup Filters, MU-F-2A and MU-F-2B

The filters downstream of the demineralizers are the same as the upstream filters (see Table 4). They are provided to keep particulate matter and resin fines from entering the makeup tank and being introduced into the reactor coolant and reactor coolant pump seals. The filter vessels conform to ASME code classification III-C lethal and are designed for a flow rate of 80 gpm with a 5 psi pressure differential across the filter. The outside diameter of the vessels is 12 3/4 inches and the overall length

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envelope is approximately 71 inches. The removable cartridge envelope size is 6 inches in diameter X 24.72 inches long. The filters are fitted with a hinged cover for replacement of the filtering elements. Drain lines on each filter are directed to the auxiliary building sump. A spring is provided for each element to force a seal at the top of the element. The elements are depth-type design affording particulate retention capability and are made of epoxy impregnated organic media with type 304 stainless steel core. The filter elements are rated at 1 micron nominal with 98% retention. A remotely controlled air cylinder operated stop valve (MU-V11A/B) is provided at the inlet to each filter to permit selection of the standby (alternate) filter from the main Control Room, Panel Number 3. A manually operated stop valve is installed in the outlet from each filter for isolation purposes during cartridge replacement.

2.1.7 Makeup Tank, MU-T-1

The makeup tank (see Table 6) functions to receive the purified reactor coolant and makeup water and serves as a surge tank for the reactor coolant inventory control. The outside diameter of the tank measures 8 feet with an overall height of approximately 13 feet. The contained volume is approximately 3800 gals. of water with the remainder filled with gas. The tank conforms to ASME code classification III-C lethal. A 1x2 inch relief valve (MU-R1) set at 100 psig protects the tank from exceeding its design pressure. The inlet line to the tank connects to a nozzle which sprays the inlet water into the gas space. Connections leading to the sampling station are provided in both the gas and water space. A one inch line leading from the hydrogen and nitrogen supply headers connects to a ring header in the water space to introduce either gas into the tank.

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2.1.8 Makeup Pumps, MU-P-1A, MU-P-1B and MU-P-1C

The makeup pumps (see Table 7) which inject the coolant from the makeup tank into the reactor coolant pump seals and reactor coolant system are 9 stage, horizontal, gear driven at 6800 rpm, single suction centrifugal pumps, rated at 300 gpm each with a total discharge head of 5545 feet. The pumps are designed for operation up to 3000 psig with a fluid temperature of 200°F. The makeup pumps will deliver up to 550 gpm at 1600 feet total discharge head during an E.S. condition, dependent on parameters at the time of the condition.

The makeup pumps are normally maintained in pairs with pump, MU-P-1B, always being one of the pair. A switch on control room Panel No. 3 (Auxiliary Systems Control Panel) is provided to select pairing MU-P-1A with P-1B or MU-P-1C with P-1B. A paired set of pumps permits either pump in the pair to be the in-service pump with the other pump in the pair as backup, capable of automatic starting in the event of failure of the in-service pump. Selection of the in-service pump and the backup pump is made by positioning the control switch for the individual pump. The pump selected for service is started by moving its control switch to the "Start" position and allowing it to spring return to the neutral (mid) position. The other pump in the pair is then set up for automatic backup by moving its control switch to the "Stop" position and allowing it to spring return to the neutral (mid) position. Pump MU-P-1A is electrically powered from the 4000V safety features bus 2-1E, while MU-P-1C is powered from the 4000V safety features bus 2-2E. Pump MU-P-1B is capable of being fed from either bus. Two switches on Control Room Panel No. 3 permit selection of power supply to MU-P-1B from either bus

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in order to ensure backup capability in the event of pump failure.

The three pumps take suction from a common header and discharge into a common header. A manual stop valve is provided in the suction and discharge line for each pump for isolation purposes and a check valve in the discharge line from each pump is provided to prevent back flow through an idle pump. Two manually operated stop valves are provided between pumps MU-P-1A and P-1B and between MU-P-1C and P-1B in both the suction and discharge header to ensure the capability of pump isolation.

A line from each of two outlets from the borated water storage tank connect at each extremity of the makeup pumps' suction header (at MU-P-1A and MU-P-1C) to provide a supply of borated water for emergency high pressure injection. Each of these lines also connect to a line from the discharge of a decay heat removal pump to provide high pressure recirculation during a reactor coolant system piping failure where the reactor pressure remains higher than the discharge capacity of the decay heat removal pumps. In this case, the decay heat removal pumps, which are taking a suction from the borated water storage tank or the reactor building sump (if the borated tank is empty, provide the NPSH for operation of the makeup pumps. If the operating/backup makeup pump pair is selected as MU-P-1A and P-1B then the two isolation valves in both the suction and discharge header between MU-P-1B and P-1C must be closed and the valves between MU-P-1A and MU-P-1B must be open. Conversely, if MU-P-1C and P-1B is the selected pair, then the two isolation valves in the suction and discharge header between MU-P-1B and P-1A must be closed. Separation of the header's in this manner ensures that there

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are always two independent suction and discharge paths available for emergency high pressure injection. During LOCA conditions, the SFAS will automatically attempt to start MU-P-1C. If a pump is out-of-service, it is imperative that the isolation valves in the common suction and discharge headers are properly positioned to ensure two separate paths (one to each reactor coolant loop) for high pressure injection.

There are two separate lube oil systems associated with each of the makeup pumps; one is for the geared speed increaser, and the other, for the pump and motor bearings. The speed increaser lube oil system consists of a shaft driver (main) lube pump, an auxiliary, AC motor driven lube pump in parallel with the shaft driven pump, and oil cooler. Cooling water to the cooler is supplied by the nuclear services closed cooling water system. The lube oil pumps take suction from the increaser lube sump, through a check valve, which maintains the pumps' prime during idleness, and a strainer. The lube oil pumps discharge through the cooler and to the geared speed increaser. A check valve is provided in the discharge of the auxiliary lube pump to prevent back flow when the motor driven pump is not in operation. The bearing lube oil main and auxiliary pumps, like the geared speed change auxiliary pump, start when the control switch for the associated makeup pump is placed to "Start". A pressure switch in the geared speed changer oil system starts the auxiliary pump if the pressure decreases to 7 psig. Low lube oil pressure and high temperature is alarmed by the computer. A light adjacent to each makeup pump control switch on Panel No. 3 indicates if the auxiliary pump is running.

The pump and motor bearing lube oil system consists of a main and an auxiliary, AC motor driven lube oil pumps piped in parallel. The pumps take suction from the lube oil reservoir and discharge into a common line and through a cooler to supply the motor bearings and the pumps's radial and thrust bearings. Drainage from the bearings is returned to the lube oil reservoir. Cooling water to the cooler is from the nuclear services closed cooling water system. The bearing lube oil main pump runs continuously while the make up pump is in operation supplying bearing lube oil. A pressure switch in this system automatically starts the bearing lube oil auxiliary pump of the bearing lube oil pressure decreases to 5 psig, and stops this auxiliary pump at 15 psig. Indicating lights adjacent to each makeup pump control switch on panel no. 3 indicates the status of the main and auxiliary lube oil pumps. An interlock is provided to a make up pump start if the motor lube system pressure is not at least 4 psig and to stop the make up pump if the lube oil pressure decreases to 2 psig. Low lube oil pressure and high temperature is alarmed by the computer.

The 700 h.p. motor which drives the make up pump is supplied with cooling water from the nuclear services closed cooling system. A flow switch in the cooling water inlet line to each pump's motor cooler prevents the motor from starting unless 95 gpm minimum of cooling water is being supplied. This interlock is overridden by a signal from the SFAS to permit pump start without cooling water during emergency conditions. Low cooling water is alarmed by the computer and also annunciated in the Control Room. Motor high temperature is also alarmed by the computer.

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A two inch recirculation line fitted with an orifice sized for 95 gpm at 6500 ft. Δp is provided from each makeup pump to regulate bypass flow and maintain minimum pump flow for proper pump operation. The recirculated water is returned to the makeup tank through the seal return coolers. Two normally open electric motor operated stop valves, MU-V36 and MU-V37, are provided in the common line which connects the recirculation line from each pump to the inlet of the seal return coolers. These valves are closed upon receipt of a signal from the safety features actuation system to achieve the required emergency injection flow during a LOCA.

2.1.9 Major System Valves

Letdown Coolers Inlet Stop Valve, MU-V1A/MU-V1B

One 2500 psig, 650°F, 2½ inch, 316 SS, electric motor operated gate valve is provided at the inlet to each purification letdown cooler to permit isolation of the cooler for periodic changeover during reactor operation. The valves are interlocked to the respective intermediate cooling water supply valves to ensure a supply of cooling water to the cooler prior to the admittance of reactor coolant. Remote manual control of the valves is provided from the Control Room, panel number 3. Power supply to the electric motor valve operators is from the 480V motor control centers 2-32B for valve MU-V1A and 2-42B for valve MU-V1B.

Letdown Coolers Outlet Stop Valve, MU-V2A/MU-V2B

One 2500 psig, 600°F, 2½ inch, 316 SS, electric motor operated gate valve is provided at the outlet of each purification letdown cooler to permit isolation of the cooler for periodic changeover during reactor operation. Each valve also serves

as an internal reactor building isolation valve and closes automatically on receipt of an SFAS signal. Remote manual control and indication of the valves is provided from the Control Room on Panel Number 3 and on containment isolation Panel Number 15. Indication only is provided in Panel No. 13. Power supply to the electric motor valve operators is from the 480V engineered safety features motor control center 2-11EA for MU-V2A and from 2-21EA for MU-V2B.

Letdown Isolation Valve, MU-V376 Rev 1

One 2500 psig, 300°F 2½ inch, 316 SS, air piston operated gate valve is provided in the letdown line just downstream of the reactor building penetration. The valve serves as an external reactor building isolation valve and closes automatically upon receipt of a signal from the safety features actuation system. The valve is interlocked to the letdown temperature instrumentation string MU5-TE to automatically close the valve if the letdown temperature reaches 135 thereby affording protection against excessive temperature to the purification demineralizer resin. Remote manual control and indication of the valve is provided from the Control Room on Panel Number 3 and also on Panel Number 15. Indication only is provided in Panel 13.

Block Orifice Inlet Stop Valve, MU-V4

One 2500 psig, 300°F 1½ inch, 316 SS, air piston operated gate valve is provided at the inlet to the block orifices. The valve functions to provide isolation of the block orifice when use is not required. Remote manual control of the valve is provided from the Control Room, Panel Number 3.

Auxiliary Letdown Flow Control Valve, MU-V5

One 2500 psig, 300°F 2½ inch, 316 SS, diaphragm operated globe valve is provided in the letdown line around the block orifice

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to be used either alone or in conjunction with the block orifice to provide letdown flow at low reactor coolant pressure. During normal reactor operation valve MU-V5 can be isolated from the flow path by a stop valve upstream and downstream of the flow control valve. Remote manual control of the valve is provided by a hand controller located on panel 3 in the Control Room.

Purification Demineralizer Filters Inlet Stop Valve, MU-V224A/MU-V224B

One 150 psig, 200°F, 2½ inch, SS, air piston operated gate valve is provided at the inlet to each purification demineralizer filter to permit periodic changeover during reactor operation. Remote manual control of the valves is provided from the Control Room, panel number 3.

Purification Demineralizers Inlet Stop Valve, MU-V6A/MU-V6B

One 150 psig, 200°F, 2½ inch, 316 SS, air piston operated gate valve is provided at the inlet to each purification demineralizer to permit periodic changeover during reactor operation. Remote manual control of the valves is provided from the Control Room, panel number 3.

Letdown Transfer Valve, MU-V8

One 150 psig, 200°F, 2½ inch, 316 SS, electric motor operated 3 - way selector valve is fitted in the letdown stream between the purification demineralizers and the makeup filters. The valve is normally positioned such that the letdown flow is directed to the makeup tank MU-T-1. However, when a change in the reactor coolant boron concentration is

required, the valve position is altered to bleed reactor coolant to the bleed holdup tanks or the deborating demineralizer with boron free water added as makeup. The following interlocks are associated with this valve:

a. Feed and Bleed Interlock with control rods-feed (adding water to purification train) and bleed (let down to bleed hold up tanks or deborating demineralizers) will cause MU-V8 to be positioned to the make up tank (feed) or the bleed hold up tanks/ the deborating demineralizers (bleed) if the following conditions are satisfied;

1. Rod Position Margin

The Boron Feed and Bleed Controller subsystem shall provide an output signal that shall enable continuous feed and bleed under the following conditions, if and only if the group rod position requirements (Section 3 - below) are satisfied:

Rod Position Margin	Action
(Nominal Rod Position ±2.25) + 10"	Enable feed and bleed on group withdrawal.
Nominal Rod Position ±2.25 in.	Terminate feed and bleed on group insertion.
(Nominal Rod Position ±2.25 in.) - 10"	Enable feed and bleed on group insertion
Nominal Rod Position ±2.25 in.	Terminate feed and bleed on group withdrawal.

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b. Make up Tank Low - Low Level Interlock - causes valve MU-V8 to return to the normal letdown position (flow to makeup tank) should a low-low water level condition in the makeup tank arise;

c. Batch Controller Interlock - causes valve MU-V8 to return to the normal letdown position when a pre-determined amount of makeup feed water has been added to the system.

Remote manual control of the valve is provided from the Control Room, Panel Number 3. Power supply to the electric motor valve operator is from the 480V motor control center 2-32B.

Makeup Feed Control Valve, MU-V9

One 150 psig, 200°F, 2½ inch, 316 SS, diaphragm operated globe valve is provided in the makeup feed line to the normal letdown flow line upstream of the makeup filters. This valve serves to control the rate of makeup water (feed) from either the demineralized service water system or from the discharge of the waste transfer pump to the makeup system. The valve is sized to pass a maximum of 140 gpm and is interlocked with the batch controller to close when a pre-determined amount of feed has been added to the makeup system. Remote manual control of the valve is provided from the Control Room, Panel Number 3.

Makeup Feed Stop Valve, MU-V10

One 150 psig, 200°F, 2½ inch, 316 SS, air piston operated gate valve is provided in the makeup feed line between the makeup flow control valve and the normal letdown line. The following interlocks are associated with this valve:

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"Enable" means that the logic circuitry does not initiate an action, but rather permits the operator to act. "Terminate" means that the logic circuitry will initiate an automatic stop action. The above listed enable and terminate setpoints shall be individually adjustable.

2. Low Power Enable

Below 15% neutron power, the Boron Feed and Bleed Controller subsystem shall enable continuous feed and bleed, regardless of the rod position margin requirements (Section 1 - above), if and only if the group rod position requirements (Section 3 - below) are satisfied.

3. Group Rod Position

The Boron Feed and Bleed Controller will receive two other signals from the System Logic for the Control Rod Drives. These are a single contact closure indicating that control rod groups 1, 2, 3 and 4 are 100% (139") withdrawn and a second single contact closure indicating that control rod group 5 is greater than 25% (34.75" $\pm$ 2.25") withdrawn. The Controller shall allow continuous feed and bleed if and only if both (1) control rod groups 1, 2, 3 and 4 are 100% withdrawn and (2) control rod group 5 is greater than 25% withdrawn. It shall not be possible to circumvent these two requirements for enabling continuous feed and bleed.

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a. Feed and Bleed Interlock with Control Rods - permits valve to open when bleed valve MU-V8 is in the normal (feed) or "bleed" position and the following conditions permit.

1) Rod Position Margin	Action
(Nominal Rod Position ± 2.25 in.)+ 10"	Enable feed and bleed on group withdrawal.
Norminal Rod Position ± 2.25 in.	Terminate feed and bleed on group insertion
(Nominal Rod Position ± 2.25 in.)- 10"	Enable feed and bleed on group insertion.
Nominal Rod Position ± 2.25 in.	Terminate feed and bleed on group withdrawal.

"Enable means that the logic circuitry does not initiate an action, but rather permits the operator to act. "Terminate" means that the logic circuitry will initiate an automatic stop action. The above listed enable and terminate setpoints shall be individually adjustable.

2) Low Power Enable

Below 15% neutron power, the Boron Feed and Bleed Controller subsystem shall enable continuous feed and bleed, regardless of the rod position margin requirements (Section 1 above), if and only if the group rod position requirements (Section 3 below) are satisfied.

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3) Group Rod Position

The Boron Feed and Bleed Controller will receive two other signals from the System Logic for the Control Rod Drives. These are a single contact closure indicating that control rod groups 1, 2, 3 and 4 are not 100% (139") withdrawn and a second single contact closure indicating that control rod group 5 is greater than 25% (34.75" ± 2.25") withdrawn. The Controller shall allow continuous feed and bleed if and only if both; (1) control rod groups 1, 2, 2 and 4 are 100% withdrawn and, (2) control rod group 5 is greater than 25% withdrawn. It shall not be possible to circumvent these two requirements for enabling continuous feed and bleed.

b. Batch Controller Interlock - causes valve to close when a pre-determined amount of feed water has been added to the system.

Remote manual control of the valve is provided from the Control Room, Panel No. 3.

Makeup Filters Inlet Stop Valve, MU-V11A/MU-V11B

One 150 psig, 200°F, 2½ inch, SS, air piston operated gate valve is provided at the inlet to each makeup filter to permit periodic changeover during reactor operation. Remote manual control of the valves is provided from the Control Room, Panel Number 3.

Makeup Tank Outlet Stop Valve, MU-V12

One 350 psig, 300°F, 4 inch, SS, electric motor operated gate valve is provided in the outlet from the makeup tank. Remote manual control of the valve is available in the Control Room

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at Panel Number 3. Power supply to the electric motor valve operator is from the 480V motor control center 2-42B.

Emergency High Pressure Makeup Injection Isolation Valves, MU-V16A, MU-V16B, MU-V16C and MU-V16D

One 3050 psig, 200°F, 2½ inch, 316 SS, electric motor operated globe valve is provided in each of the four emergency reactor coolant makeup injection lines. These valves serve as high pressure injection valve and open automatically upon receipt of a signal from the safety features actuation system to provide emergency high pressure makeup injection to the reactor. Remote manual control and indication of the valves is available from the Control Room on Panel Number 3 and also on Panel Number 15. Light indication only is provided in Panel Number 13. Power supply to the electric motor valve operators is from the 480V engineered safety features motor control centers 2-11EA for MU-V16A and MU-V16B and from 2-21EA for MU-V16C and MU-V16D.

Reactor Coolant System Makeup Flow Control Valve, MU-V17

One 3050 psig, 200°F, 2½ inch, 316 SS, diaphragm operated globe valve is provided in the normal reactor coolant system makeup line for makeup flow control. The extent of valve opening is automatically controlled by the pressurizer level controller RC1-LIC. Remote manual control of the valve is provided from the Control Room, Panel Number 5.

Reactor Coolant System Makeup Stop Valve, MU-V18

One 3050 psig,200°F, 2½ inch, 316 SS, air piston operated gate valve is provided in the normal reactor coolant system makeup line downstream of the makeup flow control valve. The valve serves as an external reactor building isolation valve and

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closed upon receipt of a signal from the engineered safety features actuation system to discontinue normal makeup injection during accident conditions. Remote manual control and indication of the valve is available from the Control Room on Panel Number 15. Indication only is provided in Panel Number 13.

Total Seal Flow Isolation Valve, MU-V~~20~~ 378

One 3050 psig, 200°F, 4 inch, 316 SS, ~~air piston~~ electrically operated gate valve is provided in the common line which feeds the four individual reactor coolant pump seal injection lines. The valve serves as an external reactor building isolation valve. The air piston valve is actuated via dual operated pilot solenoid valves to guard against loss of one essential power source. Remote manual control and indication of the valve is available from the Control Room at Panel Number 3. Indication only is provided in Panel Number 15.

Total Seal Return Internal Isolation Valve, MU-V25

One 2500 psig, 300°F, 4 inch, 316 SS, electric motor operated globe is provided in the common seal return line from the reactor coolant pumps. The valve serves as an internal reactor building isolation valve and closes automatically upon receipt of a signal from the safety features actuation system. Remote manual control and indication of the valve is available from the Control Room on Panel Number 3 and also on Panel Number 15. Indication only is provided in Panel No. 13. Power supply to the electric motor valve operator is from the 480V engineered safety features motor control center 2-21EA.

Total Seal Return External Isolation Valve, MU-V-~~26~~ 377

One 2500 psig, 300°F, 4 inch, 316 SS, ~~air piston~~ electrically operated gate valve is provided in the common seal return line from the reactor coolant pumps. The valve serves as an external

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reactor building isolation valve and closes automatically upon receipt of a signal from the safety features actuation system. Remote manual operation and indication of the valve is available from the Control Room on Panel Number 3 and also on Panel Number 15. Indication only is provided in Panel Number 13.

Reactor Coolant Pump Seal Flow Control Valve, MU-V32

One 3050 psig, 200°F, 4 inch, 316 SS, diaphragm operated globe valve is provided in the total seal flow injection line to the reactor coolant pumps. The valve is normally set to pass approximately 32 gpm (8 gpm to each RC pump seal) and is automatically controlled by MU-9-FIC. Remote Manual control is provided from the Control Room Panel Number 3.

Individual Seal Return Isolation Valves, MU-V33A, MU-V33B, MU-V33C, MU-V33D

One 2500 psig, 650°F, 1 inch, 316 SS, electric motor operated gate valve is provided in each individual seal return line from the four reactor coolant pumps. The following interlocks are associated with these valves:

a. Loss of Seal Injection and ICCW Flow Interlock - causes valve to close automatically on coincident low seal injection flow and loss of intermediate closed cooling water flow:

b. Loss of Seal Injection on Idle Pump Interlock - causes valve to close on coincident low seal injection flow if respective reactor coolant pump is idle;

Remote manual control of the valves is available from the Control Room at Panel Number 4. Power supply to the

electric motor valve operators is from the 480V motor control centers 2-32B for valves MU-V33A and MU-V33B and from 2-42B for valves MU-V33C and MU-V33D.

Seal Return Coolers Inlet and Outlet Stop Valves, MU-V166A/MU-V166B and MU-V167A/MU-V167B

One 150 psig, 200°F, 4 inch, 316 SS, electric motor operated gate valve is provided at the inlet and at the outlet of each seal return cooler for periodic changeover during reactor operation. Remote manual control of the valves is available in the Control Room at Panel Number 3. Power supply to the electric motor valve operators is from the 480V motor control centers 2-32A for valves MU-V166A and MU-V167A and from 2-42A for valves MU-V166B and MU-V167B.

Makeup Pumps Recirculation Isolation Valves MU-V36 and MU-V37

Two 3050 psig, 200°F, 2 inch, 316 SS, electric motor operated gate valves are provided in the common makeup pumps recirculation line to the seal return coolers inlet line. These valves close automatically upon receipt of a signal from the safety features actuation system to ensure full makeup pump discharge capacity for emergency high pressure injection. Remote manual control of the valves is available from the Control Room on Panel Number 3. Power supply to the electric motor valve operators is from the 480V engineered safety features motor control centers 2-11EA for valve MU-V36 and 2-21EA for valve MU-V37.

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2.2 Instruments, Controls, Alarms and Protective Devices

Instrumentation and controls for the makeup and purification system (see Table 8) are provided for the following functions:

1. Control of the reactor coolant inventory by
   (1) Controlling reactor coolant letdown flow by flow-restricting orifice and remote manually positioned flow control valve.

   (2) Controlling reactor coolant makeup flow by regulating the flow control valve from the pressurizer level indicator-controller in the reactor coolant system.

2. Manual remote control of the letdown cooler isolation valves from the control room console.

3. Monitoring of letdown flow and indication of flow rate on the control room console and by the computer.

4. Letdown temperature is monitored and indicated on the control room console. High-temperature alarm is monitored by computer and annunciator. The high temperature alarm is also utilized to trip the letdown isolation valve, MU-V376, closed.

5. The letdown high pressure alarm is monitored by computer and annunciator.

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6. Control of the reactor coolant pump seal injection flow.

7. Total seal injection flow is monitored and indicated on the control room console. High and low flows are alarmed. The total flow signal is also utilized to control the seal control valve (MU-V32) to pass a preset flow to the reactor coolant pump seals.

8. Monitoring of individual reactor coolant pump seal injection flow with control room console indication and low alarm. The individual flow signals are also interlocked to the respective reactor coolant pump motor to prohibit pump start without sufficient flow and also to close the respective seal return valve on low flow.

9. Normal makeup flow (to outlet of RC-P-1A) is monitored and indicated on the control console and high flow is alarmed by an annunciator.

10. Emergency high pressure injection flows (to inlet of RC-P-1A,2A,1B,2B) are monitored and indicated in the control room with high and low flow alarms annunciated. The low flow alarms are interlocked to the safety features actuation system to be operable only when the safety system has been actuated.

11. The seal return flow from each reactor coolant pump is monitored by the computer. High flow is alarmed by annunciator.

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12. Filter differential pressures are monitored and indicated on the control room console. High differential pressures are alarmed by the computer and annunciator.

13. Various valves and pumps are manually controlled from the control room console.

14. The boric acid and demineralized water makeup system is composed of basically four subloops (Interlock Systems): a) valves MU-V8, and b) MU-V-10, c) MU storage tank level, and d) MU tank fluid flow.

Reference B&W "Feed and Bleed Report" for TMI Unit 2, dated October 1971 for a detailed description of the system operation. Basically, the system operates in the following manner:

Valve MU-V8 is a three-way valve which has two operating positions -- bleed(flow to bleed holdup tank or deborating demineralizers) and normal (letdown flow to the makeup tank).

Valve MU-V10 is an "On-Off" valve for controlling chemical or makeup feed to the MU storage tank. The operator, using switch MU-V10-M1S, can open the valve, if any of the following are required:

1. Demineralized Water
2. Make-Up from Reactor Coolant Bleed Holdup Tank.
3. Boric Acid
4. Deborating Demineralizer Outlet

A listing of panel-mounted annunciators and computer inputs is given in Table 9.

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3.0 PRINCIPAL MODES OF OPERATION

3.1 Startup

Startup of the makeup and purification system consists of insuring all lines and components are filled with borated water and all air is vented from the system. In addition cooling water is lined up to all coolers and resin efficiency is determined for the make-up and purification demineralizers. All electrical power supplies are energized and a complete start-up valve line up is completed. Interlocks to all valves and pumps must be verified.

3.2 Normal Operation

During normal makeup and purification system operation, reactor coolant is drawn from the reactor "A" loop at the steam generator outlet and is directed to the tube side of of a letdown cooler, either MU-C-1A or MU-C-1B. The two letdown coolers are arranged in parallel with one cooler normally in service for letdown flow rate up to 70 gpm. The second cooler is utilized as a spare or to accommodate higher flow rates up to a maximum of 140 gpm. Electric motor operated stop valves,MU-V1A and MU-V1B at the inlet to each cooler and MU-V2A and MU-V2B at the cooler outlets provide for remote manual cooler isolation. The inlet valve to each cooler is interlocked with the intermediate cooling water inlet valve to ensure a flow of cooling water prior to placing the cooler in service. The intermediate cooling water manual outlet control valve from each cooler is normally in an open position to prevent a pressure buildup in the cooler shell. In passing through the coolers, the letdown coolant is cooled from operating temperature to approximately 120F with the heat being transferred to the

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intermediate closed cooling water system. The outlet of the coolers connect to a common line which exits the reactor building through penetration R-541. Downstream of the penetration, a remotely controlled air cylinder operated valve, MU-V37, is provided for building and system isolation. The cooled letdown water then flows through a pressure breakdown device where the pressure is reduced from normal operating to approximately 100 psig. Three pressure reduction devices, arranged in parallel, are provided; a block orifice (MU-1-FE), a remotely operated contol valve (MU-V5), and a manual throttle valve (MU-V100). The block orifice is the normal pressure reduction device for flow rates up to 45 gpm. For higher flows up to the maximum of 140 gpm, at startup and low pressure conditions, the control valve must be used. The control valve may be used alone or in conjunction with the block orifice. The manual throttle valve is used only when maintenance is being performed on the block orifice or remote control valve, or during shutdown conditions. The block orifice is isolated at the inlet by remotely controlled air cylinder operated valve, MU-V4, and at the outlet by a manual stop valve, MU-V102. The control valve is provided with manual stop valves, MU-V101 and V103, at the inlet and outlet respectively. A temperature element in the letdown line downstream of the pressure breakdown devices is provided to indicate temperature and to alarm on a high temperature of 135F. The element also transmits an electrical signal which within 4 seconds closes the air cylinder operated building isolation valve MU-V37, if this temperature (135°F)is reached. This interlock serves to protect the demineralizer resins from excessive temperatures which could cause the resins to become rapidly degraded. The saturation level of the demineralizers for boric acid will be attained after approximately one day of operation with normal

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letdown flow. The letdown flow normally passes through one of the two filters MU-F-2A and 2B followed by one of the two purification demineralizers MU-K-1A and 1B which are arranged in parallel. The filters remove suspended solids and the demineralizers, serve to purify the coolant by removing soluble corrosion and fission products and other impurities from the reactor coolant. At the inlet to each filter a remotely controlled air cylinder operated valve, MU-V224A and MU-V224B, is provided for isolation. The filter outlets are isolated by manual stop valves, MU-V225A, and MU-V225B. A by-pass linefitted with manual stop valve MU-V226 is provided around the filters. The filters serve to prevent active corrosion products from being deposited in the demineralizer beds. Normally, one filter is in service for flow rates up to 80 gpm; the second filter is utilized as a spare for use when the normal filter becomes plugged or when flow rates greater than 80 gpm are required. The flow out of the purification and deborating filters, then passes a ½" branch to the nuclear sampling system, to the inlet of make-up and purification demineralizers. At the inlet to each demineralizer, a remotely controlled air cylinder operated valve MU-V6A/MU-6B, is provided for isolation. Each demineralizer outlet line is fitted with a stop check valve, MU-V107A.MU-V107B, to prevent reverse flow. Sample lines leading to the nuclear sampling station are connected to the common demineralizer inlet line and to the common outlet to provide influent and effluent sampling capabilities. Periodic sampling and comparison of the influent and effluent chemistry and radioactivity test results, indicates the purification capability of the resin as well as the quality of the reactor coolant. Each demineralizer can accommodate a flow rate of up to 70 gpm. The second

demineralizer will be placed in service at higher flow rates or when the first demineralizer resin has been exhausted. The letdown flow, after passing through the demineralizer, is directed to a remotely controlled, electric motor operated, three-way valve, MU-V8. The normal position of this valve is such that the demineralizer effluent is directed through the makeup filters and subsequently into the makeup tank. If, however, a change in the boron concentration in the reactor coolant is required, the position of the valve can be remotely transferred to direct the letdown flow to the liquid radwaste disposal system where the borated coolant is either retained in a bleed holdup tank or passed through a deborating demineralizer and returned to the system through a makeup line. The makeup line connects into the letdown piping downstream of the three-way valve. Makeup to the system is available from four sources: the station demineralized water system; the bleed holdup tanks; boric acid pumps; and, from the deborating demineralizers. Dilution (bleed) and makeup control are discussed in detail at the conclusion of this sub-section. Downstream of the demineralizers, the flow is directed through one of two filters, MU-F2A and MU-F2B which are arranged in parallel. At the inlet to each filter, a remotely controlled air cylinder operated valve, MU-V11A or MU-V11B is provided for isolation. The filter outlets are isolated by manual stop valves MU-V132A or MU-V132B. A by-pass line fitted with manual stop valve MU-V149, is provided around the filters. The filters serve to remove suspended solid particles that passed through the demineralizer and also prevent resin fines which may be carried over with the demineralizer effluent from entering the reactor or the reactor coolant pump seals. Normally, one filter is in service for flow rates up to 80 gpm; the second filter is utilized as a spare for use when the normal filter becomes plugged or when flow rates greater than 80 gpm are required.

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From the filters, the coolant flows to the inlet of the make-up tank, MU-T-1. Up to the inlet pipe connection, all major process piping in the system is 2½ inch size. Between this connection and the makeup pumps discharge header, the piping size is 4 inch with the exception of the makeup pumps' suction pipes and header which is 6 inch size. The coolant is sprayed into the gas space of the makeup tank to release gaseous fission products entrained in the water and to increase the potential for hydrogen saturation. The average water volume in the tank during normal operation is approximately 3800 gallons. Makeup water is added to maintain the tank level between 55-86 inches. A hydrogen overpressure of 15 psig is maintained in the tank to provide a concentration of 15 to 40 cc/kg hydrogen in the reactor coolant system. Hydrogen gas is introduced into the water space through a ring header which connects to a line from the hydrogen manifold. Two self-actuated control valves, MU-V29A and MU-V29B, connected in parallel are provided at the hydrogen manifold for pressure regulation. Manual isolation valves are provided upstream and downstream of the regulators for isolation. In the common line between the regulators and the tank, a solenoid operated stop valve, MU-V28, and a check valve (MU-V171) in series, are provided. Provisions for nitrogen addition to the tank during reactor shutdown is made through the same gas addition line. A line from the plant nitrogen storage system connects through a solenoid operated stop valve, MU-V27 and a check valve MU-V170 to the gas addition line. Nitrogen supply during normal operation is isolated by the solenoid valve and various other valves in the nitrogen supply system. Sample lines leading to the sampling station are provided from both the gas and water space. If the tank water level falls to a pre-set low-low limit with the bleed

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control valve MU-V8 in the bleed position, an electrical signal automatically transfers the valve to divert the letdown flow through the filter and into the tank. When required, the makeup tank is vented through remotely controlled air cylinder operated valve MU-V13 and manual throttle valve MU-V136, via the gaseous radwaste disposal system to remove non-condensible gases. A drain line leading to the liquid radwaste disposal system and fitted with a manual throttle valve MU-V169 is provided. The makeup tank can be isolated, if required, by a manual stop check valve, MU-V133, at the inlet and by a remotely controlled, electric-motor operated valve, MU-V12, at the outlet. A by-pass line to the discharge header of the makeup pumps is provided around the tank to allow for makeup and chemical addition to the reactor coolant during reactor shutdowns.

The makeup pumps, MU-P-1A, P-1B and P-1C take suction from the makeup tank through a tank outlet line which connects to the common suction header for the pumps. The pumps are arranged in parallel and each has a manual stop valve at the suction, and a check and manual stop in series at the discharge. Two manual valves in series are provided in both the suction and discharge header between pumps MU-P-1A and P-1B and between pumps MU-P-1C and P-1A and between pumps MU-P-1B and P-1C. The outlet line from the makeup tank connects to the suction header at pump MU-P-1B. Depending upon which pump is in service, the double isolation valves in the common suction and discharge headers must be open between MU-P-1B and the in-service pump or, if MU-P-1B is in service, with its paired pump. The double valves in the common suction and discharge header for the third pump must be closed to ensure header isolation and thereby

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redundancy for high pressure injection. The arrangement of valves and piping at the pumps permits flexibility in operating either of the pumps for normal service (should one pump be incapacitated because of maintenance) while still ensuring that at least two of the pumps are available to provide the safety features function of the system. The common suction header at pumps MU-P-1A and P-1C is connected through separate lines with the outlet from the borated water storage tank and the outlets from the decay heat removal coolers. These lines provide a source of water from the borated water storage tank for emergency high p essure injection, and high pressure recirculation from the reactor building sump via the decay heat removal system.

During normal power operation, the makeup pump discharge is directed through two paths. One path is through a diaphragm operated control valve, MU-V17, in a 2½ inch line leading to the reactor coolant system. The extent of valve opening is controlled by the pressurizer level instrumentation and makeup is automatically added to the coolant system to maintain a constant level in the pressurizer. A by-pass line is provided with a flow indicator, upstream shutoff valve MU-V233B and a downstream shutoff valve MU-V233A, around the makeup control valve, MU-V17. The purpose of this bypass is to provide a small flow of water at all times through the makeup line although the normal makeup is not required because of a transient operating condition resulting in a high pressurizer water level. The bypass flow maintains adequate circulation to keep the piping in the vicinity of the makeup injection nozzle sufficiently cool and prevents thermal

shock when normal makeup is resumed. The bypass valving must be regulated to pass 1 gpm of water through the makeup line. The local flow indicator is provided to set and monitor correct flow. Flow through the normal makeup path enters the reactor building through penetration R-572 and enters the reactor coolant piping downstream (at the discharge) of reactor coolant pump RC-P-1B. A stop check valve is provided inside the secondary shield to prevent reverse flow and permit isolation. The flow control valve is provided with manual isolation valves at the inlet and outlet. A by-pass line with a throttle valve MU-V155 for manual cont is also fitted around the control valve. A remotely controlled air cylinder operated isolation valve MU-V18 is provided downstream of the control valve and by-pass for building isolation purposes.

The second flow path from the discharge of the makeup pump is through a remote manual diaphragm operated flow control valve, MU-V32, which provides seal injection water to the reactor coolant pumps. The control valve is set to supply a total of 32 gpm to the seals; 8 gpm per pump. Manual stop valves at the inlet and outlet of the control valve are provided for isolation; a bypass fitted with a throttle valve (MU-V160) is provided around the control valve for manual control. Seal water then passes through one of two, parallel, seal water supply filters (MU-F-4A and MU-F-4B) for added protection for the reactor coolant pump seals. Each filter is supplied with a 2-inch manual inlet and outlet valve, MU-V342A, MU-V342B and MU-V343A, MU-V343B, respectively. A 2-inch common, manual bypass valve (MU-V350) is provided around the filters. Additional information about the filters is supplied by B&W, the filter suppliers. The seal injection line is a 2 inch line from the discharge header of the seal water filters which discharges into four 1½ inch lines, one to each reactor coolant pump.

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The branch line to each reactor coolant pump seal is provided with a manual needle type valve to balance the flow to 8 gpm in each line. The seal injection lines enter the reactor building through penetrations R-573, 574, 575 and 576. A remotely controlled, air cylinder operated valve, MU-V~~20~~378, is provided in the common line outside the reactor building for isolation while a stop check valve in each of the branch lines provides for isolation inside the building.

With the normal seal injection flow of 8 gpm, 6.9 gpm enters the reactor coolant system as in-seal leakage, while 1.1 gpm is returned to the makeup tank via the seal return coolers. The seal return coolant or controlled bleedoff is directed from each reactor coolant pump through a 1 inch line fitted with electric motor operated gate valve MU-V33A/B/C/D. Each valve is interlocked to close upon loss of seal injection to the respective pump with an attendant loss of intermediate cooling water to that particular pump, and also upon loss of seal injection to an idle pump. A rotometer is provided in each seal return line to measure the flow from each pump seal. In-seal leakage is determined by noting the difference between the seal injection flow to each pump and the seal return (controlled bleedoff) from each pump. The four seal return lines connect to a 1 inch common line which exits the reactor building through penetration R-545D. Upstream of the building penetration, remote manual electric motor operated stop valve, MU-V25, is provided for isolation; remote manual, air cylinder operated valve, MU-V~~26~~377, serves as the isolation valve outside the building. The air cylinder operated valve is actuated via dual operated pilot solenoid valves to guard against loss of one essential power source. Both valves close automatically upon receipt of a signal from the safety features actuation system to prevent an outflow of reactor coolant from the building. Past the building penetration, the seal return coolant then flows through

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a 1-inch manual inlet isolation valve (MU-V334), a seal water return filter (MU-F-3), and another 1-inch manual outlet isolation valve (MU-V335). The filter is also fitted with a 1-inch manual bypass valve (MU-V333) which is used during maintenance or emergency. The coolant then flows to the tube side of of one of two seal return coolers, MU-C2A/MU-C-2B before joining the inlet line to the makeup tank. Cooling water to the shell side of the seal return coolers is supplied by the nuclear services closed cooling water system. Each cooleris supplied with a 4-inch, remote, motor operated inlet and outlet isolation valve (MU-V166A, MU-V166B and MU-V167A, MU-V167B, respectively).

Chemical addition for reactor coolant pH control is made routinely. Lithium hydroxide (LiOH) is added to maintain the pH of the coolant within pre-established limits during reactor operation while hydrazine is used for oxygen scavenging during reactor shutdowns. The chemical pumps in the chemical addition system pump chemicals through independent lines into the letdown flow upstream of the makeup filters and are introduced into the reactor coolant with the normal makeup flow. Chemical addition is a manual operation and the amount of chemical added is determined after laboratory analysis of the reactor coolant.

Changes in the reactor coolant boron concentration are made as required. There are two methods available to reduce the boron concentration; the bleed and feed method, and, the deborating demineralizer method. Normally, the bleed and feed method is used when the boron concentration in the reactor coolant is greater than 190 ppm while the deborating demineralizers are used with boron concentrations less than 190 ppm. The bleed and feed method takes the letdown flow from the outlet of the purification demineralizer through the three-way valve, MU-V8, and directs the flow (bleed) to a bleed holdup tank, in the liquid radwaste disposal system. Demineralized water from the demineralized service water system is introduced through a diaphragm operated flow control valve, MU-V9, a batch controller and an air cylinder operated valve, MU-V10, into the normal letdown line upstream of the makeup filters. This water becomes the makeup for the reactor coolant system. Using the deborating demineralizer, the flow is essentially the same except that the letdown, instead of being directed to a holdup tank, is passed through a deborating demineralizer after which it is returned to the letdown piping through the makeup line. Since the return flow rate, in this case, is the same as the bleed flow, the water enters the makeup line downstream of the flow control valve MU-V9, passing through only the batch controller and the air cylinder operated valve, MU-V10. The amount of deborated water added to the makeup system by either method may be controlled manually, using the three-way valve, or automatically, by pre-setting the batch controller for the desired amount.

To prevent an inadvertent excessive dilution of the reactor coolant boric acid concentration, three safety measures are

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applied to each of the two dilution methods. The first measure is a limitation of 140 gpm on the maximum addition rate through the flow control valve, MU-V9, and the provision for pre-setting the desired flow. The second measure is an interlock between the shim (regulating) control rod group position and the three-way valve, MU-V8, which either permits or prohibits dilution depending upon the nominal regulating control rod group positions. The third measure consists of automatically returning the three-way transfer valve to the normal letdown position when the pre-set quantity of dilution water has passed through the batch controller.

To increase the boron concentration in the reactor coolant, concentrated acid from the chemical addition system is added to the letdown flow and introduced into the reactor coolant with the makeup water. Boric acid may also be added from the reclaimed boric acid tank. The amount of boric acid added is regulated by metering pumps at the boric acid source. It may be added directly to the letdown flow upstream of the filters or may be directed through the makeup line in which the batch controller is fitted. All lines in the system used to transfer concentrated boric acid are heat traced to preclude precipitation and subsequent solidification within the lines.

3.3 Shutdown

No special provisions are necessary during system shutdown except that all lines and components must remain filled with borated water. Due to the function of the system, it will never be shutdown while the reactor is operating. When the reactor is shutdown, makeup and chemical addition to the reactor coolant system is supplied from the normal sources into the letdown line upstream of the makeup filters. The

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flow, however, can bypass the makeup tank and can be directed into the discharge header of the makeup pumps from where it enters the reactor coolant system via the normal makeup line. The driving force for the additions is provided by the respective chemical addition pumps, reactor coolant system pressure? or the boric acid pumps. During periods of system shutdown, the makeup tank should be maintained at the normal water level with a nitrogen overpressure in the gas space.

3.4 Special or Infrequent Operation

Makeup from the boric acid pumps to the makeup stream, directly upstream of the makeup filters, may be used through a 1½" heat traced line, a 1½" manual valve MU-V127 and a 1½" check valve MU-V325, to bypass the normal makeup path.

Provisions have been incorporated into the design of the system to add makeup to the core flooding tanks to adjust the water level or the boron concentration in the tanks. A one inch line fitted with a restricting orifice and manual throttle valve, MU-V168, is connected to the discharge header of the makeup pumps and branches into two 1 inch lines each leading to one of the core flooding tanks. Manual stop valves, MU-V179A and MU-V179B are provided in each branch line for isolation. This method of makeup addition is used during reactor shutdowns. Another line, from the discharge of the core flooding tank makeup pump in the chemical addition system, connects to the common line before it branches to each core flooding tank for addition of makeup during reactor operation.

Provision has also been made in the system design to replace the resins in the purification demineralizers, or the filtering

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elements in the makeup system filters without disrupting normal system operation. Each demineralizer is fitted with a sluicing outlet which connects to a 2 inch line leading to the spent resin storage tank in the solid radwaste disposal system. To change the resins, the demineralizer, either MU-K-1A or MU-K-1B, is isolated from normal service with the alternate demineralizer serving to perform the purification function. After appropriate valving in the radwaste system has been established, the resins are fluidized by back flowing demineralized water through the effluent line into the demineralizer through air cylinder operated valve MU-V292A/B. The electric motor operated sluicing valve, MU-V108A or MU-V108B is opened and demineralized water from the station demineralized water system is introduced into the unit through air piston operated valve MU-V285A or MU-V285B in the service line. A bypass line provided with a diaphragm operated valve (MU-V238A/MU-V238B) is fitted around the electric motor operated valve for each demineralizer in the event of motor operator failure. The spent resin is then discharged to the spent resin storage tank. When the resin has been removed, the demineralizer is flushed with demineralized water and drained. New resin from the resin addition tank in the liquid radwaste disposal system is added to the unit through diaphragm operated valve MU-V111A/MU-V111B in the resin fill inlet connection provided on each demineralizer. When the appropriate amount of resin has been added, the resin fill valve MU-V111A or MU-V111B is closed and the unit is filled with demineralized water and vented of air.

The elements in the makeup filters are changed by isolating the filter, either MU-F-5A or 2A or MU-F-5B or 2B, from normal service with the alternate filters providing the filtration function. The unit is then vented and drained through the

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respective filters drain line to the auxiliary building sump tank. The hinged cover is loosened and raised, and the basket containing the filtering elements is removed. A replacement basket with new elements is placed into the unit and the cover lowered and fastened. The drain valve is then closed. Letdown water should be carefully introduced into the unit with the vent open until all air has been expelled.

If a makeup pump is out-of-service for any reason, it must be ensured that the common suction and discharge headers are properly valved so that each one of the serviceable pumps is capable of providing high pressure injection to one loop. In this case, the backup selector switch must be in the "locked out" position.

During normal plant operation it may become necessary to vent the pressurizer vapor space to expel unwanted gases. This venting or degassing operation is used to reduce the amount of radioactive gas in the pressurizer vapor space or to reduce the amount of dissolved gas in solution of the primary coolant. The flow path during degassing operation is from the pressurizer vapor space, to the nuclear sampling system (Ref B&R Dwg. 2031). Gaseous flow in the nuclear sampling system through the pressurizer sample cooler, by-passes the sample "bomb" in the sampling system, through three parallel needle valves, and enters the makeup "stream" down stream of MU-V8 and upstream of the make up filters through a ½" pipe and a ½" check valve MU-V313. This excess gas in the makeup tank is vented to the vent gas header through 1" vent valves MU-V13 and MU-V136.

The excess hydrogen which is maintained in the makeup tank is added through a ½" pressure control valve (MU-V29A or MU-V29B), a ½" solenoid operated valve (MU-V-28) and a ½" check valve (MU-V171) from the Nuclear Plant Hydrogen manifold (Ref. B&R dwg. 2036). Hydrogen makeup is controlled by cycling hydrogen valve (MU-V28) to increase the hydrogen partial pressure in the makeup tank, which in turn will increase the hydrogen concentration (cc/kg) in the reactor coolant. Frequency and duration of hydrogen addition is determined by periodic sampling as specified in the TMI chemistry manual.

Operating the makeup system with greater than seventy (70) GPM, letdown flow will necessitate placing the non-operating purification and deborating filter, makeup and purification demineralizer and makeup filter in service. These actions are required due to the limited capacity of these componenets. In addition, block orifice by-pass valve (MU-V5) is adjusted to regulate by-pass flow whenever letdown flow to the block orifice (MU-1-FE) is greater than fourty-five (45) GPM.

In the unlikely event seal water to one or all reactor coolant pumps is lost, operation of the pump may be continued without any special operation of the makeup and purification system. Seal water return valves are interlocked to close automatically on a low seal water flow or loss of seal water flow. Operation in this mode is possible due to the inherent design of the reactor coolant pump seals.

3.5 Emergency Operation

The makeup pumps in the system serve a safety features function by providing borated water from the borated water storage tank to the reactor coolant system immediately following the LOCA. The high discharge pressure capability of the pumps permits makeup water to be added while the reactor pressure is high and before the pressure has decayed sufficiently for emergency low pressure injection using the decay heat removal pumps. Following a loss-of-coolant accident, the safety features equipment will be automatically actuated by a signal from the safety features actuation system (SFAS). The building isolation valves, MU-V2A/MU-V2B, MU-V3, MU-V18, MU-V20, MU-V25 and MU-V26 close, halting all normal system flow out of and into the reactor building. The high pressure injection valves, MU-V16A/B/C and D, in the makeup lines to the four reactor coolant pump discharge lines open, as do the suction valves DH-V5A/B, in the lines from the borated water storage tank to the makeup pumps' suction header. A signal from the SFAS will start pumps MU-P-1A and 1C. If either MU-P-1A or 1C is out-of-service, MU-P-1B must be valved to the same section of the common suction and discharge headers as the out-of-service pump. (Normal operation under this condition, therefore, provides no back-up capability.) The two makeup pumps operate in parallel to inject the borated water into the reactor. Either pump MU-P-1A or MU-P-1B discharges into a 4 inch line (the normal flow path having been stopped by the building isolation valve) which branches into two 2½ inch lines leading to the discharge piping of reactor coolant pumps RC-P-1B and RC-P-2B. Either pump MU-P-1B or MU-P-1C discharges into another 4 inch line which branches into two 2½ inch lines to reactor coolant pumps RC-P-1A and RC-P-2A.

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A flow meter in each emergency injection branch line, indicates flow and alarms on a high flow of 260 gpm and a low flow of 75 gpm. The MU-V16 series of valves (A/B.C & D) are electric motor operated stop valves in the emergency injection branch line to each reactor coolant pump and provide isolation upstream of reactor building penetration for each line. A high flow alarm from the branch line flowmeters could indicate a piping failure downstream of the flow orifice and, therefore, the flow indication from both injection lines to each loop must be compared. A low flow alarm would be indicative of a makeup injection valve failing to open and an attempt should be made to open the valve remotely.

As the reactor coolant pressure decreases, the discharge flow from the makeup pumps will increase. When the reactor pressure has decreased to approximately 200 psig, the decay heat removal pumps will provide the makeup injection and operation of the high pressure injection pumps in the makeup and purification system are terminated manually. (When it becomes necessary to change the condition imposed by the safety features actuation system on a system component, the actuation signal must first be bypassed and reset.)

A second safety features function served by the makeup pumps is recirculation of the coolant from the reactor building emergency sump after an accident. In the event of a small reactor coolant system leak where the reactor pressure decreases slowly, the supply of borated water in the borated water storage tank may be exhausted before the reactor pressure has fallen to 200 psig when recirculation, using the decay heat removal

system, is initiated. In this case, the makeup pumps are utilized for recirculation. When the level in the borated water storage tank approaches the low-low setpoint, valves DH-V6A and DH-V6B in the suction lines from the reactor building sump are opened to provide suction for the decay heat removal pumps. In addition, valves DH-V7A and DH-V7B in the lines connecting the outlet of the decay heat removal coolers to the suction header of the makeup pumps are opened. The decay heat removal pumps then discharge the coolant from the reactor building sump, through the decay heat removal coolers and into the suction header of the makeup pumps, providing the required NPSH for operation. The makeup pumps discharge the cooled water via the emergency injection lines into the reactor coolant system. This method of recirculation is continued until such time as the reactor pressure decreases sufficiently to permit recirculation using only the decay heat removal pumps. The makeup pumps and other system equipment having safety features functions are powered electrically from the emergency diesel generator buses to ensure availability in the event of a station power failure.

4.0 HAZARDS AND PRECAUTIONS

There are no explicit hazards associated with the system. The normal precautions must be taken with a system in which a radioactive liquid is transported. Additional precuations must be observed due to the explosive nature of hydrogen gas which is introduced into this sytem for oxygen scavenging in the reactor coolant. All equipment vents and drains are directed to their respective radwaste disposal systems. The system must be maintained in good repair in order to serve its normal functions and is continually monitored during normal system operation to indicate performance.

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The system must be operated in accordance with the standard procedure prepared for this system. This procedure has been developed from the recommendations of the reactor and equipment manufacturers and incorporates all safety precautions from both a radiological and engineering standpoint.

TABLE 1

LETDOWN COOLER

Identification	MU-C-1A, MU-C-1B
Number Required	Two
Manufacturer	Graham Mfg. Company
Cleanliness Factor	0.85
Heat Transfer, BTU/hr.	16.1×10^6
Tube Side:	
Fluid flow, lbs/hr. - Source	3.5×10^4 - Reactor Coolant
Design Press., psig	2500
Design Temp., F	600
Material	304 SS
Pressure drop, psi	3.0
Shell Side:	
Fluid flow, lbs/hr. - Source	2.0×10^5 ICCWS
Design Press., psig	200
Design Temp., F	350
Material -	CS
Pressure drop, psi	15.0
Classifications:	
ASME Code Class. Tube/Shell	III-C lethal/VIII
Nuclear	N-1
Quality Control	1
Seismic	I
Cleanliness, tube/shell	B/C

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TABLE 2

SEAL RETURN COOLER

Identification	MU-C-2A, MU-C-2B
Number Required	Two
Vendor	Babcock & Wilcox Co.
Manufacturer	Whitlock Mfg. Co.
Cleanliness Factor	0.85
Heat Transfer, BTU/hr.	1.38×10^6
Tube Side:	
Fluid flow, lbs/hr. - Source	9.2×10^4 - Reactor Coolant
Design Press., psig	150
Design Temp., F	200
Material	304 SS
Pressure drop, psi	10
Shell Side:	
Fluid flow, lbs/hr. - Source	9.2×10^4 - NSCCWS
Design Press., psig	150
Design Temp., F	250
Material	CS
Pressure drop, psi	15
Classifications:	
ASME Code Class. Tube/Shell	III-C lethal/VIII
Nuclear	N-1
Quality Control	3
Seismic	I
Cleanliness, tube/shell	B/C

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TABLE 3

SEAL INJECTION AND SEAL RETURN FILTERS

SEAL INJECTION FILTERS

Identification	MU-F-4A, MU-F-4B
Number Required	Two
Vendor	B&W
Manufacturer	Pall Trinity
Type	Disposable Cartridge (23 micron absolute)
Rated Capacity, gpm	50
Design Temperature, ^{o}F	200
Design Pressure, psig	3050
Materials of Construction	SS
Code	ASME, Section III, Class 2, 19

Classifications:

Nuclear	N-2
Quality Control	2
Seismic	I
Cleanliness	B

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TABLE 3 (cont'd)

SEAL INJECTION AND SEAL RETURN FILTERS

SEAL RETURN FILTER

Identification	MU-F-3
Number Required	One
Vendor	B&W
Manufacturer	Pall Trinity
Type	Disposable Cartridge (20 micron absolute)
Rated Capacity, gpm	20
Design Temperature, °F	200
Design Pressure, psig	150
Material of Construction	SS
Code	ASME, Section III, Class 3, 19

Classifications:

Nuclear	N-3
Quality Control	3
Seismic	I
Cleanliness	B

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TABLE 4

MAKE-UP AND PURIFICATION DEMINERALIZER FILTERS AND MAKE-UP FILTERS

Identification	MU-F-5A, 5B (Make-up and Purification Demineralizer Filters)
	MU-F-2A, 2B (Make-up Filters)
Number Required	Four
Vendor	Babcock & Wilcox Co.
Manufacturer	Pall Trinity
Type	Disposable Cartridge (1 micron at 98% retention)
Rated Capacity, gpm	80
Design Temperature, F	-20 to 250
Design Pressure, psig	300
Materials of Construction	SS
Code	ASME Section III, Class C, Lethal

Classifications:

Nuclear	N3
Quality Control	3
Seismic	I
Cleanliness	B

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TABLE 5

MAKEUP AND PURIFICATION DEMINERALIZERS

Identification	MU-K-1A and 1B
Number Required	Two
Vendor	Babcock & Wilcox Co.
Manufacturer	Illinois Water Treatment Co.
Design Temperature, F	200
Design Pressure, psig	150
Rated Capacity, gpm	70
Resin Volume, $ft.^3$	50
Type	Mixed Bed
Ratio (cation/anion)	2:1
Material of Construction	SS
Code	ASME Section III, Class C, Lethal

Classifications:

Nuclear	N3
Quality Control	3
Seismic	I
Cleanliness	B

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TABLE 6

MAKEUP TANK

Identification	MU-T-1
Number Required	One
Vendor	Babcock & Wilcox Co.
Manufacturer	Buffalo Tank Division
Size	8' OD x 13' High
Design Temperature, F	200
Design Pressure, psig	100
Capacity, gals.	4,500
Material of Construction	SS
Tank Thickness	.347"
Code	ASME Section III, Class C Lethal

Classifications:

Nuclear	N3
Quality Control	3
Seismic	I
Cleanliness	B

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TABLE 7

MAKEUP PUMP

Pump Details	
Identification	MU-P-1A, MU-P-1B, MU-P-1C
Number Installed	Three
Vendor	Babcock & Wilcox Co.
Manufacturer	Bingham Pump Co.
Model No.	3 x 4 x 7½ MSD
Type	9 Stage, Horizontal, Single Suction, Centrifugal
Rated Capacity, gpm	300
Rated TDH, ft.	5545 (min)
NPSH, ft.	28
Speed, rpm	6800 (Horizontal speed increaser)
Design Pressure, psig	3000
Design Temperature, F	200
Lubricant/Bearings	Forced Oil
Gear Increaser	Forced Oil
Coolant	NSCCW System
Motor Details	
Manufacturer	Westinghouse
Type	
Enclosure	Drip proof
Rated Horsepower, hp	700
Speed, rpm	1760
Power	4000v, 89 amps (full load) 60hz, 3Ø
Source (for each pump-motor) P-1A	4160V Engineered Safety Feature Bus 2-1E
P-1B	4160V Engineered Safety Feature Bus 2-1E/2-2E
P-1C	4160V Engineered Safety Feature Bus 2-2E
Lubricant/Coolant	Sealed Bearings/NSCCW System

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TABLE 7 (Continued)

Classifications:

Nuclear	N-2
Quality Control	2
Seismic	I
Cleanliness	B

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TABLE 8

INSTRUMENTATION AND CONTROL

NOTE: For reference to I and C Logic System, see I and C Schematic Dwg. 3090.

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-RE-720	Radiation Monitor	Monitor Primary System Letdown Radiation	Local	Scintillator	80 Kev-2 Mev	0-2V	N/A
MU-RI-720-1	Radiation Indicator	Indicates Letdown Radiation Level	Panel 12	Ratemeter	0-2V	$10-10^6$ cpm 10-50 MVDC	later
MU-RI-720-2	Radiation Indicator	Indicates Letdown Radiation Level	Panel 12	Ratemeter	0-2V	$10-10^6$ cpm 10-50 MVDC	later
MU-UR-3264	Multipoint Recorder	Receives signal from MU-RY-720 1 & 2 to record radiation level	Panel 12	Multipoint	10-50 MVDC	10-50 MVDC	N/A
MU-RY-720-1&2	Relay	Receives signal from MU-RE-720 to give Hi-Radiation Alarm	Panel 12	--	N/A	N/A	later
MU-FHS-722	Handswitch	Operates MU-V25, RCP Seal water return isolation (Reactor Building)	Panel 15	Push button	N/A	N/A	N/A
MU-FHS-727	Handswitch	Operates MU-V18, Make-up to primary loop	Panel 15	Push button	N/A	N/A	N/A
MU-PT-732	Pressure Transmitter	Sends signal to MU-PI-732 for Make-Up Pump Suction Header Pressure	Rack	Gage	0-160 psig	10-50 ma	N/A
MU-PI-732	Pressure Indicator	Indicates Make-Up Pump Suction Header Pressure	Panel 8	Milliameter	10-50 ma	0-160 psig	N/A
MU-PS-733	Pressure Switch	Sends signal to MU-PAL-733 for low suction pressure to make-up pump MU-P-1A	Rack	Diaphragm	2-30 psig	N/A	12.5 psig
MU-PS-734	Pressure Switch	Sends signal to MU-PAL-734 for low suction pressure to make-up pump MU-P-1B	Rack	Diaphragm	2-30 psig	N/A	12.5 psig
MU-PS-735	Pressure Switch	Sends signal to MU-PAL-735 for low suction pressure to Make-up Pump MU-P-1C	Rack	Diaphragm	2-30 psig	N/A	12.5 psig
MU-DPI-1574	Differential Pressure Indicator	Indicates differential pressure across Make-up Pump MU-P-1A, Suction Strainer	CA Mtg.	D/P Cell	0-100" H_2O	0-125" H_2O	N/A
MU-DPI-1575	Differential Pressure Indicator	Indicates differential pressure across Make-up Pump MU-P-1B, Suction Strainer	CA Mtg.	D/P Cell	0-100" H_2O	0-125" H_2O	N/A
MU-DPI-1576	Differential Pressure Indicator	Indicates differential pressure across Make-up Pump MU-P-1C, Suction Strainer	CA Mtg.	D/P Cell	0-100" H_2O	0-125" H_2O	N/A
MU-PT-1579	Pressure Transmitter	Sends signal to MU-PI-1579 for letdown pressure	Rack 774	Gage	0-50 psig	10-50 ma DC	N/A
MU-PI-1579	Pressure Indicator	Indicates letdown pressure	Panel 8	Milliameter Vertical	10-50 ma DC	0-50 psig	N/A

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TABLE 8 (Continued)

INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU- TE-1580	Temperature Element	Measures temperature seal water cooler outlet	Piping	RTD	20-200°F	100 OHM 80°C	N/A
MU-TT-1580	Temperature Transmitter	Transmits signal from MU-TE-1580 to MU-TI-1580 for seal water cooler outlet temperature	Cable Room	Solid state R/I	100 OHM 80°C	10-50 ma DC	N/A
MU-TI-1580	Temperature Indicator	Seal water cooler outlet temperature	Panel 8	Milliameter Vertical	10-50 ma DC	20-220° F	N/A
MU-TT-1581	Temperature Tranmmitter	Transmits signal from MU-16-TE (B&W) to MU-TI-1581 for make-up tank temperature	Cable Room	Solid State R/I	0-220° F	10-50 ma DC	N/A
MU-TI-1581	Temperature Indicator	Make-Up tank temperature	Panel 3	Milliameter	10-50 ma DC	0-220° F	N/A
MU-PS-1760	Pressure Switch	Sends signal to MU-PAL-1760 for low discharge pressure of make up pump MU-P-1A	Rack	Diaphragm	500-3000 psig	N/A	2200 psig
MU-PS-1761	Pressure Switch	Sends signal to MU-PAL-1761 for low discharge pressure of make-up pump MU-P-1B	Rack	Diaphragm	500-3000 psig	N/A	2200 psig
MU-PS-1762	Pressure Switch	Sends signal to MU-PAL-1762 for low discharge pressure of make-up pump MU-P-1C	Rack	Diaphragm	500-3000 psig	N/A	2200 psig
MU-FHS-3076	Hand Switch	Operates MU-V224A, Purification and Deborating Filter Inlet	Panel 3	Selector switch	N/A	N/A	N/A
MU-FHS-3077	Hand Switch	Operates MU-V224B Purification and Deborating Filter Inlet	Panel 3	Selector switch	N/A	N/A	N/A
MU-FHS-3078	Hand Switch	Operates MU-V108A, Purification Demineralizer MU-K-1A Resin Discharge	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-FHS-3079	Hand Switch	Operates MU-V-238A, Purification Demineralizer MU-K-1A Alternate Resin Discharge	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-FHS-3080	Hand Switch	Operates MU-V-108A, Purification Demineralizer MU-K-1B Resin Discharge	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-FHS-3081	Hand Switch	Operates MU-V238B, Purification Demineralizer MU-K-1B Alternate Resin Discharge	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-FHS-3082	Hand Switch	Operates MU-V106, Purification Demineralizer Outlet Sample	Panel 329	Selector switch	N/A	N/A	N/A

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TABLE 8 (Continued)

INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-FMS-3083	Hand Switch	Operates MU-V135, Make-Up Tank Liquid Sample	Panel 329	Selector Switch	N/A	N/A	N/A
MU-FMS-3092	Hand Switch	Operates MU-V166B, Seal Water return Cooler MU-C-2B Inlet Block	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3093	Hand Switch	Operates MU-V167B, Seal Water return Cooler MU-C-2B Outlet Block	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3094	Hand Switch	Operates MU-V166A, Seal Water return Cooler MU-C-2A Inlet Block	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3095	Hand Switch	Operates MU-V167A, Seal Water return Cooler MU-C-2A Outlet Block	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3427	Hand Switch	Operates MU-V26, RCP seal water return Isolation (Auxiliary Building)	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FMS-3428	Hand Switch	Operates MU-V16A, Make-Up pumps to Primary Loop	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FMS-3429	Hand Switch	Operates MU-V16B, Make-Up pumps to Primary Loop	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FMS-3430	Hand Switch	Operates MU-V16C, Make-Up Pumps to Primary Loop	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FMS-3431	Hand Switch	Operates MU-V16D, Make-Up Pumps to Primary Loop	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FMS-3441	Hand Switch	Operates MU-V294, Demineralized Water to Make-Up stream	Panel 8	Pushbutton	N/A	N/A	N/A
MU-FMS-3442	Hand Switch	Operates MU-V36, Make-Up Pumps to seal return coolers	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3443	Hand Switch	Operates MU-V37, Make-Up Pumps to seal return coolers	Panel 3	Selector Switch	N/A	N/A	N/A
MU-FMS-3444	Hand Switch	Operates MU-V104, Purification and Deborating Filter Outlet Sample	Panel 329	Selector Switch	N/A	N/A	N/A
MU-FMS-3445	Hand Switch	Operates MU-V111A, Make-Up and Purification Demineralizer MU-K-1A Resin Fill	WDS Panel 302A	Pushbutton	N/A	N/A	N/A
MU-FMS-3446	Hand Switch	Operates MU-V111B, Make-Up and Purification Demineralizer MU-K-1B Resin Fill	WDS Panel 302A	Pushbutton	N/A	N/A	N/A

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INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-FHS-3447	Hand Switch	Operates MU-V285A, Make-Up and Purification Demineralizer MU-K-1A Demineralized Water Inlet	WDS Panel 302A	Pushbutton	N/A	N/A	N/A
MU-FHS-3448	Hand Switch	Operated MU-V285B, Make-Up and Purification Demineralizer MU-K-1B Demineralized Water Inlet	WDS Panel 302A	Pushbutton	N/A	N/A	N/A
MU-FHS-3449	Hand Switch	Operates MU-V292A, Nitrogen and Demineralized Water to Make-Up and Purification Demineralizer MU-K-1A	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-FHS-3450	Hand Switch	Operates MU-V292B, Nitrogen and Demineralized Water to Make-Up and Purification Demineralizer MU-K-1B	WDS Panel	Pushbutton	N/A	N/A	N/A
MU-DPI-3451	Differential Pressure Indicator	Indicates Differential pressure of Purification and deborating filters	Panel 3	Milliameter	10-50 ma DC	0-30 psig	N/A
MU-DPT-3451	Differential Pressure Transmitter	Sends signal to MU-DPI-3451 for purification and deborating filters differential pressure	Rack 474	D/P cell	0-30 psig	10-50 ma DC	N/A
MU-DPS-3451	Differential Pressure Switch	Sends alarm signal to MU-DPAH-3451 for high pressure drop across filters	Cable Room	Solid State	N/A	N/A	25 psig
MU-FHS-3469	Hand Switch	Operates MU-V3, Letdown cooler combined outlet	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FHS-3471	Hand Switch	Operates MU-V2B, Letdown cooler MU-C-1B cooler MU-C-1B outlet	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FHS-3470	Hand Switch	Operates MU-V2A, Letdown cooler MU-C-1A outlet	Panel 15	Pushbutton	N/A	N/A	N/A
MU-FHS-3475	Hand Switch	Operates MU-V134, Make-Up tank gas sample	Panel 329	Selector Switch	N/A	N/A	N/A
MU-DPT-3836	Differential Pressure Transmitter	Sends signal to MU-DPI-3836 for Seal Return Filter differential pressure	Mtg. A23	D/P cell	0-75 psi	10-50 MADC	N/A
MU-DPI-3836	Differential Pressure Indicator	Indicates Differential pressure of Seal Return Filter	Panel 3	Milliameter	10-50 ma DC	0-75 psi	N/A
MU-DPS-3836	Differential Pressure Switch	Sends alarm signal to MU-DPAH-3836 for high pressure drop across filter	Cable Room	Solid State	N/A	N/A	70 psi
MU-DPT-40	Differential Pressure Transmitter	Sends signal to MU-DPI-40 for seal injection filters differential pressure	Mtg. A10	D/P cell	0-30 psi	± 10V DC	N/A

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INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-DPI-40	Differential Pressure Indicator	Indicates differential pressure of seal injection filters	Panel 3	Millimeter	±10V DC	0-30 psig	N/A
MU-DPS-40	Differential Pressure Switch	Levels alarm signal to MU-DPAH-40 for high pressure drop across filters	Cable Room	Solid State	N/A	N/A	25 psig

B & W INSTRUMENTATION AND CONTROLS

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-1-FE	Flow Element	Restricts letdown flow and reduces pressure to the Make-Up & Purification Demineralizer Filters	Piping	Block Orifice	0-2500 psig	0-45 GPM	N/A
MU-2-PT	Pressure Transmitter	Transmitts signal to MU-2-PI for R.C. Make-Up Header Pressure	Local	Electric	0-3000 psig	± 10 VDC	N/A
MU-2-PI	Pressure Indicator	Indicates R.C. Make-Up Header Pressure	Panel 3	Vertical	± 10 VDC	0-30 x 100 psig	N/A
MU-3-MIC	Manual Indicating Controller	Operates MU-VS, auxilary letdown flow control valve	Panel 3	Hand	N/A	0-100%	N/A
MU-4-FE	Flow Element	Measures letdown flow	Piping	Flow Nozzle	0-160 GPM	0-200" H_2O	N/A
MU-4-DPT	Differential Pressure Transmitter	Transmits signal to MU-4-FT for letdown flow	Rack 474	Electric	0-200" H_2O	± 10 VDC	N/A
MU-4-FI	Flow Indicator	Indicates letdown flow	Panel 3	Vertical	± 10 VDC	0-16 x 10 GPM	N/A
MU-5-TE	Temperature Element	Measures letdown cooler outlet temperature	Piping	RTD	0-200°F	100 OHM @ 32°F	N/A
MU-5-TT	Temperature Transmitter	Transmits signal to MU-5-TI for letdown cooler outlet temperature	Rack 474	D.C. Signal Converter (R)	100 OHM @ 32°F	± 10 VDC	N/A
MU-5-TI	Temperature Indicator	Indicates the letdown cooler outlet temperature	Panel 3	Vertical	± 10 VDC	0-20 x 10°F	N/A
MU-5-TS	Temperature Switch	Monitors and transmitts alarm signal to MU-5-TAH & NSS Computer for letdown cooler outlet temperature high	Rack 474	Signal Monitor	± 10 VDC	200°F	115°F
MU-6-PS	Pressure Switch	Monitors and transmitts alarm signal to NSS computer for letdown high pressure	Rack 474	Static-O-Ring	25-375 psig	N/A	145 psig

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B & W INSTRUMENTATION AND CONTROLS

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-7-FE 1,2,3 & 4	Flow Element	Measures R.C. Pump Seal inlet flow	Piping	Flow Nozzle	0-15 GPM	0-200"H_2O	N/A
MU-7-DPT 1,2,3, &4	Differential Pressure Transmitters	Transmitts signal to MU-7-FI 1,2,3,&4 for R.C pump seal inlet flow	Rack 459	Electric Py	0-200"H_2O	± 10 VDC	N/A
MU-7-FI 1,2,3,& 4	Flow Indicators	Indicates R.C. pump seal inlet flow	Panel 3	Vertical	± 10 VDC	0-15 GPM	N/A
MU-8-DPIS 1 &2	Differential Pressure Indicator Switch	Indicates and Transmitts alarm signal on high pressure drop across the Make-Up and Purification Demineralizers (MU-K-1A/1B)	Local	Electric	0-500 psi	±10 VDC	25 psi
MU-9-FE	Flow Element	Measures R.C. Pump seal inlet header flow	Piping	Flow Nozzle	0-80 GPM	0-1000"H_2O	N/A
MU-9-DPT	Differential Pressure Transmitter	Transmitts signal to MU-9-FI for R.C. pump seal inlet header flow	Local	Electric	0-1000"H_2O	± 10 VDC	N/A
MU-9-FI	Flow Indicator	Indicates R.C. pump seal inlet header flow	Panel 3	Vertical	± 10 VDC	0-80 GPM	N/A
MU-9-FS	Flow Switch	Monitors and transmitts alarm signal to MU-9-FAL for the total R.C. pump seal inlet header Hi/Lo flow	Rack 459	Signal Monitor	± 10 VDC	0-80 GPM	42 GPM (Hi) 22 GPM (Lo)
MU-9-FIC	Flow Indicating Controller	Operates MU-V32, the reactor boolant pump seal flow control	Panel 3	Hand	N/A	N/A	N/A
MU-10-FT 1,2,3, & 4	Flow Transmitters	Transmitts signal to MU-10-FS 1,2,3,&4 for R.C. Pump loop seal return line high flow	Local	Rotameter	0-2 GPM	10-50 MA	N/A
MU-10-FS 1,2, 3, & 4	Flow Switches	Monitors and transmitts alarm signal to MU-10-FAH for R.C. pump loop seal return line high flow	Rack 459	Signal Monitor	10-50 MA	0-2 GPM	1.4 GPM
MU-12-FT	Flow Transmitter	Transmitts signal MU-12-FI,FZS for make-up storage tank make-up flow	Local	Turbine Flow	0-175 GPM	N/A	N/A
MU-12-FI, FIX MC, FZS	Flow Batch Controller	Indicates, measures, operates MU-V2, and transmitts interlock signal to MU-010 for controlling the make-up water (feed) rate to the make-up system	Panel 3	Digital Flow Totalizer	N/A	0-175 GPM	N/A
MU-14-LT 1 & 2	Level Transmitter	Transmitts signal to MU-14 LR for make-up tank level Hi/Lo	Local	Electric	0-100"	± 10 VDC	N/A
MU-14-LR	Level Recorder	Monitors and records make-up tank level	Panel 3	Strip Chart Recorder (WR)	±10 VDC	0-100"H_2O	N/A

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B & W INSTRUMENTATION AND CONTROLS

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoints
MU-14-LS 1	Level Switch	Monitors and transmitts alarm signal to MU-14-LAH & LAL for make-up tank-level Hi/Lo	Panel 3	-	-	-	86"Hi 55"Lo
MU-14 LS 2	Level Switch	Monitors and Transmitts interlock signal to MU-V8, returns let-down transfer valve to normal position on low/low signal	Rack 474	Signal Monitor	± 10 VDC	0-100"H_2O	18"
MU-14-HS	Manual Switch	Selects make-up tank level transmitter	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-16-TE	Temperature Element	Measures temperature of make-up tank (MU-T-1)	Local	RTD	0-200°F	100 OHM @ 32°F	N/A
MU-17-PT	Pressure Transmitter	Transmitts signal to MU-PI & PS for make-up tank pressure	Local	Electric	0-100 psig	± 10 VDC	N/A
MU-17-PI	Pressure Indicator	Indicates make-up tank pressure	Panel 3	Vertical	± 10 VDC	0-10 x 10 psig	N/A
MU-17-PS	Pressure Switch	Monitors and transmitts alarm signal to MU-17-PAH, make-up tank pressure high/low	Rack 474	Signal Monitor	±10 VDC	0-100 psig	90 psig (Hi) atmos. (Low)
MU-18-DPT	Differential Pressure Transmitter	Measures and transmitts an indicating and alarm signal to MU-18-dPI&dPS for make-up filters (MU-F-2A/2B) high pressure drop	Rack 474	Electric D/P	0-30 psi	± 10 VDC	N/A
MU-18-DPI	Differential Pressure Indicator	Indicates the pressure drop across make-up filters	Panel 3	Vertical	± 10 VDC	0-30 psi	N/A
MU-18-DPS	Differential Pressure Switch	Monitors and transmitts alarm signal to MU-18-DPAH make-up filters high differential pressure	Rack 474	Signal Monitor	0-30 psi	N/A	25 psi
MU-20-PI	Pressure Indicator	Indicates hydrogen manifold pressure	Rack 468	Gage	0-100 psig	0-100 psig	N/A
MU-22-PI,1,2, & 3	Pressure Indicator	Indicates make-up pumps (MU-P-1A, 1B, & 1C) discharge pressure	Local	Gage	0-3,000 psig	0-3,000 psig	N/A
MU-23-FE 1,2, 3, & 4	Flow Elements	Measures emergency reactor coolant make-up flow	Piping	Flow Nozzle	0-500 GPM	0-1000"H_2O	N/A
MU-23-DPT 1,2 3, & 4	Differential Pressure Transmitters	Transmitts signal to MU-23-FS & FI 1,2,3, & 4 for emergency R.C. make-up flow	Local	Electric	0-1000"H_2O	± 10 VDC	N/A

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B & W INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpoint
MU-23-FI 1, 2, 3, & 4	Flow Indicator	Indicates emergency R.C. make-up flow to the discharge side of R.C. pumps RC-P-2B, 1B, 2A, & 1A	Panel 8	Vertical	± 10 VDC	0-50 x 10 GPM	N/A
MU-23-FS 1,2,3,& 4	Flow Switch	Monitors and transmitts alarm signal to MU-23-FAH & FAL 1,2,3, & 4.for emergency R.C. make-up flow Hi/Lo flow	Rack 474	Signal Monitor	± 10 VDC	0-500 GPM	260 GPM (Hi) 75 GPM (Lo)
MU-24-FE	Flow Element	Measures make-up flow	Piping	Flow Nozzle	0-160 GPM	0-200"H_2O	N/A
MU-24-DPT	Differential Pressure Transmitters	Transmitts signal to MU-24-FI for make-up flow	Local	Electric	0-200"H_2O	± 10 VDC	N/A
MU-24-FI	Flow Indicator	Indicates make-up flow	Panel 3	Vertical	± 10 VDC	0-16 x 10GPM	N/A
MU-24-FS	Flow Switch	Monitors and transmitts alarm signal to MU-24-FAH for pressurizer make-up flow high	Rack 474	Signal Monitor	± 10 VDC	0-160 GPM	130 GPM
MU-36-FI	Flow Indicator	Indicates make-up valve (MU-V17) bypass flow	Local	Rotameter	0-3.5 GPM	0-3.5 GPM	N/A
MU-P 1A,1B, & 1C - MIS	Manual Indicator Switch	Operates make-up pumps (MU-P-1A,1B,1C)	Panel 3	SBM	N/A	N/A	N/A
MU-V1A & 1B - MIS	Manual Indicator Switch	Operates letdown coolers inlet stop valve (MU-V1A/ MU-V1B)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V2A & 2B MIS	Manual Indicator Switch	Operates letdown coolers outlet stop valve (MU-V2A/ MU-V2B)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V3-MIS	Manual Indicator Switch	Operates letdown isolation valve (MU-V3)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V4-MIS	Manual Indicator Switch	Operates block orifice inlet stop valve (MU-V4)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-3-E/P	Converter	Converts electrical signal from letdown flow controller (MU-3-MIC) to pneumatic signal for operating auxilary letdown flow control valve (MU-V3)	Rack 474	E/P Converter	10-50 madc	3-27 psig	N/A
MU-V6A & 6B	Manual Indicator Switch	Operates purification demineralizers inlet stop valve (MU-V6A/MU-V6B)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V8-MIS	Manual Indicator Switch	Operates letdown transfer valve (MU-V8)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-12-E/P	Converter	Converts electrical signal from flow batch controller (MU-12-MC)to pneumatic signal for operating make-up feed controll valve (MU-V9)	Rack 474	E/P Converter	10-50 madc	3-27 psi	N/A

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B & W INSTRUMENTATION AND CONTROL

Identification	Description	Function	Location	Type	Input Range	Output Range	Setpo
MU-V10-MIS	Manual Indicator Switch	Operates make-up feed stop valve, (MU-V10)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V11A & 11B MIS	Manual Indicator Switch	Operates make-up filters inlet stop valves, (MU-V11A/ MU-V11B)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V12-MIS	Manual Indicator Switch	Operates make-up tank outlet stopvalve, (MU-V12)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V13-MIS	Manual Indicator Switch	Operates make-up tank vent valve (MU-V13)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V16A, 16B, 16C, 16D, - MIS	Manual Indicator Switch	Operates emergency high pressure make-up injection isolation valves, (MU-V16A/MU16B/MU-V16C/MU-V16D)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-25-E/P	Converter	Converts electrical signal from positioner (MU-25-POC) to pneumatic signal for operating R.C. system make-up flow control valve, (MU-V17)	Local	E/P Converter	10-50 madc	3-27 psig	N/A
MU-V20-MIS	Manual Indicator Switch	Operates total seal flow isolation valve, (MU-V20)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V25-MIS	Manual Indicator Switch	Operates total seal return internal isolation valve, (MU-V25)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V26-MIS	Manual Indicator Switch	Operates total seal return external isolation valve, (MU-V26)	Panel 3	Maintianed Selector	N/A	N/A	N/A
MU-V27-MS	Manual Switch	Operates make-up tank nitrogen addition block valve, (MU-V27)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-V28-MS	Manual Switch	Operates make-up tank hydrogen addition block valve, (MU-V28)	Panel 3	Maintained Selector	N/A	N/A	N/A
MU-32-E/P	Converter	Converts electrical signal from positioner (MU-32-POC) to pneumatic signal for operating R.C. pump seal flow control valve, (MU-V32)	Local	E/P Converter	10-50 madc	3-27 psig	N/A
MU-V33A, 33B, 33C, & 33D-MIS	Manual Switch	Operates individual seal return isolation valves. (MU-V33A/MU-V33B, MU-V33C/ & MU-V33D)	Panel 4	Maintained Selector	N/A	N/A	N/A

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TABLE 9

PANEL MOUNTED ANNUNCIATORS AND COMPUTER INPUTS

PANEL MOUNTED ANNUNCIATORS

Identification	Measured Variable, Units	Alarm Setpoint Hi	Alarm Setpoint Low	Input Source	Variable Range	Panel Name and No.
MU-RAH-720-1	Primary System Letdown Radiation uc/ML	later	N/A	MU-RE-720	$10-10^6$ cpm	Radiation Monitoring Panel No. 12
MU-RAH-720-2	Primary System Letdown Radiation uc/ML	later	N/A	MU-RE-720	$10-10^6$ cpm	Radiation Monitoring Panel No. 12
MU-PAL-733	Make-Up Pump MU-P-1A Suction Header Pressure Low, psig	N/A	12.5	MU-PS-733	2-30 psig	Coolant System Monitoring Panel No. 8
MU-PAL-734	Make-Up Pump MU-P-1B Suction Header Pressure Low, psig	N/A	12.5	MU-PS-734	2-30 psig	Coolant System Monitoring Panel No. 8
MU-PAL-735	Make-Up Pump MU-P-1C Suction Header Pressure Low, psig	N/A	12.5	MU-PS-735	2-30 psig	Coolant System Monitoring Panel No. 8
MU-PAL-1760	Make-Up Pump MU-P-1A Discharge Header Pressure Low, psig	N/A	2200	MU-PS-1760	500-3000 psig	Coolant System Monitoring Panel No. 8
MU-PAL-1761	Make-Up Pump MU-P-1B Discharge Header Pressure Low, psig	N/A	2200	MU-PS-1761	500-3000 psig	Coolant System Monitoring Panel No. 8
MU-PAL-1762	Make-Up Pump MU-P-1C Discharge Header Pressure Low, psig	N/A	2200	MU-PS-1762	500-3000 psig	Coolant System Monitoring Panel No. 8
MU-DPAH-3451	Purification and Deborating Filters High Differential pressure, psig	25	N/A	MU-DPT-3451	0-30 psig	Coolant System Monitoring Panel No. 8
MU-DPAH-3836	Seal Return Filter High Differential Pressure, psig	70	N/A	MU-DPS-3836	0-75 psi	Coolant System Monitoring Panel No. 8
MU-DPAH-40	Seal Injection Filters High Differential Pressure, psig	25	N/A	MU-DPS-40	0-30 psi	Coolant System Monitoring Panel No. 8
	Make-Up Pump Trip	N/A	N/A	30T	N/A	Coolant System Monitoring Panel No. 8
	Make-Up Pump Overload	N/A	N/A	74	N/A	Coolant System Monitoring Panel No. 8
MU-12-FZA	Bleed and Feed Auto Terminate	N/A	N/A	MU-12-FZS	0-175 gpm	Coolant System Monitoring Panel No. 8
	Make-Up Pump Main Bearing Lube Pump, trip	N/A	N/A	-	N/A	Coolant System Monitoring Panel No. 8
	Make-UP Pump Aux Bearing Lube Pump, trip	N/A	N/A	-	N/A	Coolant System Monitoring Panel No. 8
	Make-Up Pump Aux Gear Lube Pump, trip	N/A	N/A	-	N/A	Coolant System Monitoring Panel No. 8

TABLE 9 (Continued)

PANEL MOUNTED ANNUNCIATORS AND COMPUTER INPUTS

Identification	Measured Variable, Units	Alarm Setpoint Hi	Alarm Setpoint Low	Input Source	Variable Range	Panel Name and No.
R&W Annunciator Inputs						
MU-5-TAH	Letdown Flow High Temperature, °F	135	N/A	MU-5-TS	0-200°F	Coolant System Monitoring Panel No. 8
MU-7-FAL 2, 3, & 4	R.C. Pump Loop Seal Injection Flow Lo, gpm	N/A	3	MU-7-FSL, 2, 3, & 4	0-15 gpm	Coolant System Monitoring Panel No. 8
MU-8-DPAH	Make-Up and Purification Demineralizers High Differential Pressure, psig	25	N/A	MU-8-DPSL & 2	0-50 psi	Coolant System Monitoring Panel No. 8
MU-9-FAL	R.C. Pumps total Injection Loop Flow Hi/Lo, gpm	42	22	MU-9-FS	0-806 gpm	Coolant System Monitoring Panel No. 8
MU-10-FAL 1, 2, 3, & 4	R.C. Pump Loop Seal Return Line High Flow, gpm	1.4	N/A	MU-10-FSL, 2, 3, & 4	0-26 gpm	Coolant System Monitoring Panel No. 8
MU-14-LAH	Make-Up Tank (MU-T-1) Level High/Low, feet	86	55	MU-14-LSL	0-100 ft. H_2O	Coolant System Monitoring Panel No. 8
MU-17-PAH	Make-Up Tank (MU-T-1) Pressure High/Low, psig	90	Atmos.	MU-17-PS	0-100 psig	Coolant System Monitoring Panel No. 8
MU-18-DPAH	Make-Up Filters High Differential Pressure, psig	25	N/A	MU-18-DPS	0-30 psi	Coolant System Monitoring Panel No. 8
MU-23-FAHL, 2, 3 & 4	HP Injection Loop A & B Flow High/Low, gpm	260	75	MU-23-FSL, 2, 3 & 4	0-600 gpm	Coolant System Monitoring Panel No. 8
MU-24-FAH	Pressurizer Make-Up Flow High, gpm	160	N/A	MU-24-FS	0-160 gpm	Coolant System Monitoring Panel No. 8
MU-59-PAH 1, 2, & 3	Make-Up Pumps Gear Lube Oil Pressure Low, psig	N/A	7	MU-59-PSL, 2, & 3	0-35 psig	Coolant System Monitoring Panel No. 8
MU-58-PAH 1, 2, & 3	Make-Up Pumps Main Lube Oil Pressure Low, psig	N/A	3	MU-58-PSL, 2, & 3	3-15 psig	Coolant System Monitoring Panel No. 8

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TABLE 9 (Continued)

PANEL MOUNTED ANNUNCIATORS AND COMPUTER INPUTS

Identification	Measured Variable, Units	Alarm Setpoint Hi	Alarm Setpoint Low	Input Source	Variable Range	Panel Name and No.
Computer Inputs						
	Seal Return Coolers Inlet Temperature, °F	N/A	N/A	MU-TE-723	0-200°F	-
	Seal Return Coolers MU-C2A Outlet Temperature, °F	N/A	N/A	MU-TE-724	0-200°F	-
	Seal Return Cooler MU-C-2B Outlet Temperature, °F	N/A	N/A	MU-TE-736	0-200°F	-
	Letdown Cooler MU-C-1A Outlet Temperature, °F	later	N/A	MU-TE-739	0-300°F	-
	Letdown Cooler MU-C-1B Outlet Temperature, °F	later	N/A	MU-TE-740	0-300°F	-
	Letdown Coolers Inlet Temperature, °F	N/A	N/A	MU-TE-741	0-300°F	-
	Make-Up Pump Suction Header Pressure, psig	N/A	12.5	MU-PT-732	0-30 psig	-
	Letdown Pressure	N/A	N/A	MU-PT-1579	0-50 psig	-
	Seal Return Coolers Outlet Temperature	N/A	N/A	MU-TT-1580	20-220°F	-
	Make-Up Tank Temperature	N/A	N/A	MU-TT-1581	70-220°F	-
BGN Computer Inputs						
	Letdown Temperature, °F	135	N/A	MU-5-TE	0-200°F	-
	Letdown Pressure, psig	145	N/A	MU-6-PS	25-375 psig	-
	Make-Up Tank Temperature, °F	135	N/A	MU-16-TE	0-220°F	-
	Make-Up Pump thrust and Radial Bearing temperature, °F	170	N/A	MU-50-TE1	100-200°F	-
	Make-Up Pump Radial Bearing temperature, °F	170	N/A	MU-50-TE2	100-200°F	-
	Make-Up Pump Gear Bearing Temperature - Pump End, °F	165	N/A	MU-51-TE1	100-200°F	-
	Make-Up Pump Gear Bearing Temperature - Pump Center, °F	165	N/A	MU-51-TE2	100-200°F	-
	Make-Up Pump Gear Bearing Temperature - Motor Center, °F	165	N/A	MU-51-TE3	100-200°F	-
	Make-Up Pump Gear Bearing Temperature - Motor End, °F	165	N/A	MU-51-TE4	100-200°F	-
	Make-Up Pump Motor Bearing Temperature - Rear End, °F	100	N/A	MU-52-TE1	100-200°F	-
	Make-Up Pump Motor Bearing Temperature - Outboard, °F	180	N/A	MU-52-TE2	100-200°F	-
	Make-Up Motor Stator Temperature, °C	125	N/A	MU-53-TE6	40-135°C	-

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