10.4 OTHER FEATURES OF STEAM AND POWER CONVERSION SYSTEM

Except for a portion of the Feedwater System piping, the features, components and systems described in this section serve no safety functions since they are not required for safe shutdown or to mitigate the effects of a LOCA and their failure will not result in the release of significant uncontrolled radioactivity.

10.4.1 MAIN CONDENSER

The three shell, single-pressure, main condenser provides a continuous heat sink for the exhaust from the three tandem-compound low pressure turbines and for miscellaneous flows, drains and vents during normal plant operation.

The main condenser also provides a heat sink for the SBS in the initial phase of reactor cooldown after plant shutdown.

10.4.1.1 Design Bases

The main condenser is designed to function as the steam cycle heat sink and collection point for the following flows:

a) main low-pressure turbines exhaust;

b) main low-pressure turbines last stage moisture removal drains;

c) feedwater heaters drain and vent;

d) steam seal regulator leak-off;

e) gland steam condenser drains;

f) condensate minimum flow recirculation;

g) condensate pumps minimum flow recirculation;

h) steam generator feedwater pumps minimum recirculation;

i) start-up feedwater dump;

j) turbine bypass;

k) demineralized water makeup; and

l) miscellaneous equipment dumps, drains and vents.

Design data of the main condenser at normal full-load operation of the plant is shown in Table 10.4-1.

The main condenser is also designed to:

→(DRN 03-2064, R14)

a) condense up to 60 percent of the full-load main steam flow bypassed directly to the condenser by the Steam Bypass System. This condition could occur in case of a sudden load rejection by the turbine generator, a turbine trip, or during start-up and shutdown, as described in Subsection 10.4.4.

←(DRN 03-2064, R14)

b) provide for removal of non-condensable gases from the condensing steam through the Main Condenser Evacuation System, as described in Subsection 10.4.2.

c) deaerate the condensate before it leaves the condenser hotwell. Free oxygen in the condensate will not exceed 0.005 cc/liter over the entire load range.

The main condenser is constructed in accordance with the Heat Exchanger Institute Standards for steam surface condensers.

10.4.1.2 System Description

The main condenser consists of three one-third capacity, divided water box, surface condensers, of the single pass type, with tubes arranged perpendicular to the turbine shaft. Cooling water for the condensers are provided by the Circulating Water System. The condensers are of the deaerating type and are sized to condense exhaust steam from the main turbine under full load conditions. The hotwell storage is located under all shells.

→(DRN 00-1039, R11-A; 03-2064, R14)

The condenser hotwells serve as a storage reservoir for deaerated condensate which supplies the condensate pumps. The storage capacity of the hotwells, 14,500 cu ft, is sufficient for approximately 4.50 minutes of operation at maximum throttle flow with some additional volume for surge protection. This supply of condensate is backed up by a demineralized water storage tank and a condensate storage tank from which condensate may be admitted by gravity into the condenser, by the condensate transfer pump or by the hotwell transfer pump. This automatic makeup is performed through a level control valve which is controlled by the "A" hotwell level signal. There is a motor operated bypass valve around this level control valve for backup as well as for plant start-up filling. The condensate storage pool provides sufficient condensate to permit eight hours of shutdown heat removal in the unlikely case of loss of all electrical power sources. On high water level in the hotwell, a motor operated valve can be remotely opened to reject condensate to either the Condensate Storage Tank or the Waterford 1 and 2 Waste Processing Facility. However, radioactivity will not be released to the Waterford 1 and 2 Waste Processing Facility.

←(DRN 00-1039, R11-A; 03-2064, R14)

The condensate outlets from the last shell are provided to the condensate pumps.

Each condenser shell has two tube bundles, each of which is connected to a separate circulating water line through a water box. The water boxes of the three shells are arranged in parallel so that the circulating water passes through all three shells as shown on Figure 10.4-1 (for Figure 10.4-1, Sheet 2, refer to Drawing G158, Sheet 2). Two 10 in. diameter connections are provided on each shell for noncondensible gas evacuation.

Each of the one-third capacity low pressure heaters No. 5 and No. 6 is mounted in the neck of each of the condenser shells.

Thirty in. diameter hotwell equalizing pipes are provided between the three hotwells.

Eleven ft. by nine ft. crossover ducts are provided between three condenser shells for equalizing the exhaust steam flow.

Stainless steel expansion joints are provided for the exhaust connections from the low pressure turbines.

An inlet connection is provided on two condenser shells for exhaust steam from the steam generator feedwater pump turbines. These connections are equipped with directional vanes to preclude tube failure.

There are six turbine bypass valves. Two valve outlets are connected to each of three condenser shells. These six connections at condenser shells are equipped with perforated piping and impingement plates and are physically located about nine ft. above the top row of tube bundles to preclude tube failure.

10.4.1.3 Safety Evaluation

The main condenser is normally used to remove residual heat from the Reactor Coolant System (RCS) during the initial cooling period after plant shutdown when the main steam is bypassed to the condenser through the Steam Bypass System. The condenser is also used to condense a portion of the main steam bypassed to the condenser in the event of sudden load rejection by the turbine-generator or a turbine trip.

→(DRN 03-2064, R14)

In the event of a load rejection greater than 60 percent, the SBS (see Subsection 10.4.4) will permit a full load rejection, to house load, without reactor trip and without lifting of the main steam safety valves. The spring loaded safety valves and/or the power operated atmospheric dump valves are available to discharge steam if the dump demand exceeds the capacity of the SBS to protect the main steam line from overpressurization.

←(DRN 03-2064, R14)

If the main condenser becomes unavailable during normal plant shutdown, sudden load rejection or turbine-generator trip, the spring loaded safety valves will discharge full main steam flow to the atmosphere and effect a safe shutdown condition. Non-availability of the main condenser considered here includes failure of circulating water pumps to supply cooling water, failure of condenser evacuation system to remove non-condensible gases, excessive leakage of air through turbine gland packings due to failure of the Turbine Gland Seal System, or failure of the condenser due to any other reason.

The prevention of flooding of the engineered safety features equipment located in the Reactor Auxiliary Building due to a failure of water boxes or circulating water piping is discussed in Subsection 10.4.5.

During normal operation and shutdown, the main condenser does not have radioactive contaminants. Radioactive contaminants can only be obtained through primary-to-secondary system leakage due to a steam generator tube leak. Noncondensable gases will be monitored for radioactivity prior to being discharged to the atmosphere, as discussed in Subsection 10.4.2.3.

A full discussion of the radiological aspects of primary-to-secondary leakage, including anticipated operating concentrations of radioactive contaminants, is included in Chapter 11. No hydrogen buildup in the main condenser is anticipated.

10.4.1.4 Tests and Inspections

The surface condenser water boxes were shop hydrostatically tested to 55 psig. After installation, the condenser is tested for leak tightness by filling with water to a level about the turbine exhaust flange. Field tests run to demonstrate performance are governed by the provisions of ASME Power Test Code for Steam-Condensing Apparatus.

10.4.1.5 Instrumentation Applications

In addition to level gauges provided at all hotwells, all level control devices for water level control are located at condenser "A" hotwell-

An automatic sampling system takes suction from each hotwell and measures the sodium content of the condensate to provide an indication of condenser tube leak.

Local and remote indicating devices are provided for monitoring pressures and water levels in the condenser shells.

Low hotwell water level alarm is provided in the control room. Vacuum switches are provided on all condenser shells to detect loss of vacuum. In the event of loss of any condenser shell vacuum, the turbine steam bypass valves to the intact condenser close automatically.

10.4.2 MAIN CONDENSER EVACUATION SYSTEM

10.4.2.1 Design Bases

The Main Condenser Evacuation System (MCES), shown on Figure 10.4-2 (for Figure 10.4-2, Sheet 1, refer to Drawing G153, Sheet 1), is designed to remove noncondensible gases and inleaking air from the steam space of three condenser shells during plant startup, cooldown, and normal operation. The system has no safety-related function and is classified as quality group D.

→(DRN 01-1284)

The original configuration and operation of the system was changed to disable the capability to divert MCES exhaust to the plant stack in the event of a high radiation condition. The technical and regulatory basis for this change is documented in Reference One. The analysis of record for evaluating plant changes remains FSAR Section 11.3.3.

←(DRN 01-1284)

The MCES is designed to remove air from the three condenser shells to create a vacuum in the condenser during plant startup.

No hydrogen buildup in the main condenser is anticipated.

10.4.2.2 System Description

The system consists of three 100 percent capacity condenser vacuum pump assemblies. Each assembly consists of one motor driven, rotary water seal type two stage vacuum pump and seal water system. Each seal water system includes one centrifugal circulating pump, one heat exchanger, one separator and all necessary piping, valves, instruments and electric devices for automatic operation of the system. Energizing the condenser vacuum pump starter automatically starts the seal water system associated with the condenser vacuum pump assembly.

→(DRN 03-2064, R14)

During station startup, all of the condenser vacuum pumps may be used for evacuating a combined turbine and main condenser steam space of 228,000 cubic feet and maintain a condenser pressure of 2.26 in. of HgA.

←(DRN 03-2064, R14)

→ (DRN 00-134, R11; 99-0481, R11; 00-786, R11-A)

The noncondensible gases and water vapor mixture are drawn directly from each shell of the condenser. The mixture flows through the condenser vacuum pump(s), then to the separator where most of the water vapor is condensed and the noncondensible gases are released to the atmosphere via a discharge silencer. The condensed water normally is returned to the condenser however, a safety overflow drain-line is routed to the Industrial Waste Sump. Upon receipt of a high radiation signal by the raidation monitor on the industrial waste discharge header, discharging from the industrial waste sump will be stopped. Once it is analyzed, it will be directed to the proper location. Depending on main condenser vacuum level, one or two of the three condenser vacuum pumps are in standby and are properly controlled to startup on failure of the running pump.

← (DRN 00-134, R11; 99-0481, R11; 00-786, R11-A)

10.4.2.3 Safety Evaluation

→ (DRN 99-2113, R11)

The noncondensible gases, vapor mixture and condensed water discharged to atmosphere and industrial waste sump from the MCES, as described in Subsection 10.4.2.2, are not normally radioactive. The noncondensible gases and vapor mixture from the condenser vacuum pump(s) are monitored for radioactivity prior to being discharged to the atmosphere. The industrial waste sump discharge is also monitored for radiation. The presence of radioactivity would indicate a primary-to-secondary system leak in the steam generator(s); condensed water would be diverted for discharge through the Waste Management System. A discussion of radiological aspects of primary-to-secondary leakage and anticipated radioactive releases to the environment during normal operation of the system are discussed in Chapter 11.

← (DRN 99-2113, R11)

Low condenser vacuum will cause a turbine trip as discussed in Section 7.7.

10.4.2.4 Tests and Inspections

Pre-operation testing ensures proper operation of valves and verifies pressure switch setpoints.

Testing of the MCES during normal operation will be minimal since the system will be in use. The system can be shutdown for short periods of time during plant operation, for inspection if required, without adversely affecting condenser performance.

10.4.2.5 Instrumentation Applications

→ (DRN 99-2113, R11; 00-873, R11-A; 03-214, R12-B)

Radiation detectors are provided on the MCES noncondensible gas exhaust common header and on the discharge of the industrial waste sump. Should presence of radioactivity having a concentration greater than a predetermined setpoint be detected, the motor operated valve on the industrial waste sump will be remotely closed in the main control room and the Waste Management System will be opened to ensure that there will be no high level radioactive condensed water above specified limits discharged into the oil separator pit.

← (DRN 99-2113, R11; 00-873, R11-A; 03-214, R12-B)

10.4.3 TURBINE GLAND SEALING SYSTEM

The Turbine Gland Sealing System (TGSS) provides sealing of the turbine generator shaft and the main feedwater pump turbine shafts against leakage of air into the turbine casings and escape of steam into the Turbine Building. The system is shown in Figure 10.4-3. The system has no safety-related function and is classified as quality group D.

10.4.3.1 Design Bases

The TGSS is designed to prevent atmospheric air leakage into the turbine casings and main condenser, and steam leakage out of the casings of the turbine-generator and steam generator feedwater pump turbines.

10.4.3.2 System Description

The Turbine Gland Sealing System controls the steam pressure to the turbine glands to maintain adequate sealing under all conditions of turbine operation. The system consists of individually controlled diaphragm operated valves, relief valves, and a gland steam condenser.

The design of the diaphragm operated valves is "fail safe" such that failure of any valve will not endanger the turbine.

→ (DRN 99-2366)

At startup, the sealing steam source may be either main steam or auxiliary steam. When sufficient pressure has been established in the steam generator, the auxiliary steam source valve is closed and main steam provides sealing. As the turbine load is increased, the steam pressure inside the high pressure turbine increases and the steam leakage path is outward toward the rotor ends, thus eliminating the need to supply sealing steam to these glands. The leak-off steam and air mixture then flows to the gland steam condenser which is maintained at a pressure slightly below atmospheric so as to prevent escape of steam from the ends of glands. The gland steam condenser returns seal leakage to the main condenser as condensate.

← (DRN 99-2366)

Each of the low pressure turbine glands have a gland steam supply regulator. Both high pressure turbine glands are supplied from one regulator. A spill-over valve in the high pressure turbine gland seal will provide pressure regulation for the dumping of excess turbine gland leakage to the main condenser during high plant loads.

Noncondensable gases from the gland steam condenser are monitored for radioactivity. If radioactivity is detected, these gases are routed to the plant vent instead of being directly discharged to atmosphere, as discussed in Chapter 11.

Exhauster vacuum on the low pressure side of the seals can be maintained with either or both blower(s) in operation. Failure of one blower automatically starts the second blower. Operation of these two full capacity blowers will be alternated periodically, thus eliminating the need for periodic testing. The system will be tested in accordance with written procedures during the initial testing and operation program, and is readily available for inservice inspection. The system is normally in operation when the plant is operating and thus special tests are not required to insure operability.

10.4.4 STEAM BYPASS SYSTEM

10.4.4.1 Design Bases

The Steam Bypass System (SBS) is designed to accomplish the following functions:

→(DRN 03-2157, R13; 03-2064, R14)

a) to permit turbine load rejections to the condenser up to 60 percent of the rated main steam flow without opening the main steam safety valves or tripping the reactor with the exception that there is a probability that the reactor may trip at power levels between 50% and 70% at certain times in core life (a trip is more probable at 70% power at Beginning of Cycle).

←(DRN 03-2157, R13; 03-2064, R14)

b) to provide a means of manually controlling reactor coolant temperature during plant normal heatup and cooldown, when the condenser is available,

c) to provide automatic removal of the reactor coolant system energy following a unit trip and effect a smooth transition to hot standby conditions,

d) to automatically control main steam pressure during hot standby, and

e) to provide the operator with an optional automatic trip of the turbine in case of a load rejection that exceeds the capacity of the Steam Bypass System with the reactor power cutback system unavailable.

The Steam Bypass System located downstream of the main steam isolation valves is designed in accordance with ANSI B31.1 (1973), ANSI B16.5 (1968), ANSI B16.25 (1972), MSS-SP-25 (1964) and MSS-SP-61 (1961) requirements. The system has no safety-related function.

10.4.4.2 System Description

The SBS is shown in Figure 10.2-4 Sheet 2.

→(DRN 03-2064, R14)

Following a turbine or reactor trip, stored energy in the reactor coolant and reactor core must be removed. Since the turbine is no longer able to utilize the energy supplied, an alternate heat sink is provided. For the case of a simultaneous turbine and reactor trip, the Steam Bypass System passes steam directly to the condenser. The capacity of this system is 60 percent of rated main steam flow.

←(DRN 03-2064, R14)

The Steam Bypass System is comprised of the control valves and associated instrumentation and controls. A total of six parallel air operated angle valves (located in the Turbine Building) are connected to the main steam header outside of the containment and downstream of the main steam line isolation valves. Each turbine bypass valve discharges the steam directly to the main condenser (two valves to each condenser shell).

→(DRN 00-786, R11-A)

The main function of the Steam Bypass System is to limit the pressure rise in the steam generator, following a reactor or turbine trip, to a level which prevents opening of the main steam line safety valves. The bypass valves also open to the condenser to remove decay heat following a reactor shutdown or during hot standby conditions. During normal operation, the turbine bypass valves are under the control of the Steam Bypass Control System, as discussed in Subsection 7.7.1.4.1.

←(DRN 00-786, R11-A)

The turbine bypass valves close automatically in the event of the loss of condenser vacuum. They are also designed to fail closed upon loss of actuator power or control signal to prevent uncontrolled bypass of steam to the condenser.

During plant shutdown, one turbine bypass valve is remotely or manually positioned to remove Reactor Coolant System sensible heat to reduce the reactor coolant temperature. Since steam pressure decreases as the system temperature is reduced, bypass valve flow capacity becomes limited at low pressures and other bypass valves are opened to complete the cooldown at the design rate until shutdown cooling is initiated. All turbine bypass valves can be remotely operated from the main control room. These valves are pneumatically operated and are also equipped with handwheels for manual operation.

The turbine bypass valves are capable of stroking from the full closed to the full open position in one second maximum time and are also capable of modulating the flow by stroking from the full open to the full closed (and from the full closed to the full open) position in 15 seconds minimum to 20 seconds maximum, utilizing a full input signal.

The valve and piping for the system are located in the Turbine Building to facilitate access to the main condenser.

10.4.4.3 Safety Evaluation

The Steam Bypass System has no safety feature functions since overpressure protection is provided by ASME Code Section III main steam safety relief valves. The consequences of the failure of the turbine bypass valves is discussed in Chapter 15.

10.4.4.4 Tests and Inspections

→(DRN 00-786)

Before the Steam Bypass System is placed inservice, all system valves are tested to assure operability. The turbine bypass lines are initially tested hydrostatically to confirm the absence of leaks. The turbine bypass valves may be tested while the main turbine is in operation. All system piping and valves are readily accessible for inservice inspection. The turbine bypass valves are equipped with isolation valves to facilitate maintenance.

←(DRN 00-786)

10.4.4.5 Instrumentation Applications

Other than described in Subsections 10.4.4.2 and 10.4.4.3, control scheme for turbine bypass valves are discussed in Section 7.7.

10.4.5 CIRCULATING WATER SYSTEM

→ (DRN 99-2495)

The Circulating Water System (CWS) provides cooling water for removal of heat from the main condenser. This system also supplies cooling water to turbine closed cooling water heat exchangers, blowdown heat exchangers and provides a discharge path for effluent from the Dry Cooling Tower Sump Pumps. The system is schematically shown in Figure 10.4-1 (for Figure 10.4-1, Sheet 2, refer to Drawing G158, Sheet 2). In addition, the system serves as the preferred heat sink for normal reactor cooldown to 350°F, but has no safety function.

← (DRN 99-2495)

10.4.5.1 Design Bases

The CWS is designed to supply the cooling water required to remove the heat loads developed in the main condenser, turbine closed cooling water heat exchanger, blowdown heat exchangers, primary water treatment plant.

The CWS design includes the following subsystems:

a) Circulating Water Air Evacuation System,

b) River Water Supply System,

c) Screen Wash System, and

d) Circulating Water Drainage System

All CWS components are designed to withstand transient conditions as described in the following paragraphs and to prevent excessive corrosion due to the concentrated brackish type circulating water.

The seismic design of all CWS components is in accordance with Uniform Building Code.

10.4.5.2 System Description

The CWS consists of the following:

a) Four 25 percent capacity, vertical mixed flow type, circulating water pumps

b) Eight traveling screens

c) Three screen wash pumps

d) Two circulating water air evacuation pumps and

e) Piping, valves, expansion joints and instrumentation.

The intake structure is divided into eight bays. One traveling screen is installed in each bay. The water is taken from the Mississippi River through an intake canal to the intake structure passing through intake trash racks and traveling screens which removes debris. Each circulating water pump, installed at the intake structure, takes suction from two bays. The intake chambers width and depth are designed to give a low velocity through the traveling screens and to provide sufficient submergence for the pumps.

→(EC-34828, R306)

The circulating water pumps discharge the water through individual 96 in. steel pressure pipes into transition block No. 1. Two 132 in. pipes, first steel and then concrete, carry water from this transition block to condenser intake block. This piping is tapped to supply circulating water to the auxiliary systems. Two 84 in. steel lines are provided per condenser shell. A total of six lines carry water to the condenser water boxes from the intake block.

←(EC-34828, R306)

→(EC-34828, R306)

Warm water from the condenser is discharged to condenser discharge blocks A & B, through six 84 in. steel lines. Two 132 in. reinforced concrete pipe lines carry this warm water from condenser discharge blocks A & B to transition block No. 2, also collecting water from auxiliary systems. Four 108 in. steel pipes carry water from the transition block, pass over the levee and continue to the discharge structure. The discharge canal carries water from this structure to the Mississippi River. The system is designed to prevent recirculation of heated water into the system and to thoroughly dilute the heated water in the Mississippi River. The temperature of the heated water is continuously monitored by plant monitoring computer and an alarm is annunciated in the main control room when the heated water approaches its thermal limit.

←(EC-34828, R306)

The design data for all pumps in CWS are given in Table 10.4-2. Treated water is used for sealing purposes and for cooling circulating water pump and motor bearings.

Three 50 percent capacity screen wash pumps are installed at the intake structure. All the debris washed from the screens is collected in a concrete trash box attached to the intake structure. This trash is sluiced back into the river.

Two air evacuation pumps are provided for maintaining a siphon at the discharge line levee crossing. For sealing and bearing cooling of these pumps, treated water is used.

Isolation valves are provided upstream and downstream of specific equipment to enable maintenance. Elastomer bellows type expansion joints are provided upstream and downstream of each condenser waterbox. All circulating water pump discharges have bellows type expansion joints and motor operated butterfly valves. CWS piping is constructed of carbon steel and reinforced concrete.

The CWS is also capable of providing makeup water to the UHS wet cooling tower basins. Refer to Subsection 9.2.5.3.3 for further details.

10.4.5.3 Safety Evaluation

The CWS is normally used to supply cooling water to the main condenser to remove residual heat from the Reactor Coolant System during the initial cooling period of plant shutdown when the main steam is bypassed to the condenser. However, if the CWS fails to supply cooling water due to failure of the circulating water pumps or the circulating water piping, the bypassed main steam cannot be condensed in the main condenser. This is considered a condenser failure and safe shutdown of the reactor in such an event is discussed in Subsection 10.4.1.

All circulating water components including the expansion joints are designed for a pressure of 50 psig and are hydrostatically tested to 75 psig.

The CWS pump discharge valves are motor operated butterfly valves. Specified procedure is observed for pump startup and shutdown to preclude the possibility of excessive water hammer.

Maximum pressure in the CWS for any operational transient event is 82 ft. (35.5 psi) which is well below the design pressure of the system.

→(DRN 04-616, R13-A; 05-1425, R14-A)

In the event a failure occurs to a CWS component inside the Turbine Building, there is a potential of discharging circulating water into the Turbine Building at a maximum rate of 1,320,000 gpm (all four pumps at runout). The turbine operating floor is at an elevation of +15 ft. MSL, with grade elevation in this area of +14.5 ft. MSL. Only the condensate pumps pit, circulating water piping area, and feedwater pump suction pipe trench are located under the operating floor. The Turbine Building houses no safety-related equipment. Up to an elevation of +30.0 ft. MSL, the Reactor Building and Reactor Auxiliary Building are protected against external flooding. There are no paths by which this external flood water could enter any safety-related structure.

←(DRN 04-616, R13-A; 05-1425, R14-A)

To prevent degradation of the engineered safety features (ESF) due to a break in the circulating water pipe, condenser expansion joints or condenser water boxes, all ESF equipment is located in watertight portions of the Reactor Auxiliary Building.

10.4.5.4 Tests and Inspection

Inspection and testing of pumps are performed at manufacturer's shops in accordance with applicable codes.

10.4.5.5 Instrumentation Application

The CWS is provided with all necessary instruments and controls to operate the plant safely.

Motor operated butterfly valves are provided at the discharge of each circulating water pump. Each circulating water pump motor starter is interlocked with its respective discharge valve to prevent overloading of the pump motor during startup. Opening and closing of the discharge valves are interlocked to protect all CWS components during all modes of operation and hydraulic transients. The circulating water pump discharge valves and condenser inlet and outlet valves are provided with position switches. Indicating lights showing open and closed position of these valves are provided in the control panel.

A rotameter is located in the piping to measure the flow of treated water to each circulating water pump bearing cooling and seal water systems. An alarm will sound on a signal from the low flow switch. A separate rotameter is installed to measure the water flow to each circulating water pump motor bearing cooling system.

The bearings and stator of each circulating water pump motor are provided with thermocouples and resistance thermal detectors, respectively. The temperature of the bearings is monitored by the plant monitoring computer. The anticipated hottest temperature of the stator of each motor is also monitored by the plant monitoring computer. The plant monitoring computer alarms on high temperature at any point.

Local pressure indicators are provided on the discharge of each circulating water pump.

Circulating water temperature and pressure is monitored at the inlet and outlet of the condenser waterboxes, by the plant monitoring computer.

→(EC-34124, R306)

The differential pressure across the traveling screens is measured by a differential level sensor. A selector switch controls manual or automatic system operation. Manual operation is normally used at WF3 to minimize debris carryover to the condenser. The traveling screens will rotate effecting the cleaning of all screens. An alarm sounds in the main control room on a high differential pressure signal from a differential pressure switch.

←(EC-34124, R306)

10.4.6 CONDENSATE CLEAN-UP SYSTEM

The Condensate Clean-up System consists of Condensate Polisher System and the Backwash Treatment System. The Condensate Polisher System and Backwash Treatment System are designed to operate during all normal plant conditions, either continuously or intermittently, as required to maintain condensate purity.

10.4.6.1 Design Bases

The Condensate Polisher System is designed to perform the following functions:

a) To remove potentially corrosive and/or scale forming ionic species from the main condensate stream by ion exchange and to maintain a feedwater quality as good or better than required by the steam generator manufacturer during start-up, shutdown and the normal operation of the unit.

b) To remove high levels of particulate metal oxides, principally iron oxide and silica by filtration from the condensate stream during unit start-ups.

→(DRN 03-2064, R14)
The Condensate Polisher System is designed to process the station's full condensate flow (24,200 gpm) and to produce an effluent meeting the specifications of Table 10.4-16. The system is not essential for plant operation and may be taken out of service for repair/maintenance without compromising the ability to operate the plant.
←(DRN 03-2064, R14)

The function of the Backwash Treatment System is to separate the exhausted resin and other particles from the condensate polisher backwash water for proper disposal.

The Condensate Polisher and Backwash Treatment Systems have been designed in accordance with the requirements of the ASME Code, Sections II, V, VIII and IX. The appropriate requirements of ANSI, ASTM, ASME, Hydraulics Institute, IEEE, NEMA and other industry standards have been included in the design and fabrication for the components in the system. Piping and components are non-safety class and the systems are non-seismic. The systems meet the requirements of the Uniform Building Code.

Design parameters for major components of the Condensate Clean-up System are provided in Table 10.4-17. Flow diagrams are as shown on Figures 10.4-8 and 10.4-9.

10.4.6.2 System Description

10.4.6.2.1 Condensate Polisher System

The Condensate Polisher System can be operated with or without a resin precoat. When utilizing a resin precoat, the system acts as a filter demineralizer type, utilizing a mixture of finely ground powdered cationic and anionic ion exchange resin as filtering and demineralizing media. When the system is operated without a resin precoat, the filter elements will provide the only medium for filtration. There is no demineralization of the condensate when operating without a resin precoat.

The use of a powdered resin demineralizer system eliminates the need for both sulfuric acid and sodium hydroxide handling and storage, since the resin is received and used in the regenerated form. Upon reaching exhaustion, the resin is in a chemically neutral form and is flushed to the backwash storage tank.

→(DRN 05-565, R14)

The system filter elements can also be precoated with various filter media such as diatomaceous earth, cellulose fiber or activated carbon to target the removal of suspended material or impurity contaminates that will not ion exchange with resin. These filter media can be used in various combinations or individually and with or without resin depending on the impurities to be removed from the condensate. Their performance is monitored and upon exhaustion are flushed to the backwash storage tank.

←(DRN 05-565, R14)

The Condensate Polisher System consists of six demineralizer vessels, five operating with one spare, utilizing a single common precoat system and control panel. Each operating vessel will remain in-service until the useful ion exchange capacity is exhausted or the pressure drop becomes excessive. The exhausted vessel is replaced with the spare vessel. The exhausted vessel is backwashed and recoated, if in the precoat mode, with a fresh batch of precoat. Backwash water containing spent resin flows to a backwash storage tank. The backwash storage Lank is equipped with a sparging system to preclude resin settling. The support equipment for the system includes a single precoat tank, two (2) precoat pumps, six (6) holding pumps, and an air surge reservoir.

The system is located in the condensate system downstream of the condensate pumps, on the ground floor of the Condensate Polisher Building. The air surge reservoir is mounted on a concrete pad outside the Polisher Building.

10.4.6.2.1.1 Condensate Polishing Demineralizers

→(DRN 00-786, R11-A)

The Condensate Polisher demineralizer vessels are of carbon steel construction and built in accordance with the ASME Section VIII Code. A large surface area for demineralization and filtration is created by numerous filter elements mounted in the interior of the vessels. The filter elements are fitted with polypropylene cartridges. The cartridges are covered during the precoat operation with a slurry of commercial precoat materials to a thickness of 1/8 inch to 1/2 inch. Condensate is simultaneously filtered and demineralized as it flows through the resin layer to the inside of the filter elements and out through the vessel effluent line. The resin is held on the filter cartridges by the forward flow of the condensate and in the event of insufficient flow, a hold pump is used to retain the resin to the cartridges by recycling flow through the vessel.

←(DRN 00-786, R11-A)

10.4.6.2.1.2 Condensate Polisher Backwash and Precoat System

The resin has a fixed capacity for dissolved solids removal. When this capacity is reached, it is indicated by high effluent conductivity or sodium. Over a period of time, solids accumulate on the filter surface and cause a high differential pressure across the filter elements, which also requires resin removal and precoating. Either of these two conditions indicates that the vessel should be removed from service for precoating.

The Air Surge Backwash Method is provided to maximize the backwash efficiency and significantly reduce backwash water volume and air consumption.

The Air Surge Backwash step introduces a total of eight (8) air surges to the service vessel during the backwash procedure.

When a demineralizer vessel has completed its service run, it requires precoating with fresh resin. In order to maintain continuity of full condensate polishing flow, a vessel with a fresh precoat must be placed into the service before the exhausted vessel is removed from service. This can be done remote - manually

Precoat of the demineralizer vessel elements starts in the precoat slurry tank, where a mixture of water and precoat materials is kept in suspension by constant agitation. Precoat slurry is made up by the operator just prior to the precoating operation. Using the precoat pump, the precoat slurry is pumped from the slurry tank to the demineralizer vessel, where in passing across the filter elements, the precoat is held to the surface of the filter cartridge by the forward flow of the liquid portion of the precoat slurry. After precoating is complete, the hold pump is used to retain the resin on the elements until the demineralizer is put into service.

10.4.6.2.2 Backwash Treatment System

The Backwash Treatment System is comprised on one (1) dewatering filter, one (1) Pneumatic Hydro Pulse (PHP) filter, support equipment and a common master control panel. The support equipment for the backwash treatment system includes transfer pumps, holding tank, and the treated effluent storage tank. The system is located in the Condensate Polisher Building downstream of the backwash storage tank.

→

After the spent resin slurry has been collected in the backwash storage tank, the backwash transfer pump is actuated to transfer the resin slurry into the dewatering filter. The slurry is pumped into the upper shell of the dewatering filter. The resin is filtered out and forms a cake on top of the filter media which is between the upper and lower shells. The filtrate flows from the outlet in the lower shell and is discharged into the holding tank, while the filter cake (40-50 percent dry weight resin) is collected in a hopper for disposal. The filtrate from the holding tank is pumped to the PHP filter. The PHP filter system removes the resin fines carried over from the dewatering filter. The resin retained on the filter elements is backwashed, discharged to the backwash storage tank and collected in the dewatering filter in the subsequent filtration operation. The treated effluent from the PHP filter is collected in the treated effluent storage tank. The treated effluent is normally pumped to the Industrial Waste Sump in the Turbine Building. Treated effluent or the resin slurry in the backwash tank can be pumped via temporary piping to the Waste Management System if unacceptable levels of radioactivity are detected.

←

10.4.6.3 Safety Evaluation

The Condensate Clean-up System does not constitute a potential for radioactive release path to the environment and has no safety-related function. In the event that the fluid being processed in the system is radioactive due to leakage primary to secondary, the system only has the effect of concentrating the activity in the regeneration waste which is then processed as a low level radioactive waste.

The Condensate Clean-up System is classified as nonsafety-related and non-seismic based on the above.

10.4.6.4 Test and Inspection

The Condensate Clean-Up System will be proved operable by its use during normal plant operation. Each vessel of the system can be separately isolated for testing to ensure operability and integrity of the system.

10.4.6.5 Instrumentation Application

A complete instrumentation and control system package is provided for monitoring and controlling the Condensate Polishing System. The instrumentation is supplied as a prewired and tubed assembly. The instrumentation supplied includes the control board, primary measuring elements, transmitters, conductivity, sodium and chloride sampling and measuring system; flow control valves, pressure control valves, flow switches, pressure switches, annunciator system, indicating and recording devices and various other instruments as required for both automatic and manual control.

The Backwash Treatment System is controlled from its own master control panel. The panel is supplied as a prewired and tubed assembly and includes similar instrumentation to that provided for the Condensate Polisher System.

A flow balancing system is provided as the polisher vessels have been precoated at different times, and exhibit different resistances to flow. The variation in pressure drop across the coated elements of the different vessels is compensated by the flow control valves, which will be open more for the polisher vessel with the greatest pressure drop and less for the vessels which have been precoated more recently.

Upon reaching a pre-set high differential pressure across the polisher system the flow balancing system will disengage and an alarm will sound. If the problem is not corrected and the differential pressure reaches the high - high setpoint, a separate alarm will sound and the 16 inch automatic bypass valve will open 100%. The operator may remote - manually throttle the bypass valve, from either a manual loading station located on the panel or from the control room, from 100% open to 0% open to suit. If the high - high setpoint is reached during this operation the valve will again open 100%. System differential pressure and bypass valve position indications are provided in the control room.

10.4.7 CONDENSATE AND FEEDWATER SYSTEMS

10.4.7.1 Design Bases

The Condensate and Feedwater Systems (CFWS) and the Auxiliary Feedwater System (AFW) are shown in Figure 10.4-2 (for Figure 10.4-2, Sheet 1 refer to Drawing G153, Sheet 1).

The Heater Drain and Vent Systems are shown in Figure 10.4-4 (for Figure 10.4-4, Sheet 1 refer to Drawing G155, Sheet 1).

→(DRN 03-2064, R14)
The system is designed to supply full load feedwater flow plus steam generator blowdown (maximum of 634 gpm) at the expected steam pressures (see Figure 10.2-2). In addition the CFWS provides the proper flow to the steam generators during transient conditions which include the following:
←(DRN 03-2064, R14)

a) required plant load changes,

b) simultaneous turbine and reactor trip with normal operation of the Steam Bypass System to dissipate heat, and

c) complete loss of load without coincident reactor trip and with failure of the Steam Bypass System to operate. The main steam safety valves are assumed to open and credit is taken for a trip by the Reactor Protection System

The CFWS design include provisions for automatic isolation of the system from the steam generators when required to mitigate the consequences of a steam line break or malfunctions in the CFWS.

➔(DRN 00-1183)
Containment isolation is provided by the feedwater isolation valves. Backup is provided by the main and startup feedwater regulating valves.
←(DRN 00-1183)

A separate four element feedwater control channel and regulating valve for each steam generator is utilized.

➔(DRN 00-786, R11-A; 03-2064, R14; EC-8465, R307)
The feedwater regulating valves are sized to pass the feedwater flow corresponding to 100 percent load (8.307×10^6 lb/hr, plus blowdown, for each valve assuming a feedwater temperature of 447.5°F) with a pressure drop of 50 psi.
←(DRN 00-786, R11-A; 03-2064, R14; EC-8465, R307)

Those portions of the main feedwater system piping from the check valves located outside the containment to the steam generator feed nozzles are designed to ASME Section III, Code Class 2 (1971, up to and including Winter 1972 addenda) and seismic Category I requirements.

The piping from the condenser hotwell up to the check valves, located outside the containment, is designed and fabricated to meet ANSI B31.1 (1973) requirements and all components are classified as nonseismic category. The feedwater piping located upstream of the isolation valves to the end of the Reactor Auxiliary Building (column line G) is designed to meet seismic Category I requirements.

The design, materials, and details of construction of all feedwater heaters are in accordance with both the ASME Code Section VIII, Unfired Pressure Vessels, and Heat Exchanger Institute-Closed Feedwater Heaters. Feedwater piping is routed, protected and restrained to prevent multiple incidents in the case of the rupture of a feedwater line or other high-energy pipes.

The recirculation lines for condensate pumps and steam generator feedwater pumps to the condenser are utilized during startup to ensure that the secondary system water chemistry is acceptable prior to initiating feedwater flow to the steam generators. This also precludes overheating the pumps during start-up or reduced load operation.

The CFWS have also been designed with the capability to maintain unit operation when the systems have to operate under abnormal conditions due to one steam generator feedwater pump, or one condensate pump, or all heater drain pumps, or one string of heaters, being out of service.

An Auxiliary Feedwater System (AFWS) is provided to permit plant startup, main feedwater pump maintenance, heatup, cooldown and steam generator filling. This is accomplished by delivering water from the condensate storage tank to the steam generators via the Auxiliary Feedwater Pump. Most AFW components are located on the ground floor of the turbine generator building.

10.4.7.2 System Description

The CFWS are closed systems with deaeration accomplished in the main condenser. Condensate from the condenser "A" hotwell is pumped by three motor-driven condensate pumps through the gland steam condenser, then through two stages of low pressure and three stages of intermediate pressure feedwater heaters to the suction of two turbine-driven steam generator feedwater pumps. The feedwater is then pumped through one stage high pressure feedwater heaters to the steam generators.

There are three vertical, can-type, motor-driven condensate pumps, operating in parallel.

Data for the condensate pumps, heater drain pumps, steam generator feedwater pumps and feedwater heaters are shown in Tables 10.4-3, 10.4-4, 10.4-5 and 10.4-6, respectively.

Each condensate pump is equipped with a recirculation control system to permit direct recirculation of the pump requiring minimum flow to the main condenser. In addition to these individual pump recirculations, minimum condensate system flow is maintained by recirculating condensate from downstream of the gland steam condenser to the main condenser. The two low pressure heaters are located in each of the condenser necks and are arranged in three parallel strings. The condensate then passes through the intermediate pressure heaters located outside the condenser necks and is manifolded at the steam generator feedwater pumps suction. Upon discharge from the steam generator feedwater pumps, the feedwater flows through three parallel high pressure heater strings and to the steam generators. Bypasses and cross-ties between the split-streams are provided as required for flexibility of operation. High pressure heaters 1A, 1B, and 1C drain into intermediate pressure heaters 2A, 2B, and 2C. Condensate collected in intermediate pressure heaters 2A, 2B, and 2C then drain to the heater drain pumps where the drains are pumped to the steam generator feedwater pumps suction. Shell drains from the intermediate and low pressure heaters, except heaters 2A, 2B, and 2C, are cascaded to the next lower pressure heaters and ultimately to the main condenser. Alternate drains are also provided to automatically drain each heater directly to the main condenser.

→(DRN 03-2064, R14)

There are two horizontal turbine-driven, single stage, steam generator feedwater pumps operating in parallel. Each pump has a capacity of approximately 56 percent of the total calculated system flow at 100% power and is equipped with a recirculation control system to permit direct recirculation of the feedwater to the main condenser.

←(DRN 03-2064, R14)

Steam generator water level is maintained by a four element feedwater control system. Steam generator blowdown (Subsection 10.4.8) is used in conjunction with chemical addition (Subsection 10.4.10) to maintain feedwater quality.

→(DRN 00-1183)

As shown in Figure 10.4-2 (for Figure 10.4-2, Sheet 1, refer to Drawing G153, Sheet 1), the Emergency Feedwater System piping joins the main feedwater piping outside the containment. These connections are located between the pneumatically/hydraulically operated main feedwater isolation valves and the containment penetrations for main feedwater piping. The Emergency Feedwater System described in Subsection 10.4.9 is used to achieve safe plant shutdown by removal of reactor decay heat from the steam generators in the event of loss of the normal feedwater system or loss of offsite power.

←(DRN 00-1183)

The AFW pump takes suction directly from the condensate storage tank or in conjunction with flow from the blowdown system. The discharge flow from the pump is directed to the main feedwater system at a point upstream of the feedwater control valves.

During hot standby operations, the AFWS can be used to replace water losses such as from the blowdown system, the atmospheric dump valves, etc. Flow is controlled manually by the operators so that steam generator water level remains constant. Flow into each steam generator is determined by position of the feedwater control valves. Feedwater flow chemistry is controlled by sampling the AFW pump discharge and manually adjusting the chemical injection from the Chemical Feed System.

The AFWS can be utilized for heatup/cooldown in lieu of the CFWS. Transfer between the AFWS and the CFWS can be manually accomplished by adjusting the feedwater pump turbine speed and/or the AFW main control valve.

→ (DRN 99-2366)

One 12 in. dump line from upstream of the feedwater control valves to the condenser "A" and two three in. steam lines from auxiliary steam outlet to each condenser shell are provided for start-up cleaning and dearation, to exclude oxygen and non-condensible gas in the Condensate and Feedwater System. There are also provisions for two four in. lines from downstream of the feedwater control valves to the blowdown filters.

← (DRN 99-2366)

One 12 in. pipe, with a check valve and a motor operated globe valve, is provided around the steam generator feedwater pumps to allow the condensate pumps to fill the steam generators during start-up, when the steam generator feedwater pumps are inoperable.

→ (DRN 00-1183)

The Condensate and Feedwater Systems are isolated from the steam generators by closing the hydraulic/pneumatic operated main feedwater isolation valves (MFIVs) upon receipt of a main steam isolation signal (MSIS). The operators for the MFIVs are each furnished with two separate closure trains, powered by diverse power. However, both trains must be actuated for full and rapid valve closure during a design basis event. The accumulators are furnished with integral piston stop tubes on the nitrogen side to ensure that nitrogen pressure can be effectively monitored, and that a minimum volume of nitrogen is available for valve closure.

The main feedwater isolation valves are energized to close in a maximum of seven seconds during steam generator feed pump (SGFP) operation. Reactor trip override, which slows the SGFPs to 3900 rpm upon a reactor trip, is credited for rapid valve closure when these pumps are in operation. During operations using the auxiliary feedwater (AFW) pump, up to a 30 second closure time is allowable during a postulated feedwater line break (FWLB) event. The longer closure time is allowable because 30 seconds of AFW flow following a FWLB is bounded by the 7 second analyzed closure time. The auxiliary feedwater pump high discharge pressure trip is credited for valve closure when the AFW pumps are in operation.

The main feedwater isolation valve configuration is similar to that of the main steam isolation valve, which is shown in Figure 10.3-1. For each feedwater line to the steam generator, a check valve is provided to preclude backflow.

← (DRN 00-1183)

The main feedwater control and control bypass valves are used as a back up to their related main feedwater isolation valve and are furnished with emergency closure circuits so that the closure of these valves can be effectuated through override of their normal control signals.

The emergency closure circuits are actuated by Main Steam Isolation Signal from redundant channels as shown in Table 7.3-9.

The maximum time required for closure of the valve from a fully open position is 5 seconds for main feedwater control valve and 5 seconds for main feedwater control bypass valve.

The design of the main feedwater line penetration assemblies is discussed in Subsection 3.8.2.

The main feedwater isolation valves hydraulic-pneumatic actuators are provided with heaters and shields to ensure that the safety function of the valves is not adversely affected by an increase in viscosity of the hydraulic fluid due to cold ambient temperatures or icing.

10.4.7.3 Safety Evaluation

→(DRN 05-235, R14)

The Condensate and Feedwater Systems are capable of operation at full load with one out of three condensate pumps out of service or one out of three heater drain pumps out of service. The CFWS are capable of operation at partial load with two or three heater drain pumps out of service, one feedwater pump out of service, or one heater string out of service.

←(DRN 05-235, R14)

If the plant is operating with two steam generator feedwater pumps and two condensate pumps and one of the condensate pumps trips, one of the steam generator feedwater pumps automatically trips.

A loss of normal feedwater flow results in a reduced capability for steam generator heat removal. Such a loss could result from a pipe break, pump failure, valve malfunction, or loss of ac power. In the event of such an occurrence, the Emergency Feedwater System ensures a sufficient supply of cooling water (refer to Subsection 10.4.9).

The malfunction of any feedwater heater shell necessitates isolation of the flow path in which the malfunctioning feedwater heater shell is located. In case of malfunction of any of the heater shells, the isolation valves for the malfunctioning feedwater heater(s) are closed, and permitting flow to be bypassed around the out-of-service feedwater heater(s).

Seismic and safety classifications and the analysis of postulated high energy line failure are presented in Sections 3.2 and 3.6, respectively.

Environmental design bases and qualifications are discussed in Section 3.11.

During normal operation, condensate and feedwater contain no radioactive contaminants. However, in the event of primary-to-secondary system leakage due to a steam generator tube leak, it is possible for the CFWS to become radioactively contaminated. A full discussion of the radiological aspects of primary-to-secondary leakage, including anticipated operating concentrations of radioactive contaminants, means of detection of radioactive contamination, anticipated releases to the environment and limiting conditions for operation, is included in Chapters 11 and 12.

The potential for feedwater instability was initially considered in the design of the feedwater piping system. Routing of feedwater piping is such that draining of the feedwater line is minimized. The two ft.-nine in. drop in the feedwater piping immediately outside the feedwater nozzle and the existence of two check valves on each main feedwater line, between the steam generator and the feedwater pumps are considered to provide adequate assurance that the piping will not drain.

→(DRN 03-1588, R13; EC-8465, R307)

←(DRN 03-1588, R13; EC-8465, R307)

Preoperational testing will be performed to verify the design adequacies of the steam generator sparger rings and J-tubes, piping layout and operation of pumps and valves. This specific preoperation testing, as described in Chapter 14, is to ensure that no destructive flow instabilities will occur during transient conditions.

In the event that one of the steam generators reach the Hi-Hi Level setpoint the following automatic actions take place: a) reactor trip followed by turbine trip, b) the MFIV to the affected steam generator closes due to a signal transmitted from the wide range, Class 1E, level instrumentation (both MSIV's remain open), and c) cooldown is effected via the other steam generator by use of the main feedwater pumps.

The above assumes no loss of offsite power (which would activate EFW).

Once the water level in the affected setpoint steam generator drops below "Hi Level" alarm the isolation signal resets but the MFIV remains closed until the operator opens it manually. If no action is taken by the operator, EFW will automatically be initiated upon reaching the Lo-Lo Level.

The Auxiliary Feedwater System is a non-seismic system whose electrical components are powered from non-IE sources. It is not intended that this system be used during emergency operations. However, the design of the system is such that sufficient flow (to meet Chapter 15 requirements) can be delivered to the steam generators at maximum steam generator pressure if power is available to the pump's motor.

10.4.7.4 Tests and Inspections

All steam generator feedwater pumps, heater drain pumps, auxiliary feedwater pump and the condensate pumps are tested at the manufacturers' shops to demonstrate successful operation and performance of the equipment. Hydrostatic and performance tests were governed by the provisions of the ASME Power Test Codes for Centrifugal Pumps and the Hydraulic Institute Test Code for Centrifugal Pumps.

Shop hydrostatic tests at one and one half times the design pressure on all shell and tube sides were performed at a minimum temperature of 60°F. Performance tests for feedwater heaters will be conducted during operation.

The Condensate, Feedwater and Auxiliary Feedwater Systems are hydrostatically tested in the field after installation in accordance with applicable codes.

The components are given preoperational and functional tests to insure that they will perform in accordance with design. The closure times of the main feedwater isolation valves are determined during the preoperational test of the Condensate and Feedwater Systems. This is accomplished by measuring the elapsed time from the generation of a main steam isolation signal until the valve is closed. This test will be repeated during the life of the unit. The preoperational testing is also to verify pumps, valves, and control operability and setpoints, and to verify design head capacity characteristics of all pumps.

The main feedwater isolation valves cannot be tested during normal operation without causing severe system transients. Therefore, they are provided with an exercise mode which allows the valves to be cycled from full open to 90 percent open and back to full open during power operation. This ensures that the valve stems are free to move in the event a rapid closure is required. Full-scale testing of the actuation system will be accomplished during scheduled plant shutdown periods.

Instrumentation will be adequate to permit the operators to monitor the component and plant performance. Equipment, instruments and controls will be regularly inspected and monitored to insure proper functioning of components and systems.

Checking and recalibration of instruments and controls will continue during operating periods as well as during shutdown periods.

All ASME Code Section III feedwater piping is furnished with removable insulation to allow inservice inspection of the welds.

10.4.7.5 Instrumentation Applications

The water level in each of the steam generators is inferred by the measurement of the downcomer water level. The steam generator steam flow signal, feedwater flow signal and feedwater temperature signal are combined with this level signal in a four element controller. Outputs of the four element controllers actuate the main feedwater regulating valves to effect the desired feedwater flow to each steam generator.

Following a turbine trip, the main feedwater regulating valves are closed at approximately a uniform rate. Simultaneously, bypass valves, each sized for 15 percent of the rated flow, will be opened to provide approximately five percent of full flow at about one minute after the trip. This matches the reduced steam production rate. Subsequently, the operator remotely controls the valves to maintain steam generator water level. For each main feedwater control valve, a 100 percent capacity motor operated bypass valve is provided for back-up in case of outage of the regulating unit.

Refer to Sections 7.3 and 7.7 for a complete description of feedwater flow control system.

The steam generator feedwater pumps are tripped automatically on any one of the following trip signals:

a) low pump suction pressure,

b) low pump flow,

c) low lube oil pressure,

d) pump turbine overspeed,

e) thrust bearing wear,

f) recirculation failure, or

g) condenser vacuum low.

10.4.8 STEAM GENERATOR BLOWDOWN SYSTEM

The Steam Generator Blowdown System (SGBS), shown on Figure 10.4-5 is used in conjunction with the Sampling System to control the chemical composition of water in the steam generator shells within the specified limits.

The SGBS, with the exception of the blowdown piping from the steam generators to the outside containment isolation valves, has no safety-related function and is classified as quality group D.

10.4.8.1 <u>Design Basis</u>

The SGBS is designed to fulfill the following requirements:

a) to maintain the steam generator shell side water chemistry within the conditions shown in Table 10.3-2;

→(DRN 00-786, R11-A; 03-2064, R14)

b) to provide a continuous blowdown rate of approximately 150 gpm to 300 gpm under normal plant operating conditions;

←(DRN 00-786, R11-A)

c) to permit a maximum blowdown rate of approximately 634 gpm under abnormal plant operating conditions;

→(DRN 00-786, R11-A)

←(DRN 03-2064, R14)

d) to direct the blowdown to the blowdown demineralizers for further treatment; and

←(DRN 00-786, R11-A)

e) to achieve and maintain the chemistry requirements of the water inventory in the Condensate and Feedwater Systems prior to introduction of feedwater into the steam generators during plant start-up operation.

The portion of the SGBS from the steam generators to and including the air-operated containment isolation valves comprises an extension of the steam generator boundary. This portion of the system has been designed in accordance with safety class 2 and seismic Category I requirements. The remainder of the system is non-seismic.

The steam generator blowdown tank has been designed in accordance with ASME Code, Section VIII requirements. The appropriate requirements of ANSI, ASTM, ASME, Hydraulics Institute, IEEE and NEMA have been included in the design and fabrication standards for the components in the system.

→(DRN 01-776, R12-A; 03-2064, R14)

The SGBS can accommodate flow rates of approximately 634 gpm. The tank is normally vented to the extraction steam line to heater No. 4. An alternate blowdown steam vent to the condenser is provided for use at start-up, blowdown tank high water level, blowdown tank high pressure or turbine trip. The blowdown is directed to the Blowdown Treatment System. Blowdown can also be directed to the circulating water system or the Low Volume Wastewater Basin. The components of the SGBS are located outside the containment in the Reactor Auxiliary Building.

←(DRN 01-776, R12-A; 03-2064, R14)

10.4.8.2 System Description and Operation

The SGBS consists of the following components:

a) one steam generator blowdown tank;

b) two blowdown pumps (A and B);

c) one blowdown booster pump

d) two blowdown control valves 5BD-F611 and 5BD-F612;

e) two blowdown heat exchangers (A and B);

→(DRN 99-2262, R11)

f) DELETED

g) two blowdown demineralizers;

←(DRN 99-2262, R11)

h) one regenerative waste tank;

i) one regenerative waste tank pump;

→(DRN 99-2262, R11)

j) DELETED

k) DELETED

←(DRN 99-2262, R11)

l) piping, valves, flow elements and instrumentation; and

→(DRN 99-2262, R11)

m) DELETED

←(DRN 99-2262, R11)

Waterford 3 is currently bypassing the electromagnetic fliters and using non-regenerable resin which, upon exhaustion, is sluiced, dewatered, and processed for off site disposal. Fresh resin is added after exhausted resin has been sluiced from the vessels. Operating procedures as stated herein are modified when bypassing the electromagnetic filters and using non-regenerable resin.

For the physical data of the above listed equipment, see Tables 10.4-7 through 10.4-11 and 10.4-11a.

There are two blowdown lines, one coming from the bottom of the shell side of each steam generator. Each blowdown line has a connection which leads to the sampling system, two pneumatically operated isolation valves located on each side of the containment penetration, one flow element and a blowdown control valve. Each blowdown line leaves the containment through its own penetration and discharges into the steam generator blowdown tank.

The containment isolation valves are normally open and can be remotely operated from the main control room. These valves automatically close upon receipt of either a Containment Isolation Actuation Signal (CIAS) or an Emergency Feedwater Actuation Signal (EFAS).

→(DRN 05-151, R14)

Only the outboard isolation valves can be credited as containment isolation valve in each line. Both inboard and outboard isolation valves support isolation of the line for DBEs requiring steam generator isolation in accordance with Chapter 15.

←(DRN 05-151, R14)

The flow element is furnished with a flow transmitter and transmits blowdown rates to the control room.

The blowdown control valve, which is located near the blowdown tank, drops the pressure from the steam generator pressure to heater No. 4, extraction steam line pressure. These valves are used to control the rate of blowdown. The steam generator blowdown tank is vented to the extraction steam line of heater No. 4 by means of a 12 in. diameter vent line. This vent causes the blowdown to flash to the heater pressure, resulting in a lower effluent temperature.

Water level sensors monitor the level in the tank and send signals to the level control valve, located downstream of the heat exchangers which will control the level in the tank. The blowdown valves close when the level in the tank reaches a high-high level or when the pressure in the tank reaches a high level.

The blowdown pumps are remotely operated from the control room. The operation of the pumps is determined by the rate of blowdown and operator's discretion. The pumps trip on a low-low level. A pressure switch located on the discharge of each pump will signal loss of pump operation. A blowdown booster pump is provided to permit blowdown at reduced rates without operating the blowdown pumps or to provide additional NPSH margin for the blowdown pumps when necessary.

→(DRN 01-776, R12-A)

Following the initial stages of cleaning the Condensate and Feedwater Systems prior to plant start-up, a recirculation flow from the discharge of the condensate pumps back to the condenser passes through the blowdown filters and demineralizers. Following this state of cleanup, flow from the discharge of the feedwater heaters is passed through the blowdown filters and demineralizers. Blowdown can also be directed to the circulating water system or the Low Volume Wastewater Basin. The maximum recirculation cleanup flow rate is 1400 gpm and is at or below 120°F to prevent resin damage.

←(DRN 01-776, R12-A)

The steam generator blowdown rate is determined by the results of the steam generator shell water sample analyses. During normal plant operation with zero condenser and steam generator primary-to-secondary leakage, the steam generator will require very little blowdown. This small blowdown rate will be required to maintain steam generator water chemistry. An analysis of activity levels expected within the steam generators under normal operating conditions with an assumed primary to secondary leak and fuel cladding failure is provided in Section 11.1.

→(DRN 00-786, R11-A; 01-0717)

During normal plant operation, the effluent from the steam generator blowdown tank (47.3 to 236.5 gpm depending on the blowdown rate) is processed in the steam generator blowdown demineralizers. Each demineralizer must process a minimum flow of 50 gpm to prevent resin bed channeling.

←(DRN 01-0717)

The blowdown heat exchangers are used to cool the blowdown before it passes through the filters and demineralizers. The heat exchangers are cooled by circulating water which will be discharged in the circulating water discharge line. A radiation monitor will indicate activity in the circulating water line and initiate an automatic closure signal of Steam Generator Blowdown Valve BD-303 in the event of leakage in the heat exchanger whereupon, the heat exchanger can be isolated and repaired.

←(DRN 00-786, R11-A)

Manual isolation of the heat exchangers is necessary to locate faulty unit. Effluent radiological monitoring is discussed in Section 11.5. In order to cool the normal expected blowdown rate only one heat exchanger is required, but during periods of high blowdown two heat exchangers will be required. The demineralized blowdown is returned to the condenser for water conservation.

→(DRN 01-776, R12-A)

Provisions exist to discharge blowdown to either the Circulating Water System or the Low Volume Wastewater Basic. As discussed above, a radiation monitor in the discharge line to the Circulating Water System will monitor blowdown discharges to the river. The monitor will initiate an automatic closure signal of Steam Generator Blowdown Valve BD-303 in the event of high radioactivity level.

←(DRN 01-776, R12-A)

→(DRN 99-2262, R11; 00-873, R11-A)

The steam generator blowdown demineralizer system (SGBDS) consists of two mixed bed demineralizers. The blowdown is reduced in temperature and pressure and filtered before entering the demineralizers. The demineralizer resins are protected against excessive temperature by an automatic high temperature isolation and flow bypass. During normal semi-automatic operation when instrumentation on the mixed bed demineralizer outlet indicates that the bed is almost exhausted, the operator should manually divert the flow, via a local control panel switch, to the spare bed. Should the operator fail to take proper action, and the conductivity continue to rise to unacceptable levels, the exhausted bed will be automatically isolated.

During plant start-up (condensate cleanup) when both beds are in-service, the exhausted bed shall be isolated and the bypass opened or the flow rate reduced. The exhausted mixed bed resin, after being removed from service, is replaced and returned to service or placed on standby as conditions warrant.

→(DRN 00-1756, R11-A; 01-776, R12-A)

Any resin flush waste is collected in a regenerative waste tank and sampled prior to further processing. The blowdown would not be expected to be radioactive and therefore, the resin flush waste would normally be discharged to the low volume wastewater basin. In case of a primary to secondary leakage, the ion exchange resin will become radioactive. Based on a potential primary to secondary leakage of 10 percent of the time, 17,000 gallons of resin flush waste will be processed to the waste collection tanks in the Waste Management System.

←(DRN 99-2262, R11; 00-1756, R11-A; 00-873, R11-A; 01-776, R12-A)

➜ (DRN 99-2262)

← (DRN 99-2262)

10.4.8.3 Safety Evaluation

The SGBS constitutes a potential radioactivity release path to the environment even though two barriers exist between the fission products and the environment. Therefore, a means of monitoring and controlling the blowdown is an integral feature of the system design.

➜ (DRN 99-2262)

The SGBS has no safety-related function, with the exception of the piping from the steam generators to and including the containment isolation valves. These valves and piping constitute part of the containment boundary and are discussed in Subsection 6.2.4. In the event that the fluid being processed in the system is radioactive, the system only has the effect of concentrating the activity in the blowdown filters and the demineralizer resins which is then discharged to the Waste Management System during flushing. Discharge paths to the environment are isolated in the event of activity in the process fluid. The radioactive waste treatment is described in Section 11.2. Failure of any component in the system could compromise the system operation but would not affect safe shutdown of the plant.

← (DRN 99-2262)

The blowdown and sample lines and valves inside the containment are protected from missiles generated by the Reactor Coolant System to avoid any intereffect between a postulated LOCA and blowdown and sample line integrity.

→(DRN 05-151, R14)

The signal outboard containment isolation valve in conjunction with the inboard system isolation valve in each blowdown line receive containment actuation signals from separate channels to ensure that the single failure criterion is met for DBEs requiring steam generator isolation in accordance with Chapter 15.

←(DRN 05-151, R14)

A compatibility study of the primary to secondary pressure boundary material and the water chemistry of Table 10.3-2 is provided in Subsection 5.4.2.

10.4.8.4 Tests and Inspections

The Containment Isolation System will be functionally tested under conditions of normal operation in accordance with the procedure outlined in Chapter 14 to ensure that all valves close properly and that the design leakage requirements are met.

The remainder of the SGBS will also be functionally tested to ensure satisfactory operation.

The blowdown pumps have been tested in accordance with the Standards of the Hydraulic Institute and satisfy the performance requirements.

Local control panels are provided for system monitoring and control. Chemistry monitoring instrumentation (located in the Chemistry cold lab) is provided on the process line to ensure efficient demineralizer operation. System trouble alarms are provided in the control room to signal local control panel failure.

10.4.8.5 Instrument Applications

Instrument applications are described in Subsection 10.4.8.2.

10.4.9 EMERGENCY FEEDWATER SYSTEM

The function of the Emergency Feedwater System (EFS) is to ensure a sufficient supply of cooling water to the steam generators following a main steam or feedwater line break or loss of normal feedwater to provide cooldown of the Reactor Coolant System to the temperature and pressure at which the Shutdown Cooling System (SDCS) can be placed in operation. The Emergency Feedwater System is shown on Figures 10.4-2 (for Figure 10.4-2, Sheet 1, refer to Drawing G153, Sheet 1) and 10.4-6. The Auxiliary Feedwater System is described in Subsection 10.4.7.

10.4.9.1 Design Bases

The design bases of the Emergency Feedwater System are:

a) EFS supplies sufficient cooling water following loss of normal feedwater to one or both steam generators to ensure the following:

    1) to prevent radiological accidents due to partial or temporary uncovering of fuel in the reactor vessel,

    2) to reduce the reactor coolant temperature and pressure to 350 °F and 377 psig and,

3) to prevent lifting of the pressurizer safety valves.

→(DRN 05-870, R14)

4) to provide sufficient flow to one or both (depending on the specific event) Steam Generators for submergence of the Steam Generator U-tubes to reduce radioactive releases in the event of postulated accidents and to support safety analysis assumptions on iodine removal.

←(DRN 05-870, R14)

b) The system delivers feedwater against a steam generator pressure corresponding to the first main steam safety valve set pressure plus operating tolerances.

c) The system is designed to perform its intended functions in the event of a single failure in the system. The system is not classified as a high energy system, and pipe breaks were not postulated. Failures of check valves EFW-2191A, B are not considered credible failures. With prior NRC review and approval as documented in NUREG-0787 Supplement 6 and NRC Inspection Report 50-382/84-26, the EFW System was modified to incorporate a 1 in. bypass line with a 1/4 in. orifice to keep the piping down stream of the Emergency Feedwater Pumps filled in order to ensure that Emergency Feedwater System piping is not overstressed due to water hammer that may occur if the piping downstream of the EFW pumps is not full of water as shown in Figure 10.4-6. As a result of this modification a portion of the Emergency Feedwater System is continuously subjected to Main Feedwater System pressure during normal plant operation. The emergency feedwater piping is considered to be moderate energy piping in accordance with the intent of Branch Technical Position APSCB3-1 for the following reasons:

1) When pressurized, the line is static and is used only during emergency operating conditions, therefore it will not experience significant cyclic loads which would fatigue the pipe and increase the probability of a break.

2) The reservoir of high energy is limited by the 1/4" inch orifice which will limit the pipe whip and jet impingement loads to a negligible level.

3) The stress in this piping is typically 20% of the arbitrarily chosen mandatory break selection stress, see BTP MEE 3-1, (note the highest stress point is 64% of the break selection stress).

d) Safety class and seismic categorizations are listed in Table 3.2-1.

→(EC-530, R303)

e) Seismic Category I water storage for EFS contains as a minimum, sufficient water to hold the reactor at hot shutdown for two hours, followed by an orderly cooldown until the SDC may be initiated under normal shutdown conditions. In the event of tornado damage to the DCT, Seismic Category I water storage may be supplemented using water makeup to the WCT basins from non-safety related onsite water sources, or the Mississippi River as discussed in Subsection 9.2.5.3.3.

←(EC-530, R303)

f) The system is designed to operate for four hours with complete loss of either onsite and/or offsite ac power. In the event of loss of all ac power, an additional single failure is not postulated.

g) Redundant pumping capacity is provided by either two ac powered motor driven pumps or one dc power controlled steam turbine driven EFS pump to ensure system performance with multiple and diverse power sources.

h) The system is designed to preclude hydraulic instabilities.

i) The system is able to perform its design functions following any of the design basis natural phenomena.

1) safe shutdown earthquake

2) tornado, including tornado generated missiles

3) hurricane

4) flood

10.4.9.2 System Description

Performance characteristics of the EFS principal components are summarized in Table 10.4-12.

→

The EFS employs one full capacity steam turbine driven pump and two half capacity motor driven pumps, all capable of supplying one or both steam generators.

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Steam for the emergency feedwater pump turbine is supplied from either or both steam generators, taken upstream of the main steam isolation valves. The turbine steam supply valves (TSSV) 2MS-V611A and 2MS-V612B are motor operated, fail as is valves, powered by dc motors each from Class 1E A/B dc bus. There is a check valve located downstream of each TSSV to prevent steam loss in the event of the failure of the valve to close in conjunction with a secondary system depressurization. The TSSV and the check valves are designed in accordance with ASME Section III, Code Class 2, Summer 1973 Addenda requirements. Piping from each TSSV to the turbine is electrically heated to prevent standing water in the piping and to reduce the condensate load during start-up (a short run of piping in the pipe chase is not heated.) Steam traps and drain valves are provided to remove condensate.

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A flanged connection is provided on the emergency feedwater pump turbine steam supply piping to allow for post maintenance testing of the turbine. This connection is located on the roof of the Reactor Auxiliary Building and it is only used during plant outages by connecting a temporary boiler.

←

The turbine for the steam driven pump is a single stage, solid wheel, noncondensing, horizontal split casing unit, and will discharge to the atmosphere. It is designed for startup from a cold condition, and will operate with steam generator pressure ranging from 1135 psig to 50 psig. When the available steam pressure is insufficient to enable the turbine electrohydraulic governor to maintain the pump speed, the pump speed will decrease.

The turbine is equipped with redundant overspeed trips; one mechanical and one electrical. The turbine stop (trip and throttle) valve provides this overspeed protection. The turbine stop valve is normally open and requires solenoid actuation for the electrical overspeed trip to allow a spring to close it. The power supply for the trip solenoid is 125V dc, thereby maintaining complete dc powered control for the steam driven pump. The mechanical overspeed trip utilizes mechanical linkage to trip the turbine stop valve using the spring only. Remote operation of the turbine stop valve is provided by a motor powered Class 1E, 480 V ac supply. The valve is also provided with a handwheel for manual operation.

The electric motors for the EFS pumps are Class 1E and seismic Category I. The motors are able to accelerate the pumps within four seconds with 75 percent of full line voltage. The motors are powered from the 4.16 kV safety-related buses, drawing power from the startup transformers or the auxiliary transformers, or from the emergency diesel generators. Each motor is connected to an opposite channel of the electrical safety-related buses. On loss of preferred ac power, these motors will automatically be sequenced on the diesel generators.

Both electric and steam driven EFS pumps are centrifugal units with horizontally split casings and are designed in accordance with ASME Section III requirements. Pump data are listed in Table 10.4-12.

Suction of the EFS pumps is from the condensate storage pool (CSP) located inside the Reactor Auxiliary Building. There are two separate connections to the pool, each sized to provide sufficient suction flow and NPSH to all three EFS pumps. The EFS pump suction piping is provided with manually operated locked open valves for maintenance. Each suction line is provided with vortex breakers inside the CSP to prevent air entrainment to the EFS pumps when the CSP is at its lowest level.

Each EFS pump, when operating, recirculates a specified flow to the CSP. The pumps are sized to supply sufficient feedwater to steam generators plus the recirculation allowance. The continuous recirculation eliminates the need for recirculation controls, which would normally be required to ensure reliability of pumps whose discharge valves operate intermittently. Cooling water for each pump (and for the turbine oil cooler of the turbine driven pump) is supplied from an extraction point on the first stage of the associated pump. This provides a guaranteed source of cooling water under all operating conditions.

The EFS pumps discharge into a distribution header to ensure that any pump can supply feedwater to either steam generator. Headers are provided with manually operated valves for maintenance.

→(DRN 00-786, R11-A; 06-841, R15)

From the distribution header, water to the steam generators is carried by two pipelines; one, to feedwater line A. and the other, to feedwater line B (see Figure 10.4-6). Each pipeline is isolated by four pneumatically operated, fail open, isolation valves (2FW-V847B, -V848A to steam generator 1, and 2FW-V849A, -V850B to steam generator 2), arranged to ensure that in the event of a single failure, water could be supplied to either one or both steam generators, and that water could be prevented from entering the ruptured line during the postulated feedwater or main steam line break accident. The solenoids for the isolation valves are powered by 125 volt dc buses. The EFS isolation valves are designed in accordance with ASME Section III, Code Class 2, 1977 Edition through Summer 1977 Addenda.

←(DRN 00-786, R11-A; 06-841, R15)

The EFS pumps are located indoors in the Reactor Auxiliary Building and thus are protected from adverse environmental occurrences. The two motor driven pumps are located in separate compartments and the steam driven pump is located remotely from both. The EFS isolation valves and TSS valves are located outdoors, but are protected from tornado missiles, and are designed for tornado winds. All EFS piping located on the roof of the Reactor Auxiliary Building is adequately protected from freezing.

In addition to the EFS function, a portion of the EFS supply piping is used in the preoperational cleaning of the Feedwater System. This mode is prior to unit start-up or restart following normal plant shutdown. Valves 3FWV839, -V840, -V607, and -V610 (see Figure 10.4-2 [for Figure 10.4-2, Sheet 1, refer to Drawing G153, Sheet 1]) are opened and allow the EFS piping to convey feedwater to the blowdown filters. This operation is accomplished with the use of condensate pumps only. In order to prevent the loss of EFS water when required during emergency conditions, all valves will be electrically locked out. Valves 3FW-V839 and -V607, and also 3FW-V840 and -V610 are paired to operate from a common switch for each pair of valves. In addition, the EFS requires no local manual realignment of valves to conduct periodic pump surveillance tests.

Bypasses around valves 3FW-V839 and 3FW-V840 are provided to ensure that the EFS piping is full of water at all times. The bypasses consist of two restriction orifices 5FW-K856 and 5FW-K860, one in each line; four locked open valves, 5FW-V855, 5FW-V857, 5FW-V859 and 5FW-V861, one on either side of each orifice; and two check valves, 3FW-V633 and 3FW-V634, one on each line (see Figure 10.4-6).

→(EC-33720, R307)
Reference to Appendix 10.4.9B.
←(EC-33720, R307)

The EFS is shutdown manually from the main control room by the operator. Steam generator water level indication in the main control room is provided to inform the operator when the EFS can be shut down. Means are provided to start/stop each pump or to open/close the EFS isolation and TSSV from the main control room and from the auxiliary control panel.

The EFS pipeline to each steam generator contains a flow meter to be used for the following functions:

a) to indicate in the main control room the emergency feedwater flow for the operator's information, and

b) to alarm in the main control room on excessive flow.

Means are provided to throttle two isolating valves from the main control room (2FW-V852 and -V851B for steam generator 1, and 2FW-V853 and -V854B for steam generator 2) in each EFS train to permit the operator to adjust the emergency feedwater flow rate into the steam generator.
→(DRN M9900828, R11)
In addition to the water supply for the EFS, the CSP provides makeup water supply for the Component Cooling Water System, Emergency Diesel Generator Jacket Cooling Water System and Essential Services Chilled Water System. The make up requirements for these systems are only to account for evaporation and leakage, and have been included in the required technical specification level of the CSP.
←(DRN M9900828, R11)
The CSP is located inside of the Reactor Auxiliary Building. It is 21 ft. wide by 61 ft. long. and the bottom elevation of the pool is at elevation - 4 ft. MSL. The concrete floor of the pool and the walls up to elevation + 17 ft. MSL are lined with Type 304 stainless steel plate. The walls above elevation + 17 ft. MSL and the roof are not lined. The liner concrete integral structure is designed for seismic Category I loading with the CSP full of water, plus the thermal difference between the nominal and the minimum operating temperatures. The CSP is provided with an atmospheric vent to maintain atmospheric pressure inside the pool.

→(DRN M9901000, R11)
The CSP maintains a minimum EFW storage capacity of 170,000 gallons. This amount plus makeup from one WCT basin is sufficient to cool down the Reactor Coolant System (RCS), following any design basis accident, to the temperature and pressure at which the SDCS can be placed in operation. The chemical composition of the CSP is shown in Table 10.4-13. The normal makeup system to the CSP is nonseismic, but Class 1E indication in the main control room is provided to alert the operator of insufficient emergency feedwater supply.

Suction to Emergency Feedwater pumps is capable of being provided from two wet cooling tower basins, each of which maintains storage volume of approximately 174,000 gallons. This is a manual operation and is available for events that require additional emergency feedwater exceeding the amount stored in the CSP.
←(DRN M9901000, R11)
→(EC-530, R303; EC-40342, R307)
As discussed in Subsection 9.2.5.3.3, for the design basis tornado event, additional makeup for the wet cooling tower basins is available via gravity drain from the Circulating Water system or from onsite storage tanks (CST FWST, DWST, PWST) if these water sources are available post tornado. Provisions are in place (hose connections) to draw water from these sources via a non-safety related, portable diesel driven pump, which will supply water via hose directly to the basin. Additional makeup can also be provided directly to the wet cooling tower basins using a fire hose from the MSB potable water supply and fire hydrant #9.
←(EC-40342, R307)
In the event these sources are not available, provisions are in place to utilize the portable diesel driven pump to supply water from the Mississippi River to the Circulating Water system, which can be used to supply makeup to the basin via the path described above.
←(EC-530, R303)

10.4.9.3 Safety Evaluation

10.4.9.3.0 Emergency Feedwater System Requirements Evaluation

In March 1980, the NRC's office of Nuclear Reactor Regulation issued a letter requiring pending Operating License applicants with Combustion Engineering or Westinghouse designed systems to perform an Auxiliary Feedwater Evaluation. This action originated from the results of the NRR Bulletins and Orders Task Force review regarding the Three Mile Island-2 (TMI-2) accident. The required evaluation consisted of four parts.

a) A review of the Waterford 3 EFS against SRP 10.4.9 and BTP ASB 10-1.

b) A review of the Waterford 3 EFS design technical specifications and operating procedures against generic short and long term recommendations.

c) A comparison of the Waterford 3 EFS with the NRC EFS flow requirements.

d) A reliability analysis of the Waterford 3 EFS under a Loss of Main Feedwater (LMFW) transient, a LMFW and Loss of Offsite Power transients, and a LMFW and Station Blackout condition.

Parts a, b, and c appear as Tables 10.4.9A-1, 10.4.9A-2, and 10.4.9A-3 respectively. Part d appears as Appendix 10.4.9B.

10.4.9.3.1 Pipe Break

The EFS is used only for emergency shutdown of the reactor when the Main Feedwater System is inoperative. Accordingly, based on recommendations of Branch Technical Position APCSB3-1 (as further discussed in Subsection 10.4.9.1), it is classified as a moderate energy system and high energy pipe breaks are not postulated.

The EFS isolation valves and TSSV are located adjacent to the break exclusion area portions of the main steam and feedwater piping. Accordingly, pipe rupture effects of the main steam and feedwater piping on the EFS isolating and TSSV are not considered.

→(EC-41355, R307)
In the event of a main steam or feedwater line break there are four EFS isolation valves in the lines to each steam generator, arranged in two parallel paths, as indicated in Figure 10.4-6. The valves are pneumatically operated, fail open, and provided with accumulators sized for a minimum of 10 hours EFS operation. The valves are also equipped with handwheels for local manual operation. Procedures are established for operating manual handwheel overrides or lining up backup air supplies for continued safety function after 10 hour mission time of the safety related motive gas accumulator.
←(EC-41355, R307)

The EFS is designed to actuate and open only the valves feeding the intact steam generator(s). Excessive emergency feedwater loss is thereby avoided, during the feedwater or main steam pipe rupture accident, so that sufficient feedwater can be supplied to the intact steam generator-

Solenoids for the isolation valves are powered from the redundant Class 1E dc buses to ensure that the emergency feedwater flow to the affected steam generator could be shut off, and at least one path will be open to admit emergency feedwater into the intact steam generator when required, assuming any single failure. A failure mode and effects analysis is provided in Table 10.4-14.

10.4.9.3.2 Site Related Phenomena

The EFS pumps, their controls, and the flowmeters are located inside the Reactor Auxiliary Building, and thus are protected from site related phenomena. The system is designed to seismic Category I requirements. The EFS isolation valves and TSSV are located in the open area on top of the Reactor Auxiliary Building, and are protected by the Reactor Auxiliary Building walls from flooding and direct tornado and hurricane winds. The EFS piping located on top of the Reactor Auxiliary Building is designed to withstand the loads that are induced by a tornado. The EFS isolation and TSSV are protected from tornado missiles by grating installed above the valves. The grating design criteria is discussed in Section 3.5.
→(DRN M9901000, R11; 05-447, R14; EC-530, R303, LBDCR 15-032, R309)
The CSP is also located inside the RAB and thus is protected from site related phenomena. Additional water make up to the CSP is provided from seismic Class I wet cooling tower basins, in the event that tornado generated missiles would damage a portion of the ultimate heat sink. In this case, the EFS is required to operate prior to the SDC initiation and would require approximately 1.33 million gallons of water during this time. The CSP contains approximately 170,000 gallons. The storage capacity of the two wet cooling towers basins is approximately 331,500 gallons. The circulating water system contains approximately 250,000 gallons that can be made available to the EFS. In addition, provisions are in place to supply additional makeup water from on site water sources or from the Mississippi River. A complete description of ultimate heat sink operation and interface with the EFS under these conditions is provided in Subsection 9.2.5.
←(DRN M9901000, R11; 05-447, R14; EC-530, R303. LBDCR 15-032, R309)

10.4.9.3.3 Failure Mode and Effects Analysis

A Failures Modes and Effects analysis is shown in Table 10.4-14. Note that failures of check valves EFW-2191A, B are not considered credible failures.

10.4.9.3.4 Water Hammer

Feedwater hammer has been considered in layouts of the feedwater piping and design of tile steam generator feed ring. The feedwater piping design is discussed in Subsection 10.4.7 and the steam generator design is in Subsection 5.4.2.

10.4.9.3.5 Diverse Power Sources

Diverse power sources are used to ensure that the EFS is capable of performing its function with complete loss of ac power. Turbine and system safety controls are supplied from 125V dc ESF buses, as follows:

a) The TSSV are motor operated and fail as is valves. Each valve is powered by dc power from the 125V A/B dc bus.

b) Each TSSV admits steam from a different steam generator, and each valve is sized to admit sufficient steam to operator the pump at full speed.

c) The turbine trip valve solenoid, when energized, permits trip valve closure. This solenoid is powered from the 125V dc A/B bus.

d) The turbine is provided with two overspeed devices. One is electronically operated and has remote reset features. The other is mechanical and requires manual resetting. The solenoid for the electronic trip is powered from the 125V dc ESF bus.

e) The Turbine Governor Control System is electrohydraulic. Power supply to the control system is from the 125V dc ESF A/B bus.

f) The EFS isolation valves are pneumatically operated, fail open, and powered from the redundant vital 125V dc ESF buses, in such a manner that feedwater flow to the steam generator can be admitted or stopped, assuming single failure of loss of all ac power.

These provisions ensure that at a minimum the 100 percent capacity turbine driven EFS pump is available under loss of ac power.

10.4.9.3.6 Emergency Feedwater System Setpoint Evaluation

→(DRN 07-28, R15)

Subsection 7.3.1.1.6.2 describes the automatic actions of the EFW control system to regulate EFW flow to the steam generators including a description of specific actions that occur at the “Critical”, “Lo”, and “Lo-Lo” steam generator level setpoints. The Feedwater System Pipe Break (Subsection 15.2.3.1) and Loss of Normal Feedwater with an active failure in the steam bypass system (Subsection 15.2.3.2) are the events that result in the most rapid depletion of steam generator inventory, and are thus limiting with respect to the EFW control system (other non-limiting events where steam generator inventory is lost more slowly provide a greater capability for heat removal from the RCS). These limiting events have been analyzed with the EFW system modeled to behave as designed and described in FSAR subsection 7.3.1.1.6.2. In addition, the analyses account for steam generator level measurement uncertainties. Since results of the analyses are shown to meet regulatory acceptance criteria (see Chapter 15 for analyses details), the adequacy of EFW system valve positioning and flow rates at various steam generator levels is ensured.

←(DRN 07-28, R15)

→(DRN 07-28, R15)

→(DRN 00-125, R11)
←(DRN 00-125, R11)

←(DRN 07-28, R15)

10.4.9.4 Inspection and Testing Requirements

The EFS preoperational and functional tests are described in Section 14.2. The EFS pumps, their drives and all EFS automatic valves will be tested on a regular basis, as described in Subsection 3.9.6.

In-service inspection will be performed in accordance with the requirements of ASME Code, Section XI.

10.4.9.5 Instrumentation Application

Display instrumentation related to the EFS is discussed in Section 7.5. Information indicative of the readiness of the EFS prior to operation and the status of active components during system operation is displayed for the operator in the main control room and in the pumps room.

Indicating lights are provided to monitor equipment status. Each monitor driven component has ON and OFF indicating lights; each remotely controlled open-shut service valve has corresponding open-shut light indication; and each breaker control switch has an associated open-shut indicating light. A red light is used to indicate an operating status, ie., motor running, valve fully open, or breaker closed. A green light indicates that the equipment is not in an operating status, ie., motor off, valve fully shut, or breaker open.

Indicating instruments are provided as shown in Table 10.4-15. System indication is related to EFS and initiating circuits and logic is discussed in Chapter 7.

10.4.10 CHEMICAL FEED SYSTEM

10.4.10.1 Design Basis

→(DRN 00-873, R11-A)
The Chemical Feed System is designed to feed a volatile amine, oxygen scavenger, boric acid and ammonium chloride into the secondary system to maintain and control the pH and to control the oxygen level.
←(DRN 00-873, R11-A)

10.4.10.2 System Description

→(EC-34060, R306)

The Chemical Feed System consists of a Hydrazine Feed System designed to feed a hydrazine solution into a maximum operating stream condition of 109ºF and 487 psig. It also consists of two independent Chemical Feed Skids which are designed generically to feed alternate chemicals as water chemistry technology evolves. These skids are presently approved to be used for injecting ethanolamine, morpholine, boric acid and ammonium chloride. The use of these chemicals is further discussed in Subsection 10.3.5 "Water Chemistry".

←(EC-34060, R306)

The Hydrazine Feed System consists of:

a) one hydrazine solution feed tank,

→(DRN 00-873, R11-A)

b) two hydrazine solution pumps with stroke adjustment,

←(DRN 00-873, R11-A)

→(DRN 99-2236, R11)

c) one hydrazine solution pump with manual stroke adjustment for the auxiliary boiler area, and one for auxiliary feedwater

←(DRN 99-2236, R11)

d) controls, relief valve, level indicator, valves, strainers and interconnecting piping.

→(DRN 99-2236, R11)

The hydrazine solution is prepared manually by the addition of a 35 percent solution of hydrazine and the addition of water to the solution feed tank. The solution is then pumped from this tank to the condensate pump discharge or emergency feedwater pump suction piping, the auxiliary boiler area, and auxiliary feedwater.

→(DRN 00-873, R11-A)

←(DRN 99-2236, R11; 00-873, R11-A)

→(DRN 99-2236, R11; 00-873, R11-A)

←(DRN 99-2236, R11; 00-873, R11-A)

→(EC-34060, R306)

A pH control agent solution (ammonia, ethanolamine or morpholine) is prepared manually by the addition of the pH control agent and the addition of water to the solution feed tank. The solution along with the hydrazine solution is them pumped from this tank to the condensate pump discharge or emergency feedwater pump suction piping, the auxiliary boiler area, and auxiliary feedwater.

←(EC-34060, R306)

→(DRN 99-2236, R11; 00-873, R11-A)
←(DRN 99-2236, R11; 00-873, R11-A)

The Chemical Feed Skids each consist of:

a) one 150 gallon stainless steel chemical mixing/feed tank with electric mixer;
→(DRN 00-873, R11-A)
b) two 5.5 GPH chemical feed pumps with stroke adjustment;
←(DRN 00-873, R11-A)
c) controls, relief valves, level indicator, valves, strainers, calibration columns, pressure gauges, low level switch, and interconnecting piping.

→(DRN 00-873, R11-A)
The chemical solution is prepared manually by transferring chemicals from portable containers into the mixing tanks and by adding demineralized water to the mixing tank. The solution is then pumped from this tank to the condensate pump discharge and/or Auxiliary Feedwater Pump discharge. There is also a 0.6 GPH pump on Skid No. 1 which has the ability to take suction directly from the shipping containers and discharge to the same systems through a common discharge manifold. The four 5.5 GPH pumps and the mechanical mixers are interlocked to low level switches on the mixing/feed tanks to prevent the injection of air into the secondary system.
←(DRN 00-873, R11-A)

10.4.10.3 Safety Evaluation

The Chemical Feed System has no safety-related design basis. Its failure will not affect any safety-related equipment by virtue of its location in the Turbine Building.

10.4.10.4 Tests and Inspection

The Chemical Feed System is operationally checked before plant start-up to ensure proper functioning of the feed systems and chemical analyzers and controllers. At periodic intervals, the standby pumps are alternated to permit inspection of the backup system. This allows for the inspection of pumps, valves, and testing of the instrumentation and controls.

10.4.10.5 Instrumentation Application

→(EC-34060, R306)
Instrumentation is provided for manual and automatic control of the Hydrazine portion of the Chemical Feed System. pH, conductivity and hydrazine analyzers in the Secondary Sampling System provide indication of water quality and they are capable of providing signals for automatic control of the chemical injection of these two chemicals. Alarms are provided in the main control room to monitor the performance of these systems. The Chemical Feed Skids are manually operated except for the automatic low level shutoff feature.
←(EC-34060, R306)

Operation of the entire Chemical Feed System is normally manually controlled based on samples taken from a variety of sources as further discussed in Subsection 9.2.3 "Process Sampling System".

→(DRN 01-1284, R12)
SECTION 10.4 REFERENCES

1. Waterford 3 Calculation HP-CALC-97-004 "Dose Calculation for MCES Effluent Condition (No Diversion to Plant Stack)", Approved March 21, 1997.

←(DRN 01-1284, R12)

TABLE 10.4-1 Revision 307 (07/13)

MAIN CONDENSER PERFORMANCE AND DATA

CHARACTERISTICS

→(DRN 03-2064, R14) Equipment no.	A, B & C
→(EC-8465, R307) Total heat load, BTU/hr ←(EC-8465, R307)	$8{,}551.3 \times 10^6$
Effective surface area, $ft.^2$	755,000 per 3 shells
Cleanliness factor, %	90
→(EC-8465, R307) Condensate flow rate, lbs/hr ←(EC-8465, R307)	11,630,815
Circulating water flow rate, gpm	975,100
Circulating water temp in, °F	42°F/92°F
Circulating water temp out, °F	112 °F max
Oper pressure 12 in. above uppermost tube in. Hga	2.26
Average velocity in tubes, ft./sec ←(DRN 03-2064, R14)	8
Tube outside diameter, in.	1
Tube BWG	22
Tube overall length, ft.-in.	52 - 2 1/4
Number of tubes	55,458 total
Tube material	ASTM A-249 Type 304
Shell material	ASTM A-285 Gr C
Waterbox material	ASTM A-285 Gr C
Tube sheet material	ASTM A-285 Gr C
Hotwell material	ASTM A-285 Gr C
→(DRN 04-1702, R14) Condenser tube stakes ←(DRN 04-1702, R14)	ASTM A-240 Type 304

TABLE 10.4-2 (Sheet 1 of 5) Revision 15 (03/07)

CIRCULATING WATER SYSTEM COMPONENT DATA CIRCULATING WATER PUMPS

CHARACTERISTICS	DATA
Manufacturer	Allis Chalmers Corporation
Equipment number	A, B, C, D
Quantity	4
Type	Vertical-mixed flow
Liquid pumped	River water
Flow design/ gpm	250,000
→(DRN 06-841, R15)	
Maximum Runout flow, gpm (Two pumps running)	311,000
←(DRN 06-841, R15)	
→(DRN 00-786, R11-A)	
Head design, feet	49
←(DRN 00-786, R11-A)	
→(DRN 06-841, R15)	
Shut-off head, feet	135
Head from minimum water level to bottom of pump suction bell, feet	13.8
Brake horsepower design/ bhp	3557
Brake horsepower at shut-off, bhp	5629
Specific speed	7370
←(DRN 06-841, R15)	
Pump Speed, rpm	273
→(DRN 06-841, R15)	
Efficiency	87%
←(DRN 06-841, R15)	
Material of construction:	
Bowl	304 SS A 296 CFB
Discharge elbow	Carbon steel ACM 0014
Suction bell	Cast Iron-30, A-48
Diffuser and Guide Vanes	Cast Iron-30, A-48
Shaft	Carbon Steel A-235 Class E
Impeller	Ni-Aluminum bronze-type B148-9D

TABLE 10.4-2 (Sheet 2 of 5)

CIRCULATING WATER SYSTEM COMPONENT DATA

CIRCULATING WATER PUMPS

CHARACTERISTICS	DATA
Driver:	
Type	Induction electric motor
Rating/speed	4000 hp/273 rpm
Service factor	1.15
Voltage	6600
Thrust bearing type	Kingsbury
Manufacturer	Allis Chalmers Corporation

CIRCULATING WATER SYSTEM COMPONENT DATA

SCREEN WASH PUMPS

CHARACTERISTICS	DATA
Manufacturer	Goulds Pumps Inc.
Quantity	3
Type	Vertical Turbine
No. of stages	4
Liquid pumped	River water
Design capacity, gpm	3000
→(DRN 00-786)	
Total dynamic head, ft.	272
←(DRN 00-786)	
Runout capacity, gpm	3250
→(DRN 00-786)	
Shutoff head, ft.	496
←(DRN 00-786)	
Speed, rpm	1750
Brake horsepower, hp	240
Efficiency, %	84.5
Materials of Construction:	
Discharge elbow	Carbon steel, ASTM-216, Gr. WCB
Column pipe	Carbon steel, ASTM-216, GR. WCB
Suction bell	Carbon steel, ASTM 278-64
Bowl	Carbon steel, ASTM 278-64
Discharge head	Carbon steel, ASTM 216 Gr. WCB
Impeller	Carbon steel, ASTM B148-7l.9A
Shaft	Carbon steel, ASTM 120 Gr. B
Driver:	
Type	Electric-induction motor
Manufacturer	General Electric Company

TABLE 10.4-2 (Sheet 4 of 5)

CIRCULATING WATER SYSTEM COMPONENT DATA

SCREEN WASH PUMPS

CHARACTERISTICS	DATA
Rating/speed	250 hp/1775 rpm
Voltage/phase/frequency	46OV/3ph/60 hz
Service factor	1.0

TABLE 10.4-2 (Sheet 5 of 5)

CIRCULATING WATER SYSTEM COMPONENT DATA

CIRCULATING WATER SYSTEM AIR EVACUATION PUMPS

CHARACTERISTICS	DATA
Manufacturer	Nash Engineering Company
Quantity	2
Capacity acfm	795
Suction pressure, inches hg abs.	5.21
Blank off pressure, inches hg abs.	3.0
Speed, rpm	690
Brake horse power (maximum)	48
Brake horse power (normal)	40
Type	rotary, water ring
Materials of construction:	
Cylinder	grey cast iron
Rotor	Nodular iron
Vane	Nodular iron
Shaft	Carbon steel
Driver:	
TypeElectric-induction motor	
Manufacturer	General Electric Company
Rating/speed	40 hp/690 rpm
Voltage/phase/frequency	46OV/3ph/60 hz
Service factor	1.0

TABLE 10.4-3 Revision 308 (11/14)

CONDENSATE PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	A, B, C
Type	Vertical, centrifugal can type
Size of Connections:	
Suction	36-inch 150 lb FF Flange
Discharge	24-inch 300 lb FF Flange
Pumped fluid	Condensate
Design Pressure, psig	
Suction (piping)	50/vac
Discharge (piping)	610
Design Temperature, °F (piping)	150
Design Flowrate, gpm/pump	10,550
Design Head, ft.	1,080
NPSH required at design flow rate, ft.	13.7
Maximum operating flow rate, gpm/pump	12,500
NPSH required at maximum operating flow rate, ft.	15.5
→(DRN 00-1039, R11-A)	
Minimum available NPSH, ft.	15.54
←(DRN 00-1039, R11-A)	
Shut off head, ft.	1,400
Materials of Construction	
→(EC-47045,R308)	
Casing	ASTM A48 Cl 30 or ASTM A-216 WCB
←(EC-47045,R308)	
Impeller	
First stage	5% Cr Steel with 3% Ni
Subsequent stages	5% Cr Steel with 3% Ni
Shaft	A276 Ty 410
Driver	
Type	Induction motor
Service factor	1.0
Nameplate rating, hp	4,000
Voltage	6,600
rpm	1,180

TABLE 10.4-4 Revision 15 (03/07)

HEATER DRAIN PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	A, B, C
Type	Vertical, centrifugal can type
Pumped fluid	Condensate
Design pressure, psig	
Suction side (piping)	265
Discharge side (piping)	500
Design Temperature, °F (piping)	388
Size of Connections	
Suction	20-inch 300 lb FF Flange
Discharge	12-inch 300 lb FF Flange
Design flow rate, gpm per pump	3,820
Design head, ft.	710
→(DRN 06-841, R15)	
NPSH required at design flow rate, ft.	16
Minimum available NPSH, ft.	34.8
←(DRN 06-841, R15)	
Shut off head, ft.	1,300
Material of Construction	
Casing	5% Cr Steel w/3% Ni
Impeller	5% Cr Steel w/3% Ni
Shaft	A-276 Ty 410
Driver	
Type	Induction motor
Service factor	1.0
Horsepower	800
Voltage	4,000
rpm	1,780

TABLE 10.4-5

STEAM GENERATOR FEEDWATER PUMP DATA

CHARACTERISTICS	DATA
Equipment Numbers	A, B
Type	Horizontal, Centrifugal, 1-stage
Pump fluid	Condensate
Design pressure, psig	
Suction	504
Discharge	1,546
Design temperature, °F	366
Design flow rate, gpm	17,940
Size of Connections	
Suction	24-inch buttweld
Discharge	20-inch buttweld
Design head, ft.	2,150
NPSH required at design flow rate, ft.	205
Minimum available NPSH, ft.	230
Shut off head, ft.	2,730
Materials of construction	
Casing	ASTM A226 CL II
Impeller	ASTM A296 CA 40
Shaft	ASTM A276 Gr 414
Driver	
Type	Variable speed steam turbine
bhp	9,780 @ design flow rate

TABLE 10.4-5a

AUXILIARY FEEDWATER PUMP DATA

Characteristics	Data
Type	Horizontal, Centrifugal 8 - stages
Pumped Fluid	Condensate
Design pressure, psig	
Suction piping	175
Discharging piping	1925
Design temperature,°F	150
Design flow rate, gpm	900
Size of Connections	
Suction	10-inch buttweld
Discharge	4-inch buttweld
Design head, ft.	2850
NPSH reqd at design flow rate, ft.	13
Minimum available NPSH, ft.	28.7
Shutoff head, ft.	4400
Materials of construction	
Casing (barrel)	ASME SA 182F304
Impellers	ASTM A296CA6NM
Shaft	ASTM A479TP304HF
Driver	
Type	Induction Motor
Service factor	1.15
Horsepower	1000
Voltage	6600
Speed, RPM	3577

FEEDWATER HEATER DATA

	LP Heater 6A, 6B & 6C	LP Heater 5A, 5B & 5C	IP Heater 4A, 4B & 4C	IP Heater 3A, 3B & 3C	IP Heater 2A, 2B & 2C	HP Heater 1A, 1B & 1C
Type	Closed	Closed	Closed	Closed	Closed	Closed
Number of Shells	3	3	3	3	3	3
→(DRN 03-2064, R14; EC-8465, R307)						
Condensate Flow 100% RSG 3716 MWt Power lbm/hr/heater	3,876,938	3,876,938	3,876,938	3,876,938	3,876,938	5,537,947
Condensate Flow (Emergency) lbm/hr/heater	5,537,947	5,537,947	5,537,947	5,537,947	5,537,947	8,306,921
←(DRN 03-2064, R14; EC-8465, R307)						
Tube Design Pressure, psig	625	625	625	625	625	1700
Tube Material	304 SS	304 SS	304 SS	304 SS	304 SS	304 SS
Terminal Difference, °F	5	5	5	5	5	5
Drain Cooler Approach,°F	10	10	10	10	-5 SC	10

TABLE 10.4-7 (Sheet 1 of 2)

STEAM GENERATOR BLOWDOWN TANK AND PUMP DATA

STEAM GENERATOR BLOWDOWN TANK

Characteristics	Data
Quantity	1
Type	Vertical
Stored material	Condensate
Design pressure/temp	VAC-75 psig/325 °F
Max Operating press/temp	50 psig/300 °F
Tank dimensions;	
Height, ft.-in.	10 - 8 5/8
Diameter, ft.-in.	8 - 0
Material of construction	SA-515 Gr 70

STEAM GENERATOR BLOWDOWN PUMP

Equipment identification	A & B
Quantity	2
Type	Horizontal, Horizontal Split Case, 2-Stages Centrifugal
Pumped Liquid	Blowdown condensate
Design Capacity, gpm	250
Total Dynamic Head, ft. water	231
NPSH required, ft. water	4
NPSH available, ft. water	4

TABLE 10.4-7 (Sheet 2 of 2) Revision 15 (03/07)

STEAM GENERATOR BLOWDOWN TANK AND PUMP DATA

STEAM GENERATOR BLOWDOWN PUMP (Cont'd)

Characteristics	Data
Materials of construction	
Casing	A-48 CI
Impeller	A-48 CI
→(DRN 06-841, R15)	
Shaft	Steel A296 CF8M
←(DRN 06-841, R15)	
Electric Motor Driver	
Voltage	460
Rated rpm	1800
Rated hp	30

TABLE 10.4-8 Revision 15 (03/07)

STEAM GENERATOR BLOWDOWN HEAT EXCHANGERS DATA

Characteristics	Data
Equipment identification	A & B
Quantity	2
Type	Horizontal Shell & Tube
→(DRN 06-841, R15) Size ft.-in.	15-9 length 3-0 width 8-8¼ height **
←(DRN 06-841, R15)	
Design Press (psig) Temp (°F)	143/300 shell 50/140 tubes
Design Code	ASME VIII (1974) TEMA (1974)
Materials of construction	A-106 Gr B Shell A-249 Type 304 SS tubes

→(DRN 99-2262, R11)

←(DRN 99-2262, R11)

→(DRN 06-841, R15)
** two shells stacked
←(DRN 06-841, R15)

TABLE 10.4-9

→ (DRN 99-2262)

DELETED

← (DRN 99-2262)

TABLE 10.4-10

REGENERATIVE WASTE TANK PUMP AND PUMP DATA

REGENERATIVE WASTE TANK PUMP

Characteristics	Data
Quantity	1
Type	Horizontal, Vertical Split Case, 1-Stage
Pumped Liquid	Regenerative Waste Tank Effluent
Design Capacity, gpm	200
Total Dynamic Head, ft. water	90
NPSH required, ft. water	9
NPSH available, ft. water	25
Materials of construction	
Casing	A-296 CF8M 316 SS
Impeller	A-296 CF8M 316 SS
Shaft	A-322 Gr 4140
Electric Motor Driver	
Voltage	460
Rated RPM	3600
Rated HP	10

REGENERATIVE WASTE TANK

Quantity	1
Design Capacity	20,000 gal
Design Temperature	200 °F
Design Pressure	Atmospheric
Material	Stainless Steel
Code	API 650
Safety Class	Nonsafety
Seismic Category	Nonseismic

→ (DRN 99-2262)

TABLE 10.4-11 (Sheet 1 of 2) Revision 11 (05/01)

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DEMINERALIZER COMPONENT DESIGN DATA

← (DRN 99-2262)

1) Mixed Bed Vessel

Quantity	2
Design Temperature	200 °F
Operating Temperature	120 °F
Design Pressure	200 psig
Operating Pressure	100 psig
Material	ASME SA-285-C
Lining	3/16 natural gum rubber
Flow Rate, normal	60-425 gpm
maximum	700 gpm
Maximum Pressure Drop (clean)	10 psi
Resin Bed Volume	170 cubic feet
Maximum Cross Sectional Flow Rate	20 gpm/ft.^{2}
Codes	ASME Section VIII
Safety Class	Nonsafety
Seismic Category	Nonseismic

2) Piping

Material	Saran or rubber lined carbon steel or stainless steel as required
Operating Temperature	120 °F
Operating Pressure	100 psig
Codes	ANSI B31.1

3) Valves

Material	Saran or rubber lined carbon steel or stainless steel as required
Operating Pressure	100 psig
Operating Temperature	120 °F
Codes	ANSI B16.5
Pressure Standard	150 lb

→ (DRN 99-2262)

4) DELETED

← (DRN 99-2262)

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TABLE 10.4-11 (Sheet 2 of 2) Revision 11 (05/01)

→ (DRN 99-2262)

5) DELETED

← (DRN 99-2262)

TABLE 10.4-11a

Blowdown Booster Pump

Characteristics	Data
Quantity	1
Type	Centrifugal, Horizontal
Pumped Liquid	S. G. Blowdown
→(DRN 06-841, R15)	
Design Capacity, gpm	400
Total Dynamic Head, ft. water	50
←(DRN 06-841, R15)	
NPSH required, ft. water	6.5
NPSH available, ft. water	33
Material of Construction	
→(DRN 06-841, R15)	
Casing	Ductile Iron
Impeller	Ductile Iron
Shaft	4140 Steel
←(DRN 06-841, R15)	
Electric Motor Drive	
Voltage	460
Rated RPM	1750
Rate HP	10

TABLE 10.4-12 Revision 304 (06/10)

EMERGENCY FEEDWATER SYSTEM
COMPONENT DESIGN DATA

	MOTOR DRIVEN EFS PUMPS	TURBINE DRIVEN EFS PUMPS
→(DRN 98-2269, R11-A)		
Quantity	2	1
Type	Horizontal-Centrifugal	Horizontal-Centrifugal
Manufacturer	Bingham-Willamette	Bingham-Willamette
Design Flow, gpm	395	780
(Recirculation included in Design Flow, gpm)	45	80
Design head ft./psi	2673/1155	2673/1155
Runout Flow, gpm	600	1000
→(EC-19372, R304)		
NPSH @ Design Flow, ft. required/ available	14/33.8	18/35
NPSH @ Runout Flow, ft. required/ available	20/23.6	27/27.9
←(DRN 98-2269, R11-A; EC-19372, R304)		
→(DRN 01-3698, R11-B)		
Governing Code	ASME Section III 1971 Edition, W 1972 Addenda (Pump Case is S 1975 Addenda)	ASME Section III 1971 Edition, W 1972 Addenda (Pump Case is S 1975 Addenda)
←(DRN 01-3698, R11-B)		

EFS TURBINE

Quantity	1
Type	Non Condensing
Manufacturer	Terry Turbine
Steam Inlet Pressure, psig:	
Design	1135
Normal	880
Minimum	50

EFS PUMP MOTORS

Quantity	2
Type	Induction
Manufacturer	General Electric
Rated Horsepower	400
Rated Speed, rpm	3600
Voltage, Volts	4160
Governing Codes	IEEE - 323 - 1974 and IEEE - 344 - 1975

TABLE 10.4-13 Revision 11-A (02/02)

CONDENSATE STORAGE POOL CHEMICAL COMPOSITION

	NORMAL
pH	5.5 - 9.8
Specific Conductivity	≤20.0 μmos/cm
→(DRN 00-873)	
Oxygen Scavenger	(As Required)*
Amine	(As Required)*
←(DRN 00-873)	
Silica	≤200 ppb
Chloride	≤100 ppb
Sulfate	≤100 ppb
Visual Clarity	Clear

* As required to maintain steam generator chemistry specifications when using EFS.

TABLE 10.4-14 (Revision 307 07/13)

EMERGENCY FEEDWATER SYSTEM FAILURE MODE AND EFFECTS ANALYSIS

Failure Mode*	Effect on System	Method of Detection	Monitor	Remarks
One diesel gen. fails to start	Loss of one 50% capacity motor driven pump	Speed switch	Control room indication	One motor driven pump and one turbine driven pump, and all EFS isolation and TSS valves are operable. 150 percent pumping capacity available.
Loss of one dc bus (A or B)	One Diesel Gen. fails to start Loss of one motor driven pump Redundant EFS isolation valves fail in open position	Under voltage relay	Control room alarm	The other diesel generator starts. One motor driven and one turbine driven are operable. Redundant EFS isolation valves are operable, permitting isolation of EFS headers. 150 percent pumping capacity available.
Loss of A/B dc bus	Turbine driven pump may trip on overspeed TSS valves fail as is (closed)	Under voltage relay	Control room alarm	Two motor driven pumps and all valves are operable. 100 percent pumping capacity available.
Failure of an EFS isolation valve to operate	None	Limit switch	Control room indication	Redundant valves and flow paths permit operation of the system. 200 percent pumping capacity available.
Failure of one pump to start	Possible loss of turbine driven pump	Loss of re-circulation flow	Computer	All remaining pumps and all valves are operable. Minimum of 100 percent pumping capacity available.
→(EC-41355, R307) Loss of air	EFW Flow Control Valves fail open.	Steam Generator Level	Control room Indication	After 10 hour mission time of the safety related motive gas accumulator. Procedures are established for operating manual handwheel overrides.

←(EC-41355, R307)

*NOTE: Failure is assumed to occur following loss of ruptures of main steam or main feedwater line.

TABLE 10.4-15 Revision 9 (12/97)

EMERGENCY FEEDWATER SYSTEM INSTRUMENTATION APPLICATION

System	Parameter & Location	Indication Local	Indication Control Room	Alarm (1) High	Alarm (1) Low	Record	Comput	Control	Function	Instru-ment Range	Normal Operating Range	Instrument Accuracy
Condensate Storage Pool Level												
Tags LI-CD-9013 AS/BS			*		*		*			0-100 %		±1.5%
Emergency Feedwater Pumps												
1. Steam pressure at turbine inlet Tag PI-MS-8340S			*		*		*			0-1300 psig		
2. Pump discharge pressure		*(2)	*				*			0-1500 psig		±1.5%
Tags PI-FW-8322 A2S PI-FW-8322 B2S PI-FW-83225												
3. Pump discharge flow to Steam Generator Tags FI-FW-8330-AIS, A2S FI-FW-8330-BIS, B2S		*(2)	*		*					0-800 gpm		±1.5%
4. Turbine speed + Tag SI-FW-8350 A/B		*	*							0-6000 rpm	2260-4450 rpm	

(1) All alarms and recordings are in the control room unless otherwise indicated.
(2) Auxiliary Control Panel.
* Instrumentation available.
\+ The turbine and pump shafts are directly coupled. However, the speed indicator is off the turbine shaft.

TABLE 10.4-16 Revision 10 (10/99)

CONDENSATE DEMINERALIZER EFFLUENT WATER QUALITY

Parameter	Water Quality
Dissolved Oxygen	≤10 ppb
Sodium	≤0.15 ppb

The following quantities are also monitored:

Total suspended solids	Monitor
Dissolved silica	Monitor
Total iron	Monitor
Total copper	Monitor
Conductivity (cation) at 25°C	Monitor
Chloride	Monitor

CONDENSATE CLEAN-UP SYSTEM DESIGN DATA

CONDENSATE POLISHER SYSTEM

1. Service Vessels

→(DRN 03-2064, R14)

Number of Vessels	5 in service, 1 on standby
Size	72 in.Diameter
Design flow/vessel	4840 gpm (3.78 gpm/sq. ft.)
No. of Powdex Elements/Vessel	420
Total element area/vessel	1281 sq. ft.
Design pressure	700 psig max.
Design temperature	140°F
Design code	ASME Sec. VIII, Div. I with stamp

←(DRN 03-2064, R14)

2. Hold Pumps

Number	Six (6)
Capacity	150 gpm @ 140°F vs 60 TDH
Motor Size	5 HP

3. Precoat Vessels

No. of Vessels	One (1)
Size	60 in. Diameter 5 ft.-O in. High
Vessel Lining	Plastic #7155 Epoxy Phenolic

4. Precoat Pumps

Number	Two (2)
Capacity	3750 gpm @ 140°F vs 100 TDH
Motor Size	150 HP

5. Backwash Pump

Number	One (1)
Capacity	320 gpm @ 150°F vs 110 ft. TDH
Motor Size	20 Hp, 1800 rpm, 3 pH, 60 Hz, 440 volts

6. Air Surge Tank

Number	One (1)
Size	8 ft. O in. Diameter, 9 ft. 6 in. STR
Design pressure	150 psig
Design temperature	300°F
Design code	ASME Sec. VIII, with stamp

TABLE 10.4-17 (Sheet 2 of 3)

CONDENSATE CLEAN-UP SYSTEM DESIGN DATA

BACKWASH TREATMENT SYSTEM

1. Filter

Number of filters	One (1)
Type	Mott Pneumatic Hydro Pulse (PHP)
Code	ASME Section VIII Division I
Total Filter Area	57.5 sq. ft.
No. of Elements	22
Materials of Construction	
i. Elements	316L SS
ii. Tube Sheet & Internals	304 SS
iii. Housing	304 SS
iv. Element Seals & Housing Gaskets	Viton

2. Dewatering Filter

Number	One (1)
Filter Area	7 sq. ft.
Dimensions	6 ft. L x 5 ft. W x 8 ft. H

3. Holding Tank

Number	One (1)
Capacity	1000 gal.
Size	
i. Height	48 in.
ii. Width	108 in.
iii. Depth	52 in.
Materials of Construction	304 SS

4. Resin Bin

Number	One (1)
Capacity	290 gal.
Size	50 in. dia., 44 in. height
Materials of Construction	304 SS

5. Backwash Transfer Pump

Number	Two (2)
Type	Air Operated Disphragm
Pump Wetted Parts Material	316 SS
Diaphragm	Buna-N
Air Consumption	40 SCFM (Max) @ 100 psig

TABLE 10.4-17 (Sheet 3 of 3)

CONDENSATE CLEAN-UP SYSTEM DESIGN DATA

6. Backwash Recovery Pump

Number	Two (2)
Type	Positive Displacement Progressive Cavity
Capacity	30 gpm
Materials of Construction	
Internals	316 SS
Stator	Buna-N
Motor HP (each)	5

7. PHP Filter Backwash Drain Line Pump

Number	One (1)
Type	Air Operated Diaphragm
Pump Wetted Parts Material	316 SS
Diaphragm Material	Buna-N

8. Fluffing Pumps

Number	Three (3)
Type	Centrifugal
Capacity	250 gpm at 80 ft. head
Materials of Construction	316 SS
Motor HP (each)	10

9. Treated Effluent Storage Tank Transfer Pumps

Number	One (1)
Type	Centrifugal
Capacity	30 gpm
Materials of Construction	316 SS
Motor HP (each)	2