4.9 REACTOR WATER CLEANUP SYSTEM

4.9.1 Power Generation Objective

The Reactor Water Cleanup System maintains high reactor-water purity to limit chemical and corrosive action, thereby limiting fouling and deposition on heat transfer surfaces. The Reactor Water Cleanup System also removes corrosion products to limit impurities available for activation by neutron flux and resultant radiation from deposition of corrosion products. The system also provides a means for removal of reactor water.

4.9.2 Power Generation Design Basis

1. Provision shall be made for the continuous mechanical and chemical filtration and demineralization of reactor water to quality specifications.

2. Provision shall be made for discharge of reactor water at reduced activity during startup and shutdown.

3. Provisions shall be made to limit the heat loss and the fluid loss from the nuclear system.

4.9.3 Description (Figures 4.9-1, 4.9-2, 4.9-3, 4.9-5, 4.9-6, 4.9-7, 4.9-8, 4.9-9, and 4.9-10)

The Reactor Water Cleanup System provides continuous purification of a portion of the recirculation flow. The processed fluid is returned to the reactor vessel, to radwaste, or to the main condenser. Regenerative heat exchangers are provided to limit heat loss from the nuclear system. The system can be placed in service at any time during normal reactor operation or shutdown conditions.

The major equipment of the Reactor Water Cleanup System is located in the Reactor Building and consists of two pumps, regenerative and nonregenerative heat exchangers, and two filter/demineralizers with supporting equipment. The entire system is connected by associated valves and piping, and controls and instrumentation are provided for proper system operation.

Design and construction of pressure-retaining piping and components of the Reactor Water Cleanup System was initially in accordance with the requirements of USAS B31.1.0, 1967 Edition, as supplemented by the requirements of the applicable GE specifications, which were implemented in lieu of the outdated B31 Nuclear Code Cases-N2, N7, N9, and N10. Design data for the major pieces of equipment are presented in Table 4.9-1.

Reactor coolant is continuously removed from the Reactor Coolant Recirculation System, cooled in the regenerative and nonregenerative heat exchangers, filtered and demineralized, and returned to the feedwater system through the shell side of the regenerative heat exchanger. The RWCU System has one return line through reactor feedwater line B.

Because the ion exchange resins used in the filter-demineralizer are temperature-limited (Table 4.9-1), the reactor coolant must be cooled prior to processing in the units. The regenerative heat exchanger transfers heat from the influent water to the effluent water. The effluent returns to the feedwater system. The nonregenerative heat exchanger cools the influent water further by transferring heat to the Reactor Building Closed Cooling Water System. During startup and shutdown, excess water in the primary system is sent to the main condenser or to radwaste by diverting part or all of the filter-demineralizer effluent. This reduces the effectiveness of the regenerative heat exchanger. The nonregenerative heat exchanger has the capability of reducing the filter-demineralizer influent temperature to the required level, while maintaining an adequate diversion flow rate.

The filter-demineralizer units (Figures 4.9-2, 4.9-3, 4.9-6, 4.9-7, 4.9-9, and 4.9-10) are pressure precoat-type filters which use either finely ground mixed ion exchange resins or a mixture of powdered resins and fibrous material as a precoat medium, they serve as a combination filter-ion exchange medium. Spent resins are not regenerable, but are sluiced from a filter-demineralizer unit to a backwash receiver tank, (from which they are pumped to the cleanup phase separators for dewatering, decay, and disposal). A strainer is installed on the outlet of each filter-demineralizer unit to prevent resins from entering the Reactor Coolant Recirculation System in the event of a resin support failure. Each strainer is provided with an alarm which is energized by high differential pressure (20 psi). A bypass line is provided around the filter-demineralizer units for bypassing the units when necessary. Each unit has a holding pump which starts in the event of low flow, in order to hold the resin in place on the support elements.

Relief valves and instrumentation are provided to protect the equipment against overpressurization and the resins against overheating. The system is automatically isolated when signaled by any of the following occurrences.

a. High temperature downstream of the nonregenerative heat exchanger. To protect the ion exchange resin from damage due to high temperature.

b. Reactor Vessel Water Level - Low, Level 3. To protect the core in case of a possible break in the Reactor Water Cleanup System piping and equipment (see Subsection 7.3, "Primary Containment and Reactor Vessel Isolation Control System").

c. Standby Liquid Control System actuation. To prevent removal of the boron by the ion exchange resin.

d. High temperature indicative of a RWCU pipe break/critical crack in any of the following areas: main steam valve vault, RWCU pipe trench, RWCU pump rooms, or the RWCU heat exchanger room to isolate the system (see subsection 7.3).

Sample points are provided upstream and downstream of each filter-demineralizer unit. The sample analysis provides an indication of the effectiveness of the filter-demineralizer units. The influent sample point is also used as the normal source of reactor coolant samples for analysis of coolant system activity required by Technical Specifications, Section 3.4.6 and for coolant chemistry requirements specified in Section 3.4.1 of the Technical Requirements Manual. Reactor Coolant System activity analysis includes a determination of dose equivalent I-131 concentration which includes quantitative measurements for I-131, I-132, I-133, I-134, and I-135.

Operation of the Reactor Water Cleanup System is controlled from the Main Control Room. Resin-changing operations, which include backwashing and precoating, are controlled from a local control panel in the Reactor Building.

4.9.4 Inspection and Testing

The Reactor Water Cleanup System is normally in service. Satisfactory operation is demonstrated without the need for special testing. Periodic inspection and maintenance are carried out based on manufacturer's recommendations and sound maintenance practices.