4.0 REACTOR COOLANT SYSTEM

4.1 SUMMARY DESCRIPTION

The subsections in the "Reactor Coolant System" section describe those systems and components that form the major portions of the nuclear system process barrier. These systems and components contain or transport the fluids coming from or going to the reactor core.

The "Reactor Vessel and Appurtenances Mechanical Design" subsection describes the reactor vessel and the various fittings with which other systems are connected to the vessel. The major safety considerations for the reactor vessel are concerned with the ability of the vessel to function as a radioactive material barrier. Various combinations of structural loading are considered in the vessel design. The vessel meets the requirements of various applicable codes and criteria. The possibility of brittle fracture is considered, and suitable limits are established that avoid conditions where brittle fracture is possible. Periodic, cumulative-fatigue usage evaluations are performed for each reactor vessel to verify that the vessel does not approach usage limits.

The Reactor Recirculation System pumps coolant through the core. Adjustment of the core coolant flow rate changes reactor power output, thus providing a means of following plant load demand or manually changing reactor output without adjusting control rods. The recirculation system is designed with sufficient fluid and pump inertia that fuel thermal limits will not be exceeded as a result of recirculation system malfunctions. The arrangement of the recirculation system is designed so that a piping failure cannot compromise the integrity of the floodable inner volume of the reactor vessel.

The Nuclear System Pressure Relief System is designed to protect the nuclear system process barrier from damage due to overpressure. To accomplish overpressure protection a number of main steam relief valves are provided that can discharge steam from the nuclear system to the primary containment. The Nuclear System Pressure Relief System also acts to automatically depressurize the nuclear system in the event of a loss-of-coolant accidents in which the High Pressure Coolant Injection System (HPCIS) fails to deliver sufficient flow. The depressurization of the nuclear system allows low pressure Emergency Core Cooling Systems to supply enough cooling water to adequately cool the fuel. Six of the main steam relief valves used to provide overpressure protection are arranged to effect automatic depressurization.

The main steam line flow restrictors are venturi-type flow devices. One restrictor is installed in each main steam line close to the reactor vessel but downstream of the main steam relief valves. The restrictors are designed to limit the loss of coolant resulting from a main steam line break outside the primary containment. The

coolant loss is limited so that reactor vessel water level remains above the top of the core during the time required for the main steam isolation valves to close. This action protects the fuel barrier.

Two main steam isolation valves are installed on each main steam line. One valve in each line is located inside the primary containment, the other outside. These valves act automatically to close off the nuclear system process barrier in the event a pipe break occurs downstream of the valves. This action limits the loss of coolant and the release of radioactive materials from the nuclear system. In the event that a main steam line break occurs inside the primary containment, closure of the isolation valve outside the containment acts to seal the primary containment itself.

The Reactor Core Isolation Cooling System (RCICS) includes a turbine-pump driven by reactor vessel steam. Under certain conditions the system automatically starts in time to prevent the core from becoming uncovered without the use of the Core Standby Cooling Systems. The system provides the ability to cool the core during a reactor shutdown in which feedwater flow is not available.

The Residual Heat Removal System (RHRS) includes a number of pumps and heat exchangers that can be used to cool the nuclear system under a variety of situations. During normal shutdown and reactor servicing, the RHRS removes residual and decay heat. One operational mode of the RHRS is low pressure coolant injection (LPCI). LPCI operation is an engineered safeguard for use during a loss-of-coolant accident; this operation is described in Section 6.0, "Emergency Core Cooling Systems." Another mode of RHRS operation allows the removal of heat from the primary containment following a loss-of-coolant accident.

The Reactor Water Cleanup System functions to maintain the required purity of reactor coolant by circulating coolant through a system of filter/demineralizers.

The "Nuclear System Leakage Rate Limits" subsection establishes the limits on nuclear system leakage inside the primary containment so that appropriate action can be taken before the nuclear system process barrier is threatened by a crack large enough to propagate rapidly.

The main steam lines, feedwater piping, and their associated drains are attached to the reactor vessel and provide core coolant flow paths external to it. These lines penetrate the primary containment and specified portions of these lines must provide adequate nuclear system process barrier for normal and accident conditions.

Four steam lines are utilized between the reactor and the turbine which permit turbine stop valve and main steam isolation valve tests during plant operation with a minimum amount of load reduction. In addition, differential pressures on reactor internals under assumed accident conditions of a broken steam line are limited. Feedwater lines provide water to the reactor vessel entering near the top of the

vessel downcomer annulus. Drains are provided at the low point of each main steam line, at the reactor vessel bottom head, and on each side of the recirculation pumps.

The program for preoperational examination and periodic inservice examination of Reactor Coolant System is also defined.