5.3 THERMAL HYDRAULIC SYSTEM DESIGN

5.3.1 Analytical Methods and Data

The thermal and hydraulic design bases of the Reactor Coolant System (RCS) are described in Section 4.

5.3.2 Operating Restrictions on Pumps

The minimum net position suction head (NPSH) and minimum seal injection flow rate must be established before operating the reactor coolant pumps. Requirements are set forth in the pump operating instructions.

5.3.3 Temperature Power Operating Map

Reactor power is controlled to maintain average coolant temperature at a value which is a linear function of load.

5.3.4 Load Following Characteristics

Load following is discussed in Section 5.2.1.5.2.

5.3.5 Transient Effects

Transient effects on the RCS are evaluated in Section 15.

5.3.6 Thermal and Hydraulic Characteristics Summary Table

The thermal and hydraulic characteristics are given in Tables 4.3-1, 4.4-1, and 4.4-2.

5.3.7 Natural Circulation Capability

The capability to perform natural circulation cooldown has been analyzed following a transient in a Pressurized Water Reactor of different design in which significant void formation occurred in the reactor vessel head. The analysis took into account such factors as the amount of bypass flow to the upper head region, RCS cooldown/depressurization rate, heat removal via the Control Rod Drive Mechanism (CRDM) cooling fans and ambient losses. Salem is a "T-Hot" plant, i.e., one in which the upper head water temperature is assumed equal to the hot leg temperature. Analysis results are summarized below.

The average cooldown rate of the upper head fluid due to the 25°F per hour natural circulation cooldown rate is about 10°F per hour. The total upper head cooldown rate due to both the natural circulation cooldown and the CRDM fans varies from 31°F per hour initially to around 21°F per hour when the upper head temperature is cooled to 350°F. Thus, with the CRDM fans operating during the cooldown with no void formation occurring in the upper head area, the operator is required to maintain a minimum of 50°F subcooling during the depressurization.

A Salem-specific analysis has been performed to determine the natural circulation cooldown strategy to prevent void formation without CRDM fans in operation. Without the CRDM fans in operation, the plant can be cooled down to Residual Heat Removal (RHR) System conditions at a natural circulation cooldown rate of 25°F per hour with no void formation occurring in the upper head with appropriate precautions being taken by the operators. The operator is required to maintain a minimum of 50°F subcooling until the primary system pressure reaches 50 psi below the permissive to block SI. After the automatic safety injection signals are blocked, the operator establishes 200°F subcooling (approximately 430°F in the hot leg) and maintains at least 200°F subcooling (or the Technical Specification limit if it is more restrictive) to a primary system pressure of 1200 psig. Depressurization is stopped at 1200 psig and the cooldown is continued until the primary system temperature is less than 350°F. At this point, the operator is required to wait for approximately 8 hours to allow the upper head to cool off, corresponding to a saturation temperature less than the RHR cut-in pressure (325 psig). Finally, the primary system is depressurized to 325 psig and the RHR System used for further cooldown.

Unit 1 has Model-F steam generators which are similar in design to the Series 51 in natural circulation capabilities. Hence, the general conclusions drawn above are also applicable to Unit 1 with the Model-F steam generators. The Unit 2 AREVA NP Model 61/19T steam generators have adequate natural circulation capability to remove decay heat.