3.0 REACTOR

3.1 SUMMARY DESCRIPTION

The subsections included in the "Reactor" section describe and evaluate those systems most pertinent to the fuel barrier and the control of core reactivity. The "Fuel Mechanical Design" subsection describes the mechanical aspects of the fuel material (uranium dioxide), the fuel cladding, the fuel rods, and the arrangement of fuel rods in bundles. Of particular interest is the ability of the fuel to serve as the initial barrier to the release of radioactive material. The mechanical design of the fuel is sufficient to prevent the escape of significant amounts of radioactive material during normal modes of reactor operation.

The "Reactor Vessel Internals Mechanical Design" subsection describes both the arrangements of the supporting structure for the core and the reactor vessel internal components which are provided to properly distribute the coolant delivered to the reactor vessel. In addition to their main function of coolant distribution, the reactor vessel internals separate the moisture from the steam leaving the vessel and provide a floodable inner volume inside the reactor vessel that allows sufficient submergence of the core under accident conditions to prevent additional damage to the fuel and the gross release of fission products from the fuel. The reactor vessel internals are designed to allow the control rods and Core Standby Cooling Systems to perform their safety functions during abnormal operational transients and accidents.

The "Reactivity Control Mechanical Design" subsection describes the mechanical aspects of the moveable control rods. They are provided to control core reactivity. The Control Rod Drive Hydraulic System is designed so that sufficient energy is available to force the control rods into the core under conditions associated with abnormal operational transients and accidents. Control rod insertion speed is sufficient to prevent fuel damage as a result of any abnormal operational transient.

Control Rod Housing Supports are located underneath the reactor vessel near the control rod housings. These supports limit the travel of a control rod in the event that a control rod housing is ruptured. They prevent a significant nuclear excursion as a result of the housing failure, thus protecting the fuel barrier and the primary system.

The "Nuclear Design" subsection describes the nuclear aspects of the reactor. The design of the boiling water reactor core and fuel is based on a proper combination of design variables, such as moderator-to-fuel volume ratio, core power density, thermal-hydraulic characteristics, fuel exposure level, nuclear characteristics of the core and fuel, heat transfer, flow distribution, void content, heat flux, and operating pressure. All of these conditions are dynamic functions of operating conditions.

However, design analyses and calculations, verified by comparison with data from operating plants, are performed for specific steady state, transient, and accident conditions. Included in the “Nuclear Design” subsection are discussions of operating and shutdown reactivity control requirements. Also included are discussions of the reactivity coefficients and xenon characteristics of the core. Transient and accident analyses are discussed in Chapter 14, “Plant Safety Analysis.” Results of steady state, transient, and accident analyses for current reload core designs are contained in Appendix N.

The "Thermal and Hydraulic Design" subsection describes the thermal and hydraulic characteristics of the core. The low coolant saturation temperature, high heat transfer coefficient, and neutral water chemistry of the boiling water reactor are significant advantages in minimizing Zircaloy temperatures and associated temperature-dependent hydride pickup. This results in improved cladding performance at long exposures. The relatively uniform fuel cladding temperatures throughout the boiling water reactor core minimize migration of the hydrides to cold cladding zones and reduce the thermal stresses. A discussion of fuel failure mechanisms and the parameters associated with fuel damage is included in the subsection.

The "Standby Liquid Control System" provides a redundant, independent, and different way from the control rods to make the reactor subcritical, even in the cold condition. The Standby Liquid Control System is never expected to be needed because of the large number of control rods available to shut down the reactor. However, in the unlikely event that control rod insertion were to be impaired, the Standby Liquid Control System has the capability of bringing the reactor from rated power to cold shutdown (MODE 4) with the control rods remaining withdrawn in the rated power pattern.