ENCLOSURE

SEQUOYAH NUCLEAR PLANT

NATURAL CIRCULATION TEST

Demonstrate the Ability to Cooldown, Depressurize, and Boron Mix

Special Test 9B, Boron Mixing and Cooldown, was performed on unit 1 of Sequoyah Nuclear Plant after zero power physics testing.

1.0 Objective

A. To borate and verify uniform boron mixing while in natural circulation.

B. To demonstrate the capability to cool down and depressurize while in natural circulation.

C. To provide operator training in the natural circulation mode during a primary system boron addition and cooldown.

2.0 Results

With the reactor at approximately 2.5-percent power and natural circulation established, a slow boration of the reactor coolant system was started (2.7 gal/min) and allowed to run for a 2-hour period. Core exit thermocouple maps were run periodically to determine if a nonuniform boron distribution would develop in the core. Along with the T/C maps, the incore movable detectors (6) were positioned in the core at varying radial and axial positions.

The time delay from the initiation of the boron addition until the negative reactivity effects were observed in the core was approximately the same as in forced circulation (4-5 minutes). The traces from the incore detectors showed occasional indications of a slightly nonuniform distribution, but for the most part the flux levels recorded by the detectors trended consistently. The core exit thermocouple maps showed no indication of nonuniform distribution as again the exit temperature distribution was slightly better than in the full flow case.

After sampling the system to ensure adequate mixing, a slow cooldown was started and again thermocouple maps were taken periodically to detect, in this case, nonuniform temperature distributions during the cooldown. The overall temperature distribution remained very uniform throughout the cooldown with some indications of a slightly increased radial tilt as measured by the thermocouples. The thermocouple calculated tilt is not considered extremely accurate, but the trend of the tilt from 550°F to 450°F should be a relatively reliable indication of the direction of changes.

In the first performance of the test, the cooldown was accomplished using steam dump to the condenser. In the second performance, the main steam isolation valves were closed and the cooldown was accomplished using atmospheric relief valves. In this case, maintaining constant natural circulation in each loop proved to be difficult due to steaming off of individual steam generators at different times. When one steam generator was steamed off, the natural circulation flow would quickly increase in that loop and reduce in other loops. The best way to cool down proved to be positioning the relief and feedwater valves to give a continuous steam and feed flow and establishing consistent natural circulation flow in each loop rather than letting the automatic system control feedwater and steam flow.

During the cooldown, the indicated temperatures in the upper head, as indicated by the upper head thermocouples, were monitored closely to determine if the upper head temperatures would drop with system temperature under natural circulation. As seen in Figure 1, the upper head temperatures lagged the core exit and hot leg temperatures but followed the cooldown very well indicating that some natural circulation flow was reaching the upper head region.

3.0 Conclusions

Special Test 9B, Boron Mixing and Cooldown, demonstrated the ability to cool down and depressurize the plant and to demonstrate that boron mixing is sufficient under natural circulation circumstances. Approximately 300 gallons of boric acid were added during the first portion of the test. The results of the test showed that the boron mixing was as expected and better than adequate. The results also show that boron addition can be made satisfactorily to bring the unit to the cold shutdown xenon-free condition.

The second portion of the test demonstrated the ability to cool down and depressurize under such circumstances. Approximately 100°F of cooldown and 400 psig of depressurization were performed during the test. The results of this portion of the test demonstrated satisfactorily that the unit could be cooled down and depressurized from hot standby to hot shutdown under such circumstances. The results also showed that the upper head temperature followed the cooldown very well indicating that some natural circulation flow was reaching the upper head region.

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FIGURE 1

ST - 9B

NATURAL CIRCULATION COOLDOWN