INSPECTION PROCEDURE 61708

ISOTHERMAL AND MODERATOR TEMPERATURE COEFFICIENT DETERMINATIONS

PROGRAM APPLICABILITY: 2515 (SUPPLEMENTAL)

61708-01 PURPOSE

This procedure verifies that the licensee's determination of the moderator temperature coefficient (MTC) or the isothermal temperature coefficient (ITC) of core reactivity for pressurized water reactors is technically consistent with the predicted values and technical specification (TS) requirements.

61708-02 INSPECTION REQUIREMENTS

02.01 Ensure that the frequency of MTC (or ITC) determination was as prescribed by the TS.

02.02 Verify the completion of the prerequisites for the ITC measurement.

02.03 Verify licensee compliance with the ITC measurement test precautions.

02.04 Verify that the actual plant conditions established during the test were the same as those assumed in the analytical predictions.

02.05 Ensure that the MTC (or ITC) was calculated correctly and was within the limits established in the TS and the limits predicted by the vendor. If not within the TS required limits, verify the licensee followed the applicable action statement.

61708-03 INSPECTION GUIDANCE

General Guidance

a. The TS requirements for some licensees concern ITC rather than MTC determinations. The inspector should determine which inspection requirements are applicable to the licensee and utilize them as appropriate.

Due to the specific technical expertise required to properly perform core physics inspections, this inspection procedure should be conducted by regional inspectors during the startup physics testing at the beginning of core life (BOL) following each refueling. Thereafter in core life, the

resident inspectors should ensure compliance with these requirements, including the end of core life (EOL) determinations.

b. Background. The MTC is defined as the change in core reactivity per degree change in moderator temperature. The moderator is the pressurized water of the reactor coolant system (RCS). The MTC is calculated by measuring the ITC and subtracting the doppler temperature coefficient (DTC) from it.

The DTC is a measure of the nonthermal neutron resonance absorption cross-sections for U-238 and Pu-240. This value is supplied for each particular core by the fuel manufacturer.

The ITC represents the combined effects of temperature changes in the primary plant (moderator-MTC, fuel-DTC) on the net core reactivity. As temperature increases, the MTC will become more negative due to the moderator becoming less dense at an increasing rate, thereby reflecting fewer neutrons back into the core. The DTC will become more positive as temperature increases, for the resonance absorption cross-sections will flatten out and broaden, raising the likelihood of neutron absorption into the fuel.

c. Test Method. The methods for measuring ITC are not specified, but generally involve measuring and plotting flux level (core reactivity) with respect to various RCS temperatures. The slope of the plotted curve represents the measured ITC for the specific control rod configuration. At BOL, the core reactivity is measured using a reactivity computer. For EOL measurements, the reactor is normally at power above the point of adding heat (POAH). This renders interpretation of the output from the reactivity computer impossible due to prompt doppler feedback in response to power level changes. Therefore, the EOL measurements should be based upon observations of the average core temperature, boron concentration, and power level. These results should be evaluated using the calculated values for the DTC, experimentally verified values of boron worth, and reactor power levels determined by precise heat balances. The change in reactivity due to the temperature changes is determined to give the ITC. The MTC is then obtained by subtracting the DTC from the ITC.

03.01 Specific Guidance

a. Inspection Requirement 02.01

1. The regulatory basis requiring the performance of the MTC (or ITC) determination is provided by the TS. Licensees have also committed to the performance of these tests in Chapter 14 of the Updated Final Safety Analysis Report.

2. Generally, the minimum frequencies required by TS for these determinations include, but are not limited to the following:

(a) prior to initial operation above 5% rated thermal power after each fuel loading.

(b) within 7 EFPD after reaching an equilibrium boron concentration of 300 ppm.

b. Inspection Requirement 02.02. Typical ITC measurement test prerequisites should include:

1. (a) At BOL, reactor power in the startup range, but less than the POAH. This ensures that changes in RCS temperature will visibly affect the net reactivity, but that the RCS temperature will not change due to neutron flux (i.e., the reactor will not heat up the plant).

(b) At EOL, reactor power at any thermal power as permitted by TS (generally above the POAH).

2. Control rod position, boron concentrations, RCS temperature, pressure and flow rate within set reference bands. Maintenance of plant parameters within these bands is necessary to ensure that reactivity changes due to plant conditions differing from the reference won't result in an erroneous MTC determination.

3. RCS heatup and cooldown rates less than the specified maximum in order to ensure that the primary is isothermal. That is, the equilibrium plant condition where fuel and RCS temperatures are approximately equivalent.

4. Reactor trip setpoints for the operable intermediate and power range nuclear instruments (IRNI and PRNI) are set less than or equal to 25% of rated thermal power.

5. A channel functional test for each IRNI and PRNI shall have been completed satisfactorily within 12 hours prior to initiating the physics tests or reactor startup.

c. Inspection Requirement 02.03

1. If rated thermal power exceeded the maximum allowed setpoint for physics testing, ensure all reactor trip breakers were opened. This power level is specified in the TS and should also be given in the ITC measurement test procedure.

2. Verify that the plant was stabilized before test data was taken.

3. Rod shimming should have been avoided. If rods were shimmed, verify that it was performed in one steady motion and that the rod positions before and after the shim were recorded.

d. Inspection Requirement 02.04. The closer plant conditions are to the reference values at the time of data taking, the less

likely that reactivity errors will be introduced which will adversely affect the accuracy of the test results. Random changes in these conditions would require the interpolation of the test data to determine MTC, a process which is not always very precise, thereby increasing the likelihood of an inaccurate MTC determination.

e. Inspection Requirement 02.05

1. If the MTC (or ITC) is not within the required limits, the licensee is generally required by TS to return it to within its limits or shutdown to hot standby within six hours.

2. It is possible for the MTC (or ITC) to meet the TS required limits but not the vendor predicted values. In this situation, required licensee actions are dependent upon the commitments made in the Core Reload Topical Analysis Report.

61708-04 REFERENCES

ANS 19.6.1, Draft 9, "Reload Startup Physics Tests for Pressurized Water Reactors," December 1984.

END