INSPECTION PROCEDURE 61709

TOTAL POWER COEFFICIENT OF REACTIVITY AT PRESSURIZED WATER REACTORS

PROGRAM APPLICABILITY: 2514, 2515 (Supplemental)

61709-01 INSPECTION OBJECTIVES

01.01 To verify that total power coefficient of reactivity measurements follow license commitments (e.g., ANSI Standards, Initial Core Load or Core Reload Analysis Reports) and are in compliance with Technical Specifications (TS).

01.02 To verify that total power coefficient measurements are conducted in accordance with licensee procedures, are correct, and are within their acceptance criteria.

61709-02 INSPECTION REQUIREMENTS

02.01 Review the licensee's procedures for measuring the total power coefficient of reactivity. Determine the adequacy of these procedures by comparing them to the license commitment documents of 01.01 above.

02.02 Review the retained records for recent total power coefficient measurements. If possible, observe actual measurements as they are conducted. Verify that:

a. Prerequisites and initial conditions were met.

b. Precautions and limitations were observed.

c. Plant conditions were maintained as specified in the procedure. Verify that changes or relaxations of plant conditions were approved in accordance with TS and by the appropriate licensee personnel.

   Also verify that any other procedural deviations were similarly approved.

d. Calculations of total power coefficient were performed correctly, including the application of necessary correction factors.

e. Values obtained for total power coefficient were within the acceptance criteria generated from analytical predictions of core reactivity.

f. The licensee has properly resolved any discrepancies between actual measurements and the predicted coefficient values.

General Guidance

a. The total power coefficient of reactivity is always measured following initial core load during the startup phase for a PWR. Although though this measurement typically is not conducted following core reloads at PWRs, it is possible that this measurement would be necessary if a core reload departed markedly from typical fuel and poison loadings.

b. The total power coefficient is used to confirm the predicted rates of boration and dilution required to achieve the ramped moderator temperature program. The ramped moderator temperature program maintains turbine steam supply pressure at its hot zero-power value. As a result, turbine efficiency is enhanced and turbine blading damage is reduced.

c. The total power coefficient reflects the combined reactivity effects of the moderator temperature coefficient (MTC) and Doppler-only fuel temperature) power coefficient.

    1. The moderator temperature coefficient describes the change in core reactivity resulting from a change in average core moderator (coolant) temperature.

    2. The Doppler-only power coefficient also contributes to the total power coefficient. Because of resonance neutron absorption effects, negative reactivity is added to the core as fuel temperatures rise. Fuel temperatures increase markedly above moderator temperatures as reactor power level increases. Although incremental reactivity changes resulting from fuel temperature changes are small, marked fuel temperature changes occur in a reactor core when reactor power changes. Therefore, the reactivity effects of the Doppler-only power coefficient are significant.

d. The total power coefficient of reactivity is typically measured at four power levels (e.g., 35, 50, 75 and 90%). The testing usually involves multiple data gathering transients at each power level. Strip chart recorders are used to obtain temperature and other data required for calculations. Calorimetric data and coolant samples are taken to confirm reactor power and boron reactivity levels.

e. There are three major procedures conducted to measure the total power coefficient of reactivity.

    1. Moderator Temperature Coefficient Determination. Moderator temperature undergoes ramped changes in response to operator-initiated reactivity changes at constant turbine load. Doppler reactivity effects are near zero since reactor power level remains essentially constant. This procedure isolates the effects of the moderator temperature coefficient.

2. Doppler-only Power Coefficient Determination. Reactor power undergoes ramped changes in response to turbine load changes. Operator-initiated reactivity changes maintain moderator temperature essentially constant. Moderator reactivity effects are near zero. This procedure isolates the effects of the Doppler-only power coefficient. The Doppler-only power coefficient, together with the value of moderator temperature coefficient from 03.01e.1 and the curve for the moderator temperature versus reactor power level program, can be used to calculate an expected value for total power coefficient.

3. Total Power Coefficient Determination. The total power coefficient is directly determined by conducting ramped changes in turbine load while using operator-initiated reactivity changes to follow a ramped moderator temperature program. If xenon changes are taken into account, the negative of the reactivity associated with the operator-initiated reactivity changes is a direct measurement of the total power coefficient reactivity defect for the power change.

f. This inspection procedure should be performed during the startup physics testing sequence for each refueling outage.

03.01 Specific Guidance

a. Inspection Requirement 02.02a. Typical prerequisites and initial conditions for this measurement are as follows:

1. Operational alignment of the neutron monitoring system has been satisfactorily completed.

2. The reactivity computer is installed and operational.

3. Strip chart recorders are installed as required by the licensee's procedure.

4. Chemistry support is available to sample boron concentration at the required intervals and locations.

5. The reactor is critical and the plant is ready to follow turbine load changes. For example, pressurizer level is in the normal operating band and steam generator level control is in automatic.

6. Actual control rod bank configuration is as required by the licensee's procedure.

7. The detailed reactor power history for the most recent 48-hour period is available.

8. A reactor thermal power measurement (calorimetric) has been conducted.

9. Control rod worth curves are available.

b. Inspection Requirement 02.02b. Typical precautions and limitations are as follows:

1. a limitation on the maximum rate of change of reactor power

2. control bands to be observed for reactor coolant system temperature and pressure

3. a maximum reactor power limit

4. positive adherence to unrelaxed core parameter requirements such as hot channel factor or radial or axial flux peaking limits

5. awareness and understanding of applicable TS requirements (e.g., group rod height and rod insertion limits)

6. avoidance of primary system makeup during transients

61709-04 REFERENCES

Technical Specifications

Initial Core Load Analysis Report, or

Core Reload Analysis Report

Applicable Fuel Vendor Reports

ANS-19.6.1, "American National Standard Reload Startup Physics Tests for Pressurized Water Reactors," (1985)

END