INSPECTION PROCEDURE 61707

DETERMINATION OF REACTOR SHUTDOWN MARGIN

PROGRAM APPLICABILITY: 2515 (MINIMUM, SUPPLEMENTAL), 2525

61707-01 INSPECTION OBJECTIVES

01.01 To determine that the licensee is ensuring adequate shutdown margin throughout the operating cycle.

*01.02 To verify that changes in shutdown margin due to inoperable control rods have been properly addressed.

61707-02 INSPECTION REQUIREMENTS

02.01 PWR Inspection Requirements

a. Review the licensee's shutdown margin determination procedure for technical adequacy.

b. Determine that shutdown margin calculations have been performed at the frequency specified in the plant's technical specifications (TS) since the last refueling outage.

c. Verify the following for shutdown margin determinations made since the last refueling outage, or made in the last 6 months while in the applicable TS mode, whichever is less:

*1. The most recent critical conditions prior to the shutdown were accurately recorded.

*2. The calculations to assess the reactivity contributions to the total core reactivity change were correctly performed for the following parameters:

(a) boron concentration

(b) full-length control rod bank worth changes as a result of position, boration, etc.

* Minimum inspection program.

(c) shutdown bank rods

(d) part-length rods (if in use, verify that their operational status was reflected in the shutdown margin allowance)

(e) temperature

(f) power level

(g) xenon concentration

(h) samarium and other fission product concentrations

(i) fuel burnup and burnable poison depletion

*3. The results of the shutdown margin calculation met the conditions prescribed by the TS.

*4. Changes made in boron concentration as a consequence of the shutdown margin calculation were properly verified by chemical analysis.

*d. Evaluate the licensee's analysis of a condition where the shutdown margin could not be met and evaluate the adequacy of corrective actions that were taken.

e. Review the results of the licensee's procedure for demonstrating agreement between the overall core reactivity balance and the predicted values for surveillance tests performed since the last refueling or in the last 6 months while in the applicable TS mode, whichever is less.

1. Verify that the determination was made at the periodicity required by TS.

2. Verify that the determination was made using the parameters required by TS.

3. Verify that the normalization of the predicted reactivity values was accomplished within the timeframe required by TS.

f. Verify that the licensee has reviewed all data supplied by the fuel vendor that is used in the shutdown margin determination.

02.02 <u>BWR and HTGR Inspection Requirements</u>

a. Review the licensee's shutdown margin procedure for technical adequacy.

b. Examine the shutdown margin determination made at the beginning of the current operating cycle to determine if results are in agreement with TS requirements.

c. Verify the correctness of the calculations made to determine the amount of control rod withdrawal required to correspond to the specified shutdown margin.

d. Verify that the licensee has reviewed all data supplied by the fuel vendor that is used in the shutdown margin determination.

*e. Verify that a shutdown margin determination was performed after any recent incidence of the inability of a control rod to insert and that the results met the conditions prescribed by TS.

*f. Examine the licensee's analysis of a condition where the shutdown margin could not be met and evaluate the adequacy of corrective actions that were taken.

g. Review the results of the licensee's procedure for demonstrating agreement between the overall core reactivity balance and the predicted values (reactivity anomaly surveillance) for tests performed since the last refueling or in the last 6 months while in the applicable TS mode, whichever is less.

    1. Verify that the determination was made at the periodicity required by TS.

    2. Verify that the determination was made using the parameters required by TS.

    3. Verify that the normalization of the predicted reactivity values was accomplished within the timeframe required by TS.

61707-03 INSPECTION GUIDANCE

General Guidance. Because residents are generalists and do not have extensive experience and technical expertise in the core physics field, the majority of this inspection procedure should be performed by regional inspectors during the startup physics testing sequence for each refueling outage. Residents should, however, be called upon to conduct the asterisked inspection requirements to ensure TS compliance in the event of an inoperable control rod. Residents are best able to perform these inspection requirements because they can readily respond due to their location onsite, and TS compliance can easily be determined without a detailed core physics background.

03.01 Specific Guidance

a. Inspection Requirement 02.01c2. The basic computation performed to determine the reactivity change associated with each parameter is to multiply the reactivity coefficient of each parameter by the parameter's change in going from the most recent critical condition to the shutdown condition. The inspector should be aware that the "most recent critical" condition may not truly be what these words imply. For instance, occasionally a startup following an outage is made in which criticality is reached and maintained for a brief

period of time followed by a shutdown. Although this would truly represent the "most recent critical" condition, it would be incorrect to assess this as representative of core reactivity conditions. Rather, the equilibrium condition for the extended pre-outage power history would be most representative of core conditions and, therefore, should be used as the "most recent critical" condition for deriving data for the determination of shutdown margin.

Reactivity coefficients (or reactivity values) for the various parameters are normally obtained from curves found in the plant's technical data book. The inspector should verify that the curves used for obtaining the reactivity values are the most current and up-to-date and that the values observed were applied correctly in the shutdown margin determination. In addition, the inspector should verify that the curves were approved by the onsite review committee and plant manager. Ensure that the curves are controlled and so marked. The inspector should verify that the sign convention for reactivity used in the licensee's calculations is consistent throughout.

b. Inspection Requirement 02.01c4. If the available shutdown margin resulting from the total reactivity change is insufficient to meet TS requirements, an additional amount of negative reactivity in the form of boration of the reactor coolant system must be added. A calculation of the boron concentration needed to meet the required shutdown margin must be performed. Some procedures require these calculations to be independently checked. Should this be the case, the inspector should verify that the calculational check was accomplished pursuant to this requirement.

c. Inspection Requirement 02.02a. Historically BWRs have used two types of shutdown margin tests to demonstrate compliance with TS requirements. One type involves withdrawing the strongest control rod plus additional rod(s) with a calculated worth equal to or greater than the required margin. The other type (most common) is performed by pulling the strongest control rod plus additional rods until criticality is achieved. This method, recommended by GE, is termed the In-sequence Critical Demonstration. This involves pulling rods in the normal startup sequence. Table 11-1 in GE Station Nuclear Engineering Manual (NEDO-24810A, Volume 1) provides a worksheet for making calculations using this method.

d. Inspection Requirement 02.02b. Shutdown margin must be demonstrated at the beginning of cycle (BOC). For BWRs, if the core reactivity exhibits an increase with exposure (defined as the R-value) due to burnable poisons, the inspector should verify that an additional increment of shutdown margin equal to this increase was demonstrated at BOC.

e. Inspection Requirements 02.01f. and 02.02d. Data provided by the fuel vendor normally includes new core loading pattern, location of highest-worth control rod, rod worth curves, and

increase in core reactivity with exposure for BWRs (R-value). If rod worth curves, boron worth curves, or xenon values supplied by the fuel vendor have been adjusted by the licensee, the inspector should determine the reason for and validity of this adjustment.

f. Inspection Requirements 02.01d. and 02.02f. Under circumstances where the shutdown margin cannot be met, the following items, which could cause the anomolous conditions, should be checked:

1. rod drifting

2. fuel assembly positions

3. water temperature

4. water chemistry (boron carbide tubes in BWRs may have ruptured, or water coolant tube rupture in HTGRs may introduce water into the helium coolant system and graphite moderator)

5. manufacturing (manufacturing records should be matched against actual fuel)

Specific action on the part of the licensee is prescribed by the plant's TS. The inspector should verify that the required action was taken.

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