EVALUATION OF PART B OF
WESTINGHOUSE PROPRIETARY REPORT NS-EPR-2649,
"THE F_Q SURVEILLANCE TECHNICAL SPECIFICATION"
(TACS 48818)

By letter dated August 31, 1982 Westinghouse Electric Corporation submitted Document NS-EPR-2649 for review. The Reactor Physics Section of the Core Performance Branch has reviewed Part B of this document entitled "The F_Q Surveillance Technical Specification" and prepared the following evaluation. The evaluation of Part A of this document will be presented separately.

1. Description of Document

This document describes an alternative to the present technique for performing surveillance on the value of the total power peaking factor F_Q in the core.

Currently periodic plant surveillance on the height dependent radial peaking factor, $F_{xy}(Z)$, is required as partial verification that operation will not cause the $F_Q(Z)$ limit to be exceeded. The remaining verification is provided by operation within the CAOC procedures and rod insertion limits. The proposed procedure replaces the $F_{xy}(Z)$ surveillance with a measurement of steady state $F_Q(Z)$ and multiplication of the measured value by a factor, W(Z), which accounts for plant maneuvers within the restriction on axial flux difference and rod insertion permitted by the Technical Specifications. The product of the measured $F_Q^M(Z)$ and the analytically determined W(Z) is then compared to the $F_Q(Z)$ limit. Before forming the product a measurement uncertainty is added to $F_Q^M(Z)$.

The procedure may be applied to plants which use either constant axial offset control or relaxed axial offset control. In either case the W(Z) factor is developed from the series of calculations used to establish the flux imbalance limits. W(Z) is defined as

$$W(Z) = \frac{(F_Q(Z) \times P) \text{ maximum, simulated transient}}{(F_Q(Z) \times P) \text{ equilibrium}}$$

Where P is core power.

Changes in the core power distribution caused by control rod insertion, power level changes, and axial and radial xenon transients are all included in W(Z). For plants using CAOC operation the W(Z) function is determined by analyzing a full range of power shapes occurring from simulation of typical load follow operations. For a plant with RAOC operation the power shapes used in the normal operation analysis are used.

2. Summary of Evaluation

The following discussion summarizes our evaluation of the proposed F_Q surveillance Technical Specification.

The revised procedure accomplishes the same purpose as the procedure it replaces. The calculational component of the new procedure is less than that of the old since only the change in axial shape is included as compared to the previous entire axial shape. The measurement uncertainty employed is the previously accepted value for F_Q measurements.

A sufficient number of calculations is performed to permit the conclusion that there is a high probability that the W(Z) function will be bounding.

The proposal to submit the W(Z) curve in a Peaking Factor Limit Report is consistent with present practice with respect to the F_{xy} surveillance and is acceptable.

The procedures used to account for possible increases in $F_Q(Z)$ between measurements are similar to those currently used and are acceptable.

3. Evaluation Procedure

The evaluation of report NS-EPR-2649, Part B has been performed within the guidelines provided in the Standard Review Plan, Section 4.3 for methods and procedures. Enough information is provided to permit a knowledgeable person to conclude that the surveillance procedure described in the report is adequate to accomplish its purpose and that the analyses performed to implement the procedure provide a high degree of confidence that the $F_Q(Z)$ limit will not be exceeded during normal plant operation.

4. Regulatory Position

Based on its review, which is described above, the staff concludes that the proposed F_Q surveillance Technical Specification is an acceptable means of meeting the requirements for surveillance of this parameter. Further, report NS-EPR-2649, Part B may be used as a reference to support its use.

EVALUATION OF PART A
OF WESTINGHOUSE PROPRIETARY DOCUMENT NS-EPR-2649,
"RELAXATION OF CONSTANT AXIAL OFFSET CONTROL"
(TACS 48817)

By letter dated August 31, 1982 Westinghouse Electric Corporation submitted document NS-EPR-2649 for review. The Reactor Physics Section of the Core Performance Branch has reviewed Part A of this document entitled "Relaxation of Constant Axial Offset Control" and prepared the following evaluation. The evaluation of Part B of the document will be presented separately.

1. Description of Report

Axial power distribution control in Westinghouse reactors is currently achieved by following the Constant Axial Offset Control (CAOC) procedure. This procedure requires that the axial offset be kept within a narrow band (typically ±5 percent) about a target value during normal plant operation-including power change maneuvers - in order to ensure that unallowed power shapes do not occur. For some plants for which the LOCA analysis yields high values of permitted peaking factors significant margin exists between these values and those produced by the CAOC operating procedure. Some plants have employed wider operating bands within the CAOC procedure but still must follow the procedure. NS-EPR-2649 proposes to replace the CAOC with the Relaxed Axial Offset Control (RAOC) procedure.

The presence of margin to limits with the CAOC procedure implies that the allowed value of ΔI, the axial flux difference (difference between the upper and lower excore detector readings) may be increased, particularly at lower power. The result of the RAOC procedure is a curve of allowed ΔI as a function of power. The report provides the details of the manner in which the curve is constructed.

The procedure begins by constructing a xenon distribution library. Selected xenon transients are calculated and the resulting axial xenon distributions are characterized by certain parameters. These parameters are stored and the xenon distribution reconstructed from them when required. The allowed xenon distributions are limited to those for which the core ΔI values remain within tentatively chosen limits which are wider than the expected LOCA limits. Xenon libraries are prepared for BOL, MOL, and EOL burnup.

The next step in the procedure is the normal operation analysis. The only constraints employed are the rod insertion limits and the tentative ΔI limits. One dimensional calculations are performed at BOL, MOL, and EOL for a number of power levels and for xenon distributions throughout the range of the xenon library. The axial power distribution is recorded for each case. Each power shape generated is examined to see if LOCA limits are met or exceeded. The standard Westinghouse synthesis method is used. The result of this examination is a ΔI range as a function of power which meets the LOCA limits. The power shapes within this range are then examined to ascertain whether they meet the thermal-hydraulic constraints imposed by the loss of flow accident (LOFA) and the limits are revised accordingly.

The effect of the widened ΔI band on the consequences of anticipated transients is next investigated. The cool down event, control rod withdrawal event and boration/dilution event are investigated for each reload. Sensitivity studies for other events have shown that reanalysis is not required. The analyses consist of choosing initial power distributions from the allowed power-ΔI domain, being careful to include the entire domain and performing the transient calculation with each distribution. The axial power shapes are preserved from each "snapshot" in the event, and core peaking factors are synthesized by the standard procedure. The results are examined for violations of peak power and DNB limits. If required the overtemperature-delta temperature (OTΔT) or overpower-delta temperature (OPΔT) trips may be altered to provide protection by changing the F(ΔI) penalty function in the trips. Alternatively the ΔI operating band may be further restricted to limit the initial conditions.

Application of the RAOC to a particular reactor requires alteration of its Technical Specifications. Sample revised Technical Specifications are presented in the report. All reference to the CAOC is removed from the specifications and replaced by a single curve, Figure 3.2-1, of Axial Flux Difference (ΔI) as a function of power. Specification 3.2.1 requires that ΔI be maintained within the allowed operations space on the Figure. Surveillance requirements are similar to those for other alarmed limits.

2. Summary of Evaluation

The following discussion summarizes the evaluation of report NS-EPR-2649, Part A.

The xenon distribution reconstruction model makes use of standard procedures for such applications. The procedure has been verified by comparison of reconstructed distributions to the original and shown to be within acceptable limits. In particular the axial offset and axial peaking factors are reproduced to within one percent or less. We conclude that the reconstruction model adequately represents the xenon axial distributions used in the analysis.

The xenon distributions used in the analyses are obtained from xenon transient calculations which are chosen to bound any that might occur in reactor operation. The transients are initiated by step changes in power which tend to exacerbate the resulting power swings. We conclude that an adequate library of xenon distribution shapes is created.

The procedure used to obtain the ΔI band limits for the normal operation limited events (LOCA and LOFA) is straightforward and acceptable. A sufficiently large sample of power shapes is examined to assure, with high probability, that limiting shapes have been sampled. The synthesis method used to determine whether LOCA constraints are met or exceeded is the standard Westinghouse procedure and is acceptable. The thermal-hydraulic methods used to perform the DNB comparisons for the loss of flow accident are similar to those used for the same analysis in the CAOC methodology and are acceptable.

The procedures employed in the determination of whether the allowed power shapes obtained from the normal operation analysis lead to acceptable consequences for Condition II events is straightforward and acceptable. We conclude that a sufficient set of events and starting conditions are analyzed to provide a high degree of confidence that the consequences of Condition II events are acceptable after alteration of the permitted ΔI band or the DNB trip algorithms.

The rather involved CAOC Technical Specification is replaced by a specification that merely requires that the axial flux difference (ΔI) be maintained with the acceptable band as a function of power. Upon discovery that the band limits have been exceeded (a computer alarm is provided) the operator must restore ΔI to within limits within fifteen minutes or reduce power to less than 50 percent of full power. This is an acceptable specification. The surveillance requirement discusses the frequency of verification of ΔI as a function of the status of the alarm. This is typical of such specifications and is acceptable.

3. Evaluation Procedure

The evaluation of report NS-EPR-2649, Part A has been performed under guidelines for methods and procedures provided in Section 4.3 of the Standard Review Plan. Enough information is provided to permit a knowledgeable person to conclude that the procedure described is adequate to accomplish its purposes and that the analyses performed to implement and verify its suitability are state-of-art and are acceptable.

4. Regulatory Position

Based on its review, which is described above, the staff concludes that the Relaxed Axial Offset Control procedure is an acceptable method for power distribution control in Westinghouse designed pressurized water reactors. The staff further concludes that report NS-EPR-2649, Part A may be used as a reference to describe the method and suppert its use.