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Salenas, Conran

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NOV 3 1988

MEMORANDUM FOR: Edward L. Jordan, Director
Office for Analysis and Evaluation
of Operational Data

FROM: James H. Sniezek, Deputy Director
Office of Nuclear Reactor Regulation

SUBJECT: WAIVER OF CRGR REVIEW OF BAW-10163P, "CORE OPERATING LIMIT METHODOLOGY FOR WESTINGHOUSE DESIGNED PWRs"

Enclosed is a safety evaluation prepared by NRR for acceptance of the Babcock and Wilcox (B&W) topical report BAW-10163P, which describes a core operating limit methodology for Westinghouse designed reactors. A similar methodology for application to B&W cores was presented in BAW-10122P, which has been approved by the NRC. The subject topical extends the statistical design method for application in the B&W licensing of reload fuel for Westinghouse designed reactors. We propose that CRGR review of this evaluation be waived.

The methodologies used in the BAW-10163P are not new to the staff. They are generally variations of frequently used, standard methodologies. The details of the method used in BAW-10163P have been described in a previous B&W report (BAW-10122P) which has been reviewed and approved. The present report provides the justification for the B&W use of the methodology for the core physics calculations necessary for the B&W design and analysis of fuel reloads of Westinghouse designed reactors. The material in the BAW-10163P does not explore significant or new technical areas. There is no new NRC position involved in accepting the approval of this thermal-hydraulic design method.

Based on the CRGR charter, all staff approvals of topical reports should be reviewed by the CRGR. However, since this report does not present any new methodology or require new staff positions, but merely presents a specific extension of an approved methodology, we believe that CRGR review is not necessary. If you find that CRGR review is necessary, please inform us and an appropriate CRGR package will be prepared.

James H. Sniezek

James H. Sniezek, Deputy Director
Office of Nuclear Reactor Regulation

Enclosure:
As stated

Contact: L. Lois, SRXB
Ext. 20890

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Mr. J. H. Taylor, Manager
Licensing Service
Babcock and Wilcox Company, Inc.
3315 Old Forest Road
P. O. Box 10935
Lynchburg, VA 24506-0935

Dear Mr. Taylor:

SUBJECT: ACCEPTANCE FOR REFERENCING OF TOPICAL REPORT BAW-10163 "CORE OPERATING LIMIT METHODOLOGY FOR WESTINGHOUSE DESIGNED PWRs" JULY 1987 (TAC NO. 65982)

The staff has completed its review of the "Core Operating Limit Methodology for Westinghouse Design PWRs," submitted by the Babcock and Wilcox Corporation by letter dated July 23, 1987. Additional information was submitted on May 12, 1988. This topical report provides the methodology and justification for generating Limiting Conditions of Operation (LCOs) and Limiting Safety System Settings (LSSSs) for Westinghouse (W) designed PWRs. The LSSSs considered in the report are the overpower-ΔT (OPΔT) and overtemperature-ΔT (OTΔT) trip setpoints which protect the core from centerline fuel melt and departure from nucleate boiling. The topical report BAW-10122P presented a similar methodology for application to B&W cores. The subject topical report extends the core operating limit methodology for application in the B&W licensing of reload fuel for Westinghouse designed reactors.

We find the application of BAW-10163P to be acceptable for referencing in license applications to the extent specified and under the limitations delineated in BAW-10163P and the associated NRC technical evaluation. The evaluation defines the basis for acceptance of this topical report.

We do not intend to repeat our review of the matters described in BAW-10163P and found acceptable when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to the matters described in the application of BAW-10163P.

In accordance with procedures established in NUREG-0390, it is requested that Babcock and Wilcox publish accepted versions of this topical report, proprietary and non-proprietary, within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed evaluation between the title page and the abstract. The accepted versions shall include an -A (designating accepted) following the report identification symbol.

Should our criteria or regulations change such that our conclusions as to the acceptability of the report are invalidated, Babcock and Wilcox and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued effective applicability of the topical report without revision of their respective documentation.

Sincerely,

Ashok C. Thadani, Assistant Director
for Systems
Division of Engineering & Systems Technology

Enclosure:
BAW-10163P Evaluation

ENCLOSURE

SAFETY EVALUATION FOR THE TOPICAL REPORT BAW-10163P

1.0 INTRODUCTION

By letter dated July 23, 1987, from J. H. Taylor to T. E. Murley, the Babcock and Wilcox (B&W) Corporation submitted the topical report BAW-10163P for NRC review. Additional information was submitted on May 12, 1988 (Ref. 1). This topical report provides the methodology and justification for generating Limiting Conditions of Operation (LCOs) and Limiting Safety System Settings (LSSSs) for Westinghouse (W) designed PWRs. The LSSSs considered in the report are the overpower-ΔT (OPΔT) and overtemperature-ΔT (OTΔT) trip setpoints which protect the core from centerline fuel melt and departure from nucleate boiling. The LCOs consist of limits on the control rod bank positions, and the axial flux difference alarm setpoints. These preserve the initial condition peaking criteria required by the loss of coolant accident (LOCA) and the ejected rod worth and shutdown margin reactivity limits.

The topical report BAW-10122 presented a similar methodology for application to B&W cores. The subject topical report extends the statistical design technique for application in the B&W licensing of reload fuel for Westinghouse designed reactors.

The following evaluation incorporates our consultant's (BNL) contribution to this review. The applicable restrictions in the application of this topical are listed in Section 3.4.

2.0 SUMMARY OF TOPICAL REPORT

The major chapters of the report describe the criteria that are used to establish the LCOs and LSSSs, how the limits are obtained, and the comparisons that are employed in the surveillance monitoring to assure that operating and safety limits are preserved. A brief description of the neutronics computer codes used in the power distribution and peaking factor analyses is also presented, along with a discussion of the uncertainties applied to measurements. Sample Technical Specifications and a peaking factor limit report format employed in the implementation of the proposed methodology are also presented. An example application with calculated and simulated measured power distributions is given to illustrate how the proposed approach would be used to determine the limits and in the course of monitoring adherence to the technical specification limits.

2.1 Criteria used in Determining Limiting Conditions for Operation

The limiting conditions for operations (LCOs) consist of power peaking and reactivity based limits.

The power peaking limits are determined such that the consequences of a postulated loss-of-coolant accident (LOCA) or loss-of-flow accident (LOFA) remain acceptable. This is achieved by limiting the total or radial/axial peaking prior to the occurrence of such an accident.

The LOCA limits analysis involves consideration of all phases of the accident coupled with fuel rod heatup calculations, and results in limits on the initial condition total peaking as a function of core height.

The LOFA limits analysis involves generating curves of maximum allowable peaking (MAP) which represent allowable combinations of local radial peaking and axial peaking, as a function of elevation, that yield the design minimum departure from nucleate boiling ratio (DNBR) at specified inlet conditions. The MAP are based on a statistical DNB design limit.

The reactivity based LCO limits define control bank insertion limits as a function of power level such that the required shutdown margin criterion is preserved at all times, and the consequences of postulated rod ejection accident involving the most reactive control rod assembly in any control rod configuration is acceptable.

2.2 Criteria used in Determining Limiting Safety Systems Settings (LSSS)

Protection against centerline fuel melting (CFM) and DNB during steady-state and transient conditions are provided by the OPΔT and OTΔT trips respectively. These trips contain a term, f(ΔI), which is a function of the axial flux difference (AFD) and reduces the OPΔT and OTΔT setpoints for power distributions which exceed predetermined AFD limits. (The AFD is a measure of the degree of skewness in the axial power distribution about the core midplane).

The LSSS f(ΔI) function is based on limiting the maximum fuel linear heat rate so that CFM does not occur, and the DNBR is maintained above the design limit. The DNBR limit is based on a 95/95 criterion in the DNB correlation and associated uncertainties, or a probability of less than 0.1% fuel failure for the entire core, whichever is more restrictive.

The DNB related analyses involve the determination of the dependence of DNBR on system pressure and coolant inlet temperature at various power levels, and therefore defines the allowable power as a function of inlet temperature at various system pressures. The resulting core protection safety limit curves form the basis of the OTΔT and OPΔT trip functions. Power peaking limits at design overpower conditions are obtained from MAPs generated from limiting statepoints on the safety limit curves at power levels up to 118% of full power.

2.3 Derivation of Operating Limits

The determination of the LCO involves defining limits on the AFD that preclude operation above the LOCA and LOFA-DNB peaking limits, and evaluating the ejected rod worths and shutdown margins at the LCO to ensure that they are within the bounds required by the safety analysis. Power distributions throughout core life are generated with the FLAME3 code in three-dimensional geometry and including the affects of thermal feedback. The model is normalized prior to generating limiting power distributions by adjusting the radial albedos on the basis of comparisons to two-dimensional PDQ and/or three-dimensional NOODLE calculations. Various Xenon transients are simulated to determine the limiting transient Xenon power distribution, and extremes of core operation and possibly operation at reduced flow or temperature are also considered. Xenon factors which adequately represent the impact of transient Xenon are defined to bound the margin calculated for a transient Xenon case with a power distribution assuming equilibrium Xenon. Separate factors are determined for LOCA and LOFA-DNB margin calculations, and verified for each fuel cycle design by comparing results from limiting Xenon transients to those obtained from augmented equilibrium cases.

The limits on the AFD are determined by evaluating the peaking margins associated with the transient and equilibrium power distributions. The peaking margin is obtained by defining augmented total and radial peaking factors which include the calculational uncertainty, and an allowance for such operational variables as quadrant tilt. These are compared to allowable limits, and when correlated with the associated axial flux difference, appropriate AFD limits can be determined such that the allowable peaking limits imposed by LOCA and LOFA are not violated during operation.

Reactivity-based LCO limits are based on ejected rod worth and shutdown margin requirements. These are obtained in a manner similar to that described in Ref. 1. If existing insertion limits are not conservative, they are redefined to assure that the required criteria are satisfied.

The LSSS $f(\Delta I)$ function reduces the OPΔT and/or OTΔT setpoints in the presence of highly skewed axial power distributions to protect against exceeding fuel thermal CFM or DNBR limits by tripping the reactor. In the analysis, a number of Condition II events are assumed to initiate from core statepoints at the worst conditions within the LCO limits. The Condition II events considered are relatively slow transients such as rod withdrawal, boron dilution, and overcooling events. Axial flux difference limits for input to $f(\Delta I)$ are again determined by evaluating peaking margins to CFM and steady-state DNB limits. Core power levels up to 118% of full power, and rod insertions well beyond the insertion limit are considered in generating power distributions. The limits discussed in Section 3.2 form the basis for the CFM and DNB margin calculations. Limits on the AFD are determined in a manner similar to that used for determining LCO limits. The final AFD limits are verified by performing detailed LYNXT calculations to confirm the validity of the DNB MAP limits used in the DNB peaking margin calculations, and the minimum DNBR at limiting peaking conditions.

The OPΔT and OTΔT setpoints are intended to protect the core from CFM and DNB, respectively; however, one set of f(ΔI) limits may be conservatively generated so as to preserve both criteria.

2.4 Surveillance Monitoring

Once the LCOs and LSSSs have been determined, monitoring is required in order to verify that core operation is consistent with the assumptions invoked in generating the limits to provide assurance that fuel thermal limits are not violated. The monitoring philosophy compares precalculated and measured values of the total peak, F_Q , and the radial relative power density $F_{\Delta H}$, at steady-state conditions. The predicted power distribution that corresponds to a given measured statepoint may be interpolated from a data base of precalculated distributions by using the measured burnup, axial flux difference, and power level. If the measured values do not differ from the precalculated values by more than a specified amount, the core is considered to be operating as designed, and the LCO and LSSS limits are valid. If measured and calculated values at some location(s) differ by more than the predetermined amount, a margin calculation is performed. If unacceptable margins are calculated, the AFD limits and/or power level are reduced. The amounts by which measured and calculated values of F_Q and $F_{\Delta H}$ may differ (DAQ and DAH, respectively) were determined by comparing B&W predicted, with measured values for McGuire Unit 1, cycles 1, 1A, 2 and 3. A peaking factor report containing values of the constants used in the measured-to-calculated comparisons and margin calculations is provided for each cycle.

3.0 REPORT TECHNICAL EVALUATION

The present review considered the information presented in the topical report and in Ref. 2 which contains additional information provided in response to an NRC request. A number of topical reports describing the methods used by B&W to establish LCOs and LSSSs for their own plants were also consulted.

The basic elements of the proposed methodology are essentially the same as those currently employed by B&W in deriving core LCOs and LSSSs for their own PWRs (which are similar as far as these analyses are concerned to those designed by W). These methods have been reviewed and accepted by the NRC. The computer codes and associated methodologies employed in the power distribution and peaking calculations, and in the DNBR and fuel performance analyses have also been reviewed, and found acceptable. B&W developed ECCS evaluation model for W designed plant is being reviewed separately by the NRC staff. In addition, the B&W methodology is expected to yield operating regions for the control rod and AFD LCOs, and LSSS $f(\Delta I)$ that are similar to those obtained by the use of the approved W relaxed axial offset control methodology (RAOC) for given F_Q and $F_{\Delta H}$; if the B&W limits differ from the present W limits, the differences will either be reflected in the width of the operating limits or in the available margin (Ref. 2).

In view of the above, the basic B&W approach for setting the core LCOs and LSSSs is acceptable. The major area in which the proposed methodology differs from reviewed and accepted B&W procedures is in the area of surveillance monitoring. The standard B&W methodology utilizes the fixed incore detectors that are present in their plants to perform effectively continuous monitoring (frequency of power distribution measurements and comparisons of F_Q and $F_{\Delta H}$ is approximately once every six minutes).Comparisons are made directly to the LOCA or DNB limits after appropriately accounting for uncertainties. In W plants, continuous monitoring is performed via excore detectors which respond to essentially global core conditions, while incore power maps to obtain local conditions are obtained with movable detectors with a frequency of approximately once per month. The proposed B&W surveillance approach for W designed plants is therefore more complex in order to compensate for the more infrequent measurements. Since calculations form the basis for the LCOs and LSSSs, B&W proposes to compare measured power distributions to a calculated design statepoint (which may be obtained by interpolating within a data base of precalculated power distributions) to decide whether the core is operating as expected and, thus, guaranteed to have sufficient margin. Note that sufficient margin may still be available, even if the measured vs calculation deviations are larger than expected; this is the purpose for the subsequent margin calculations if the differences in the basic power distribution comparisons exceed those expected.

This basic monitoring approach outlined above can provide the required assurance of safe operation; however, it requires that all the components included in the comparisons and in the margin calculations have a firm basis in order to have a high level of confidence. B&W has determined that the factors used in the peaking factor and margin calculations are valid for W plants and B&W input to W measurement software, as well as for mixed B&W/W cores. The DNB correlation and the statistical design limit used in the thermal-hydraulic analyses have been reviewed and approved by the NRC. While B&W does not plan to update the deviation allowances which reflect expected differences between measured and calculated values of F_Q and $F_{\Delta H}$ on the basis that they are essentially coupled to the nuclear reliability factor, if additional data show that present values are not conservative then margin calculations will be performed more frequently. If the deviations in F_Q and $F_{\Delta H}$ are larger than expected, the actual available margin at the "failed" locations, relative to those obtained during the deviations of the limits, are calculated. If a negative margin for F_Q or $F_{\Delta H}$ is obtained, the required degree of assurance that the limiting criteria will not be exceeded is not present, and the positive and negative limits for both AFD and $f(\Delta I)$ are reduced proportionately, or the power is reduced appropriately.

4.0 TECHNICAL POSITION

Many of the elements of the proposed B&W methodology for deriving core operating limits for Westinghouse designed PWRs are similar to the standard B&W approach that has been reviewed and accepted by the NRC for B&W plants. The major difference relative to previously accepted B&W methodologies is in the area of surveillance monitoring. Based on the review of the topical report and supporting documentation it is concluded that the proposed methodology represents an acceptable approach for determining and monitoring core operating limits for McGuire Unit 1 and similar PWRs subject to the following limitation.

> The validity and conservatism of the parameters and assumptions used in setting the LCO's and LSSSs, the monitoring and margin calculations should be confirmed, as experience with W designed reactors is obtained, by continued analysis of calculated vs. measured comparisons and monitoring trends.

5.0 CONCLUSIONS

Based on the evaluation discussed in Section 3.0 of this report, the staff concludes that the B&W report BAW-10163P is acceptable for licensing applications subject to the limitation listed in Section 4.0.

6.0 REFEREMCES

1. "Normal Operating Controls," BAW-10122A, Rev 1, Babcock & Wilcox, (May 1984).

2. "Core Operating Limit Methodology Topical Report BAW-10163P," Letter from J. H. Taylor (B&W) to J. A. Norberg (NRC), May 12, 1988.

THE INCLUDED ATTACHMENT CONTAINS COMPANY PROPRIETARY INFORMATION

September 16, 1988

J. F. Carew

M. Todosow

Subject: Review of BAW-10163P, "Core Operating Limit Methodology for Westinghouse Designed PWRs" (FIN A-3868/Task-2)

The review of the Babcock and Wilcox topical report describing the generation of core operating limits for Westinghouse designed PWRs has been completed. The methods used to determine operating limits that preserve power peaking and reactivity design criteria, and the monitoring procedures employed to assure safe operation within these limits are described.

The Technical Evaluation Report summarizing our findings is attached.

MT:pd

Enc.

cc: T. E. Collins (NRC)
R. A. Bari (BNL)
B. L. Grenier (NRC)
J. G. Guppy (BNL)
W. Y. Kato (BNL)
L. Lois (NRC)

THIS ATTACHMENT CONTAINS COMPANY PROPRIETARY INFORMATION

TECHNICAL EVALUATION REPORT

Report Identification:	BAW-10163P
Report Title:	Core Operating Limit Methodology for Westinghouse Designed PWRs
Report Date:	July, 1987
Originating Organization:	Babcock & Wilcox

1.0 INTRODUCTION

The subject report describes the proposed Babcock & Wilcox (B&W) methodology for generating limiting conditions for operation (LCOs) and limiting safety systems settings (LSSSs) for Westinghouse (W) designed PWRs. The LSSSs considered in the report are the overpower delta-T (OPDT) and over temperature delta-T (OTDT) trip setpoints which protect the core from centerline fuel melt (CFM) and departure from nucleate boiling (DNB). The LCOs consist of limits on the control rod bank positions, and the axial flux difference (AFD) alarm setpoints. These preserve the initial condition peaking criteria required by the loss-of-coolant accident (LOCA) and loss-of-flow accident (LOFA), and the ejected rod worth and shutdown margin reactivity limits. The methods used to obtain these limits are similar to those used by B&W for their own plants, and are described along with the associated monitoring requirements.

The evaluation of the topical report follows:

2.0 SUMMARY OF TOPICAL REPORT

The major chapters of the report describe the criteria that are used to es tablish the LCOs and LSSSs, how the limits are obtained, and the compari sons that are employed in the surveillance monitoring to assure that opera ting and safety limits are preserved. A brief description of the neu tronics computer codes used in the power distribution and peaking factor analyses is also presented, along with a discussion of the uncertainties applied to measurements. Sample Technical Specifications and a peaking factor limit report format employed in the implementation of the proposed methodology are also presented. An example application with calculated and simulated measured power distributions is given to illustrate how the proposed approach would be used to determine the limits and in the course of monitoring adherence to the technical specification limits.

2.1 CRITERIA USED IN DETERMINING LIMITING CONDITIONS FOR OPERATION

The limiting conditions for operations (LCOs) consist of peaking and reactivity based limits.

The peaking limits are determined such that the consequences of a postulated loss-of-coolant accident (LOCA) or loss-of-flow accident (LOFA) remain acceptable. This is achieved by limiting the total or radial/axial peaking that can be present prior to the occurrence of such an accident.

The LOCA limits analysis involves consideration of all phases of the accident coupled with fuel rod heat up calculations, and results in limits on the initial condition total peaking as a function of core height.

The LOFA limits analysis involves generating curves of maximum allowable peaking (MAP) which represent allowable combinations of local radial peak ing and axial peaking, as a function of elevation, that yield the design minimum departure from nucleate boiling ratio (DNBR) at specified inlet conditions. The MAP are based on a statistical DNB design limit.

The reactivity based LCO limits define control bank insertion limits as a function of power level such that the required shutdown margin criterion is preserved at all times, and the consequences of postulated rod ejection accident involving the most reactive control rod assembly in any control rod configuration is acceptable.

2.2 CRITERIA USED IN DETERMINING LIMITING SAFETY SYSTEMS SETTINGS

Protection against centerline fuel melting (CFM) and DNB during steady-state and transient conditions are provided by the overpower delta-T (OPDT) and overtemperature delta-T (OTDT) trips. These trips contain a term, f(I), which is a function of the axial flux difference (AFD) and reduces the OPDT and OTDT setpoints for power distributions which exceed predetermined AFD limits. (The AFD is a measure of the degree of skew in the axial power distribution about the core midplane).

The LSSS f(I) function is based on limiting the maximum fuel linear heat rate so that CFM does not occur, and the DNBR is maintained above the design limit. The DNBR limit is based on a 95/95 criterion in the DNB correlation and associated uncertainties, or a probability of less than 0.1% fuel failure for the entire core, whichever is more restrictive.

The DNB related analyses involve the determination of the dependence of DNBR on system pressure and coolant inlet temperature at various power levels, and therefore defines the allowable power as a function of inlet temperature at various system pressures. The resulting core protection safety limit curves form the basis of the OTDT and OPDT trip functions. Peaking limits at design overpower conditions are obtained from MAPs generated from limiting statepoints on the safety limit curves at power levels up to 118% of full power.

2.3 DERIVIATION OF OPERATING LIMITS

The determination of the LCO limits involves defining limits on the AFD that preclude operation above the LOCA and LOFA-DNB peaking limits, and evaluating the ejected rod worths and shutdown margins at the LCO limits to ensure that they are within the bounds required by the safety analysis.

Power distributions throughout core life are generated with the FLAME3 code in three-dimensional geometry and including the affects of thermal feed back. The model is normalized prior to generating limiting power distributions by adjusting the radial albedos on the basis of comparisons to two-dimensional PDQ and/or three-dimensional NOODLE calculations. Various xenon transients are simulated to determine the limiting transient xenon power distribution, and extremes of core operation and possibly operation at reduced flow or temperature are also considered. Xenon factors which adequately represent the impact of transient xenon are defined to bound the margin calculated for a transient xenon case with a power distribution assuming equilibrium xenon. Separate factors are determined for LOCA and LOFA-DNB margin calculations, and verified for each fuel cycle design by comparing results from limiting xenon transients to those obtained from augmented equilibrium xenon cases.

The limits on the AFD are determined by evaluating the peaking margins associated with the transient and equilibrium power distributions. The peaking margin is obtained by defining augmented total and radial peaking factors which include the calculational uncertainty, and an allowance for such operational variables as quadrant tilt. These are compared to allowable limits, and when correlated with the associated axial flux difference, appropriate AFD limits can be determined such that the allowable peaking limits imposed by LOCA and LOFA are not violated during operation.

Reactivity-based LCO limits are based on ejected rod worth and shutdown margin requirements. These are obtained in a manner similar to that described in Ref. 1. If existing insertion limits are not conservative, they are redefined to assure that the required criteria are satisfied.

The LSSS f(I) function reduces the OPDT and/or OTDT setpoints in the presence of highly skewed axial power distributions to protect against exceeding fuel thermal CFM or DNBR limits by tripping the reactor. In the analysis, a number of Condition II events are assumed to initiate from core statepoints at the worst conditions within the LCO limits. The Condition II events considered are relatively slow transients such as rod withdrawal, boron dilution, and overcooling events. Axial flux difference limits for input to f(I) are again determined by evaluating peaking margins to CFM and steady-state DNB limits. Core power levels up to 118% of full power, and rod insertions well beyond the insertion limit are considered in generating power distributions. The limits discussed in Section 2.2 form the basis for the CFM and DNB margin calculations. Limits on the AFD are determined in a manner similar to that used for determining LCO limits. The final AFD limits are verified by performing detailed LYNXT calculations to confirm the validity of the DNB MAP limits used in the DNB peaking margin calculations, and the minimum DNBR at limiting peaking conditions.

The OPDT and OTDT setpoints are intended to protect the core from CFM and DNB, respectively; however, one set of f(I) limits may be conservatively generated so as to preserve both criteria.

2.4 SURVEILLANCE MONITORING

Once the LCOs and LSSSs have been determined, monitoring is required in order to verify that core operation is consistent with the assumptions invoked in generating the limits to provide assurance that fuel thermal limits are not violated. The monitoring philosophy compares precalculated and measured values of the total peak, F_Q, and the radial relative power density F_H, at steady-state conditions. The predicted power distribution that corresponds to a given measured statepoint may be interpolated from a data base of precalculated distributions by using the measured burnup, axial flux difference, and power level. If the measured values do not differ from the precalculated values by more than a specified amount, the core is considered to be operating as designed, and the LCO and LSSS limits are valid. If measured and calculated values at some location(s) differ by more than the predetermined amount, a margin calculation is performed. If unacceptable margins are calculated, the AFD limits and/or power level are reduced. The amounts by which measured and calculated values of F_Q and F_H may differ (DAQ and DAH, respectively) were determined by comparing B&W predicted, with measured values for McGuire Unit 1, cycles 1, 1A, 2 and 3. A peaking factor report containing values of the constants used in the measured-to-calculated comparisons and margin calculations is provided for each cycle.

3.0 SUMMARY OF TECHNICAL EVALUATION

The present review considered the information presented in the topical report and in Ref. 2 (which contains additional information provided by B&W in response to an RAI). A number of topical reports describing the methods used by B&W to establish LCOs and LSSSs for their own plants were also consulted.

The basic elements of the proposed methodology are essentially the same as those currently employed by B&W in deriving core LCOs and LSSSs for their own PWRs (which are similar as far as these analyses are concerned to those designed by W). These methods have been reviewed by the USNRC and found to be acceptable. The computer codes and associated methodologies employed in the power distribution and peaking calculations, and in the DNBR and fuel performance analyses have also been reviewed, and found acceptable. The B&W developed ECCS evaluation model for Westinghouse designed plant is being reviewed separately by the NRC staff. In addition, B&W claims that its methodology is expected to yield operating regions for the control rod and AFD LCOs, and LSSS f(I) limits that are similar to those obtained by the use of the approved W relaxed axial offset control methodology (RAOC) for given F_Q and F_H limits; if the B&W limits differ from the present W limits, the differences will either be reflected in the width of the operating limits or in the available margin. (Ref. 2)

In view of the above, the basic B&W approach for setting the core LCOs and LSSSs is acceptable. The major area in which the proposed methodology differs from reviewed and accepted current B&W procedures is in the area of surveillance monitoring. The standard B&W methodology utilizes the fixed incore detectors that are present in their plants to perform effectively continuous monitoring (frequency of power distribution measurements and comparisons of F_Q and F_H to limits is approximately once every six minutes).Comparisons are made directly to the LOCA or DNB limits after appropriately accounting for uncertainties. In W plants, continuous monitoring is performed via excore detectors which respond to essentially global core conditions, while incore power maps to obtain local conditions are obtained with movable detectors with a frequency of approximately once per month. The proposed B&W surveillance approach for W designed plants is therefore more complex in order to compensate for the more infrequent measurements. Since calculations form the basis for the LCOs and LSSSs, B&W proposes to compare measured power distributions to a calculated design statepoint (which may be obtained by interpolating within a data base of precalculated power distributions) to decide whether the core is operating as expected and therefore guaranteed to have sufficient margin available to thermal limits. Note that sufficient margin may still be available, even if the measured vs. calculation deviations are larger than expected; this is the purpose for the subsequent margin calculations if the differences in the basic power distribution comparisons exceed those expected.

This basic monitoring approach outlined above can provide the required assurance of safe operation; however, it requires that all the components included in the comparisons and in the margin calculations have a firm basis in order to have a high level of confidence that limits are preserved. B&W has determined that the factors used in the peaking factor and margin calculations are valid for W plants and B&W input to W measurement software, as well as for mixed B&W/W cores. The DNB correlation and the statistical design limit used in the thermal-hydraulic analyses have been reviewed and approved by the NRC. While B&W does not plan to update the deviation allowances which reflect expected differences between measured and calculated values of F_Q and F_H on the basis that they are essentially coupled to the nuclear reliability factor, if additional data show that present values are not conservative, conservative margin calculations will be performed more frequently. If the deviations in F_Q and F_H are larger than expected, the actual available margin at the "failed" locations, relative to those obtained during the deviations of the limits, are calculated. If a negative margin for F_Q or F_H is obtained, the required degree of assurance that the limiting criteria will not be exceeded is not present, and the positive and negative limits for both AFD and f(I) are reduced proportionately, or the power is reduced appropriately.

4.0 TECHNICAL POSITION

Many of the elements of the proposed B&W methodology for deriving core operating limits for Westinghouse designed PWRs are similar to the standard B&W approach that has been reviewed and accepted by the NRC for B&W plants. The major difference relative to previously accepted B&W methodologies is in the area of surveillance monitoring to assure that operating and safety limits are preserved. Based on the review of the topical report and supporting documentation it is concluded that the proposed methodology represents an acceptable approach for determining and monitoring core operating limits for McGuire Unit 1 and similar PWRs.

However, the proposed methodology represents a substantial departure from current B&W practice in determining operating setpoints and/or monitoring limits. Therefore, it is recommended that the validity and conservatism of the parameters and assumptions used in setting the LCO's and LSSSs, and the monitoring and margin calculations should be confirmed, as additional experience with W-designed reactors is obtained, by continued analysis of calculated vs. measured comparisons and monitoring trends.

References

1. "Normal Operating Controls," BAW-10122A, Rev 1, Babcock & Wilcox, (May 1984).

2. "Core Operating Limit Methodology Topical Report BAW-10163P," Letter from J. H. Taylor (B&W) to J. A. Norberg (NRC), May 12, 1988.

MT:pd