NMC
Committed to Nuclear Excellence

Point Beach Nuclear Plant
Operated by Nuclear Management Company, LLC

NRC 2001-029

10 CFR 50.90

May 3, 2001

Document Control Desk
U.S. Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555

Ladies/Gentlemen:

DOCKETS 50-266 AND 50-301
CLARIFICATION OF INFORMATION
TECHNICAL SPECIFICATIONS CHANGE REQUEST 216
INDIVIDUAL ROD POSITION INDICATION OPERABILITY
POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

By submittal dated November 20, 2000, Nuclear Management Company (Licensee) requested amendments to Facility Operating Licenses DPR-24 and DPR-27 for Point Beach Nuclear Power Plant, Units 1 and 2, respectively, to incorporate changes to the plant Operating Licenses and Technical Specifications. The purpose of the proposed amendments was to implement changes to the Technical Specifications (TS) to increase the allowable deviation in individual rod position indication (IRPI). Supplement 1 to this request was submitted by letter dated February 6, 2001. We requested approval of the proposed amendments by April 2001.

During a conference call between NMC representatives and NRC staff on April 11 and April 24, 2001, NRC staff requested clarifying information regarding certain aspects of the submittal. Attachment 1 of this letter provides the NMC response to the staff's questions. The information provided does not require any changes to the proposed Technical Specifications nor their Bases.

The enclosures to this letter include two copies of WCAP-15432, Revision 2, "Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2", dated April 2001 (Proprietary) and two copies of WCAP-15442 Revision 1, "Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2", dated April 2001 (Non-Proprietary).

Also included in the enclosures to this letter are a Westinghouse proprietary authorization letter, CAW-01-1449, accompanying affidavit, Proprietary Information Notice, and Copyright Notice.

A001

As WCAP-15432 contains information proprietary to Westinghouse Electric Company LLC ("Westinghouse"), it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.790 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR 2.790. Correspondence regarding the proprietary aspects of the items listed above, or the supporting Westinghouse Affidavit, should reference CAW-01-1449 and be addressed to H. A. Sepp, Manager of Regulatory and Licensing Engineering, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

We have determined that this clarification of information for the proposed amendments does not involve a significant hazards consideration, authorize a significant change in the types or total amounts of effluent release, or result in any significant increase in individual or cumulative occupational radiation exposure. Therefore, we conclude that the proposed amendments meet the categorical exclusion requirements of 10 CFR 51.22(c)(9) and that an environmental impact appraisal need not be prepared.

We request approval of the proposed amendments by May 8, 2001.

Sincerely,

Mark E. Reddemann
Site Vice President

Subscribed to and sworn before me
on this 3rd day of May, 2001

Notary Public, State of Wisconsin

My Commission expires on October 24, 2004

JG/jlk

Attachments

cc: NRC Regional Administrator
NRC Resident Inspector
NRC Project Manager
PSCW

bcc: (w/o enclosure)

R. G. Mende	A. J. Cayia	M. E. Reddemann
R. P. Pulec	J. Gadzala	R. A. Anderson
T. Webb	D. F. Johnson	R. R. Grigg
B. J. Onesti (OSRC)	J. L. Kudick (3)	D. Weaver
W. J. Hennessy	File	

CLARIFICATION OF INFORMATION
TECHNICAL SPECIFICATIONS CHANGE REQUEST 216
INDIVIDUAL ROD POSITION INDICATION OPERABILITY
POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

The following information is provided in response to the Nuclear Regulatory Commission staff's request for clarifying information on the NMC's February 6, 2001 submittal, as discussed during telephone conferences between NRC and NMC staff on April 11 and April 24, 2001.

NRC Question 1 regarded an interpretation as to what constitutes "rod motion" for purposes of invoking the allowance of the Technical Specification Note that states, "One hour is allowed following rod motion prior to verifying bank insertion limits".

The proposed Technical Specification Note allows a one hour soak following rod motion, prior to verifying bank insertion limits. For purposes of invoking the allowance granted by this note, PBNP would require that a substantial rod movement occur. Lesser rod movements would not be a basis for utilizing the allowed soak time.

NRC Question 2 regarded how Point Beach assures that the parameters presented in Table 3.1 of section 3.2 of WCAP-15432, Design Models Used in Rod Misalignment Analysis, continue to be applicable.

The reactor fuel vendor, Westinghouse, stated that the analysis described in WCAP-15432 is bounding for all anticipated future loading patterns and operating strategies. The analysis considers the limiting situations and combines them with a statistical method using the 95/95 certainty value (probability/confidence level) to bound all possibilities. Future core loading patterns will be evaluated and confirmation of the rod misalignment analysis will be validated on a cycle specific basis.

If a future loading pattern is based on a rod insertion limit that is deeper than the limit assumed in the current analysis, the rod misalignment analyses would need to be reperformed and notification would be provided to the NRC.

ENCLOSURE

Westinghouse Electric Company, LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

April 27, 2001

CAW-01-1449

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: WCAP-15432, Revision 2, "Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2 (Proprietary), April 2001

Dear Mr. Collins:

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-01-1449 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Wisconsin Electric Power Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-01-1449 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosures

cc: S. Bloom/NRR/OWFN/DRPW/PDIV2 (Rockville, MD) 1L

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 30th day
of April, 2001

PATRICIA L. CROWN COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

Notarial Seal
Patricia L. Crown, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Feb. 7, 2005
Member, Pennsylvania Association of Notaries

Patricia L. Crown

Notary Public

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services of the Westinghouse Electric Company LLC ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse Application for Withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Electric Company LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in WCAP-15432, Revision 2, "Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2," (Proprietary), April 2001 for Point Beach Units 1 & 2, being transmitted by Wisconsin Electric Power Company letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention: Mr. Samuel J. Collins. The proprietary information as submitted for use by Wisconsin Electric Power Company for the Point Beach Units 1 & 2 Nuclear Power Plants is expected to be applicable in other

licensee submittals in response to certain NRC requirements for justification in minimizing disruptions to normal plant operations due to frequent indications from the Analog Rod Position Indicator (ARPI).

This information is part of that which will enable Westinghouse to:

(a) Modify Technical Specification for bank demand allowable rod misalignment from ± 12 to ± 18 steps indicated.

(b) To minimize disruptions to normal plant operations due to frequent and erroneous indications of rod misalignment.

(c) Assist the customer to obtain NRC approval.

Further this information has substantial commercial value as follows:

(a) Westinghouse's plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) The resulting required margins will be determined that they are cycle independent for Point Beach Units 1 and 2 and plant safety will be not be compromised.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar licensing support documentation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar design programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

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non-Proprietary

Westinghouse [redacted] Class 3

WCAP-15442
Revision 1

Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2

Westinghouse Electric Company LLC
Nuclear Fuel

WESTINGHOUSE NON-PROPRIETARY CLASS 3

WCAP-15442
Revision 1

Conditional Extension of the Rod Misalignment Technical Specification for Point Beach Units 1 and 2

April, 2001

Author: A. Meliksetian
Core Analysis D

Verified: R. D. Erwin
Core Analysis D

Approved: B. R. Beebe, Manager
Core Analysis D

Westinghouse Electric Company
Nuclear Fuel
P. O. Box 355
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ABSTRACT

This report proposes modifying the Technical Specification for bank demand allowable rod misalignment from the current ±12 steps indicated above 30 steps and below 215 steps to a value up to a maximum of ±18 steps indicated (±24 steps for power below 85% Rated Thermal Power (RTP), or for bank demand ≥ 215 steps), depending upon the minimum available peaking factor margin. Such a Technical Specifications change is sought to minimize disruptions to normal plant operations due to frequent and erroneous indications of rod misalignment from the Analog Rod Position Indicator (ARPI).

The required margins to the enthalpy rise ($F^N_{\Delta H}$) and heat flux (F_Q) peaking factor limits will be determined by examining the changes in these peaking factors between similar cases with misalignments of ±12 and ±18 steps indicated (±24 steps for bank demand ≥ 215). These resulting required margins will be determined such that they are cycle independent for Point Beach Units 1 and 2. It will also be shown that plant safety will not be compromised by this Technical Specifications change.

The Technical Specifications will utilize the enclosed enthalpy rise and heat flux margin tables to allow an increase in rod misalignment to an amount indicated by the margin available from the latest flux map.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the following individuals for their contributions to the completion of this report: B. R. Beebe, R. Smith, D. Wenzel, R. Erwin, R. J. Fetterman, C. R. Tuley and J. Radawski.

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1.0 INTRODUCTION

The Analog Rod Position Indicator (ARPI) system has an uncertainty of 12 steps, the actual misalignment may be as large as ±24 steps (for indicated misalignment of ±12 steps). In most cases, these indicated misalignments are false readings caused by fluctuations in the temperature of the control rod drive shafts. For example, such fluctuations can occur after Rod Control Cluster Assemblies (RCCAs) are withdrawn from the core during startup. However, when an indication of a misalignment does occur, false or otherwise, the reactor operator must take corrective action per the Technical Specifications.

Increasing the maximum allowed indicated misalignment to the following will provide relief to the aformentioned conditions of false misalignment indications from the ARPI:

- ±18 steps (actual misalignment of ±30 steps) for core power above 85% RTP and bank demand < 215 steps,
- ±24 steps (actual misalignment of ±36 steps) for core power above 85% RTP and bank demand ≥ 215 steps,
- ±24 steps (actual misalignment of ±36 steps) for core power less than 85% RTP .

This maximum allowable misalignment indications are a function of available enthalpy rise and heat flux peaking factors margin as shown in flux maps taken each month. For real misalignments, these misalignment increases generally yield small but acceptable increases in the enthalpy rise and heat flux peaking factors, $F^N_{\Delta H}$ and F_Q. This report will briefly review the feasible single failures of the rod control system that could yield misalignments of single and multiple rods. These feasible single failures will then form the basis for the cases analyzed and documented in this report to support the increase in the misalignment permitted by the Technical Specifications.

2.0 DESCRIPTION OF ROD CONTROL SYSTEM FAILURES

To determine the misalignment cases to be analyzed for this Technical Specification change, an evaluation of the rod control system was performed, drawing from the Failure Mode and Effects Analysis (FMEA) documented in Reference 1. This evaluation considered single failures within the rod control system logic cabinets, power cabinets and the control rod drive mechanisms (CRDMs). This evaluation also considered the impacts of the revised current order timing previously documented in Reference 2.

This evaluation has determined that a single failure of the rod control system can result in six categories of failure mechanisms within the system:

A. [

]a,c.

B. [

]a,c.

C. [

]a,c.

D. [

]a,c.

E. [

]a,c.

F. [

]a,c.

3.0 ANALYSES SUPPORTING NORMAL OPERATION

For the remainder of this report, the failure mechanisms discussed in Section 2 will be referred to by the letter they are listed as; i.e. failures A through F. When analyzing these failure mechanisms for peaking factor impacts, the following cabinet configurations must be considered:

1. 1AC: groups CA1, CC1, SA1
2. 2AC: groups CA2, CC2, SA2
3. 1BD: groups CB, CD, SB

The above configurations are also illustrated in Figure 3.1. The group nomenclature used to describe the power cabinets is defined as follows: the first letter (C or S) refers to a control or shutdown bank; the second letter (A, B, C or D) refers to the bank; the number (1 or 2) refers to the group number. For example, power cabinet 1AC controls group CA1, which is group 1 of control bank A. Power cabinet 2AC controls group SA2, which is group 2 of shutdown bank A.

A key assumption in the analysis of the feasible failures is that the current Westinghouse licensing basis requires the consideration of a single failure only, [

]^{a,c}.

3.1 ANALYSIS METHODOLOGY

The failure mechanism categories described in Section 2 will be analyzed using the USNRC-approved PHOENIX-P/ANC core design system documented in References 3 and 4. For each failure analyzed, calculations are performed for misalignments of up to ±24 steps plus additional misalignments and compared to the corresponding non-misaligned reference case.

The $F_{\Delta H}$ and F_Q for these cases are calculated and compared [

]^{a,c}. Currently, both Point Beach Units operate following the relaxed axial offset power distribution control (RAOC, Reference 5) strategy with operating bands of +9% -8% at greater than 90% RTP. For the current operating cycle, this would translate into a hot full power (HFP) AO range of about 17% over the entire cycle.

3.2 CORE MODELS USED FOR ANALYSIS

To perform the analysis of the possible rod misalignments, one ANC model of Point Beach Unit 1 and one ANC model of Point Beach Unit 2 were utilized. The first model is the currently operating Unit 1 Cycle 26, and represents the current Point Beach Units licensing basis for fuel products and peaking factor limits. The second model used is intended to represent a future cycle (including transition cycle to 422V+ fuel). These two models are summarized in Table 3.1 below:

Table 3.1: Design Models Used in Rod Misalignment Analyses

Design Parameter	Current Cycle	Future Cycle
Cycle Length (End of Full Power Capability, EFPD)	488	[ ]a,c
No. of Feed Assemblies	40	[ ]a,c
No. Feeds Under Lead Bank (No. @ w/o U235)[a]	4 @ 4.0	[ ]a,c
Feed Enrichments (No. @ w/o U235)	16 @ 4.00 24 @ 4.70	[ ]a,c
Axial Blankets (w/o U235)	0.74 2.6	[ ]a,c
Burnable Absorbers (No. / Type / Length)	2320 IFBA, 120" centered;	[ ]a,c
$F^N_{\Delta H}$ Limit	1.70	[ ]a,c (a)
F_Q Limit	2.5	[ ]a,c

a. Analysis has been performed for $F_{\Delta H}$ Limit of 1.8.

3.3 MISALIGNMENT CASES ANALYZED

For the failure mechanism categories listed in Section 2, several distinct subsets of cases are analyzed in ANC. These cases are considered at beginning of cycle life (BOL, 150 MWD/MTU) and end of cycle life (EOL). Some cases are also examined at other cycle burnups, although these cases were found to

generally yield less limiting increases in peaking factors from an increase in the rod misalignment. Most of the calculations are performed assuming the reference condition as hot full power (HFP) with rods at the insertion limit (RIL); the Point Beach Units RILs are illustrated in Figure 3.2. Several of these cases are repeated at other reference rod conditions above the RILs, and at part power conditions such as 85% and 50% rated thermal power. The subsets of cases analyzed are summarized below:

1. [

   ]^{a,c}.

2. [

   ]^{a,c}.

3. [

   ]^{a,c}.

4. [

   ]^{a,c}.

5. [

   ]^{a,c}.

6. [

   ]^{a,c}.

7. [

   ]^{a,c}.

8. [

]a,c

The basic analysis approach used in this report proposes dividing the rod misalignment Technical Specification into three modes of surveillance: operation at core powers greater than 85% rated thermal power (RTP) and bank demand less than 215 steps; operation at core powers greater than 85% RTP and bank demand greater than or equal to 215 sreps; operation at core powers less than or equal to 85% RTP.

For the first mode of surveillance, the specific HFP cases analyzed for an additional 6 steps of misalignment are summarized in Table 3.3. The failure mechanisms listed in Table 3.3 are described in Section 2. Several of the limiting 6 step additional misalignment cases were repeated with only 3 steps of additional misalignment (±27 steps total) as listed in Table 3.5. The performance of the 3 step misalignment cases provide completeness and verify the bounding nature of the evaluation process utilized in this report. Results from these two tables are summarized in Table 3.2.

For the second mode of surveillance, the specific HFP cases analyzed for an additional 12 steps of misalignment are summarized in Table 3.6 (these cases are for >85% RTP and bank demand≥ 215). The failure mechanisms listed in Table 3.6 are described in Section 2. Results from these two tables are summarized in Table 3.2.

For the third mode of surveillance, additional cases were performed at part power conditions as listed in Tables 3.4 for additional misalignments of 12 steps (36 steps total). The results of the 12 additional step cases in Table 3.4 are used to determine an acceptable rod misalignment limit for core powers less than or equal to 85% RTP. Results from this table is also summarized in Table 3.2.

3.4 ANALYSIS RESULTS, POWER > 85% RTP

A complete description of all cases analyzed is presented in Tables 3.3 through 3.6. A summary of all cases analyzed and the limiting results to support the rod misalignment Technical Specifications change is given in Table 3.2. This data is presented as the change in the peak $F_{\Delta H}$ and F_Q for an increase in the rod misalignment beyond the current licensing basis of ±12 steps indicated (±24 steps actual).

Note that with the current $F^N_{\Delta H}$ and F_Q Technical Specifications, margins to the limits generally increase as power level decreases:

	For OFA and Upgraded OFA Fuel	For 422V+ Fuel	
$P > 0.5$	$F_Q(Z) \leq (2.50)/P \times K(Z)$	$F_Q(Z) \leq (2.60)/P \times K(Z)$	(1)
$P \leq 0.5$	$F_Q(Z) \leq 5.00 \times K(Z)$	$F_Q(Z) \leq 5.20 \times K(Z)$	
	$F^N_{\Delta H} < 1.70 \times [1 + 0.3 (1-P)]$	$F^N_{\Delta H} < 1.77 \times [1 + 0.3 (1-P)]$	(2)

Then, since $F^N_{\Delta H}$ and F_Q margins are usually a minimum at HFP, the amount of margin required to allow the permissible indicated misalignment to be increased from ±12 to ±18 steps for bank demand < 215 (±24 steps for bank demand ≥215 steps) will be determined based on the HFP data for the additional ±6 steps (±12 steps for bank demand ≥ 215 steps) misalignments from Table 3.3 and summarized in Table 3.2.

For all HFP ±6 step misalignment cases, the 95% probibility with 95% confidence level (95/95) increases in $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively, and the maximum increases in $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively. These results can be conservatively bounded by required $F^N_{\Delta H}$ and F_Q margins of [ ]^{a,c} and [ ]^{a,c}, respectively, for increased rod misalignment of ±6 steps. Note that these required margins are an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the 95/95 values and an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the observed maximum values for all HFP ±6 step cases.

For all HFP ±3 step misalignment cases, the 95/95 increases in $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively, and the maximum increases in $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively. These results can be conservatively bounded by required $F^N_{\Delta H}$ and F_Q margins of [ ]^{a,c} and [ ]^{a,c}, respectively, for increased rod misalignment of ±3 steps. Note that these required margins are an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the 95/95 values and an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the observed maximum values for all HFP ±3 step cases.

For all HFP ±12step misalignment cases and bank demand ≥ 215 steps, the 95/95 increases in $F_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively, and the maximum increases in $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c} respectively. These results can be conservatively bounded by required $F^N_{\Delta H}$ and F_Q margins of [ ]^{a,c} and [ ]^{a,c}, respectively, for increased rod misalignment of ±12 steps. Note that these required margins are an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the 95/95 values and an increase of [ ]^{a,c} and [ ]^{a,c} respectively over the observed maximum values for all HFP ±12 step cases.

Therefore, the proposed $F^N_{\Delta H}$ and F_Q margins for an additional 3 steps of misalignment are half of the limits proposed for an additional 6 steps. Also, the proposed $F^N_{\Delta H}$ and F_Q margins for an additional 12 steps of misalignment are twice the limits proposed for an additional 6 steps.This would suggest that margin required for an increase in the permissible misalignment for core powers greater than 85% RTP can then be specified as a linear function of the available peaking factor margin, with the misalignment increase being determined from the minimum of the available $F^N_{\Delta H}$ or F_Q margin. The proposed rod misalignment limit for core powers greater than 85% RTP are illustrated in Figures 3.3 and 3.4 for bank demands < 215 steps and ≥ 215 steps, respectively.

3.5 ANALYSIS RESULTS, POWER ≤ 85% RTP

The ±12 additional step part-power misalignment case is listed in Table 3.4, and summarized in Table 3.2. At 85% power, the 95/95 increase in the additional ±12 step $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c}. The ±12 additional step part-power 95/95 $F_{\Delta H}$ and F_Q increases are [ ]^{a,c} and [ ]^{a,c}, respectively, larger than the HFP-only ±12 additional step increases. However, by 85% power, the Technical Specification $F^N_{\Delta H}$ and F_Q limits have increased by 4.5% and 17%, respectively, as defined in Equations 1 and 2. At 50% power, the 95/95 increase in the additional ±12 step $F^N_{\Delta H}$ and F_Q are [ ]^{a,c} and [ ]^{a,c}. The ±12 additional step part-power 95/95 $F^N_{\Delta H}$ and F_Q increases are [ ]^{a,c} and [ ]^{a,c}, respectively, larger than the HFP-only ±12 additional step increases. However, by 50% power, the Technical Specification $F^N_{\Delta H}$ and F_Q limits have increased by 15% and 100%, respectively, as defined in Equations 1 and 2.

Since the peaking factor limits are increasing much faster than the required margins, the proposed rod misalignment Technical Specification limit of ±18 steps indicated for core powers above 85% RTP can be increased for core powers less than or equal to 85% RTP. At 85% RTP, the peaking factor limit increases of 4.5% in $F^N_{\Delta H}$ and 17% in F_Q [ ]^{a,c} in F_Q due to the additional ±12 additional steps of rod misalignment. Therefore, the proposed allowable indicated misalignment of ±24 steps for core powers of 85% RTP or less is justified.

3.6 PROPOSED TECHNICAL SPECIFICATION CHANGES

A graphic representation of the proposed Technical Specification for core powers greater than 85% RTP discussed in Section 3.4 is shown in Figures 3.3 and 3.4. The amount of available margin must be determined at least once every effective full power month (30 EFPD) during normal incore flux map surveillance. For Point Beach Units, the amount of F_Q margin will be based on the current F_Q surveillance methodology. The required peaking factors margins for additional misalignments at core powers above 85% RTP and bank demand below 215 steps are summarized below:

Indicated Misalignment (Steps)	**Additional Misalignment (Steps)**	**Required Margin**	
		$F^N_{\Delta H}$	F_Q
12	0	0.00	0.00
13	1	0.33	0.83
14	2	0.67	1.67
15	3	1.00	2.50
16	4	1.33	3.33
17	5	1.67	4.17
18	6	2.00	5.00

The required peaking factors margins for additional misalignments at core powers above 85% RTP and bank demand ≥ 215 steps are also summarized below:

Indicated Misalignment (Steps)	**Additional Misalignment (Steps)**	**Required Margin**	
		$F^N_{\Delta H}$	F_Q
12	0	0.00	0.00
13	1	0.33	0.83
14	2	0.67	1.67
15	3	1.00	2.50

Indicated Misalignment (Steps)	Additional Misalignment (Steps)	Required Margin	
		$F^N_{\Delta H}$	F_Q
16	4	1.33	3.33
17	5	1.67	4.17
18	6	2.00	5.00
19	7	2.33	5.83
20	8	2.67	6.67
21	9	3.00	7.50
22	10	3.33	8.33
23	11	3.67	9.17
24	12	4.00	10.0

For core powers of 85% RTP or less, as discussed in Section 3.5, the allowable indicated rod misalignment will be ±24 steps. At this amount of misalignment, the increase in the peaking factors relative to the current limit of ±12 steps is [ ]^{a,c} as defined in Equations 1 and 2 of Section 3.4.

Figure 3.1 Point Beach Units 1 and 2 Control and Shutdown Rod Configuration By Subgroup and Power Cabinet

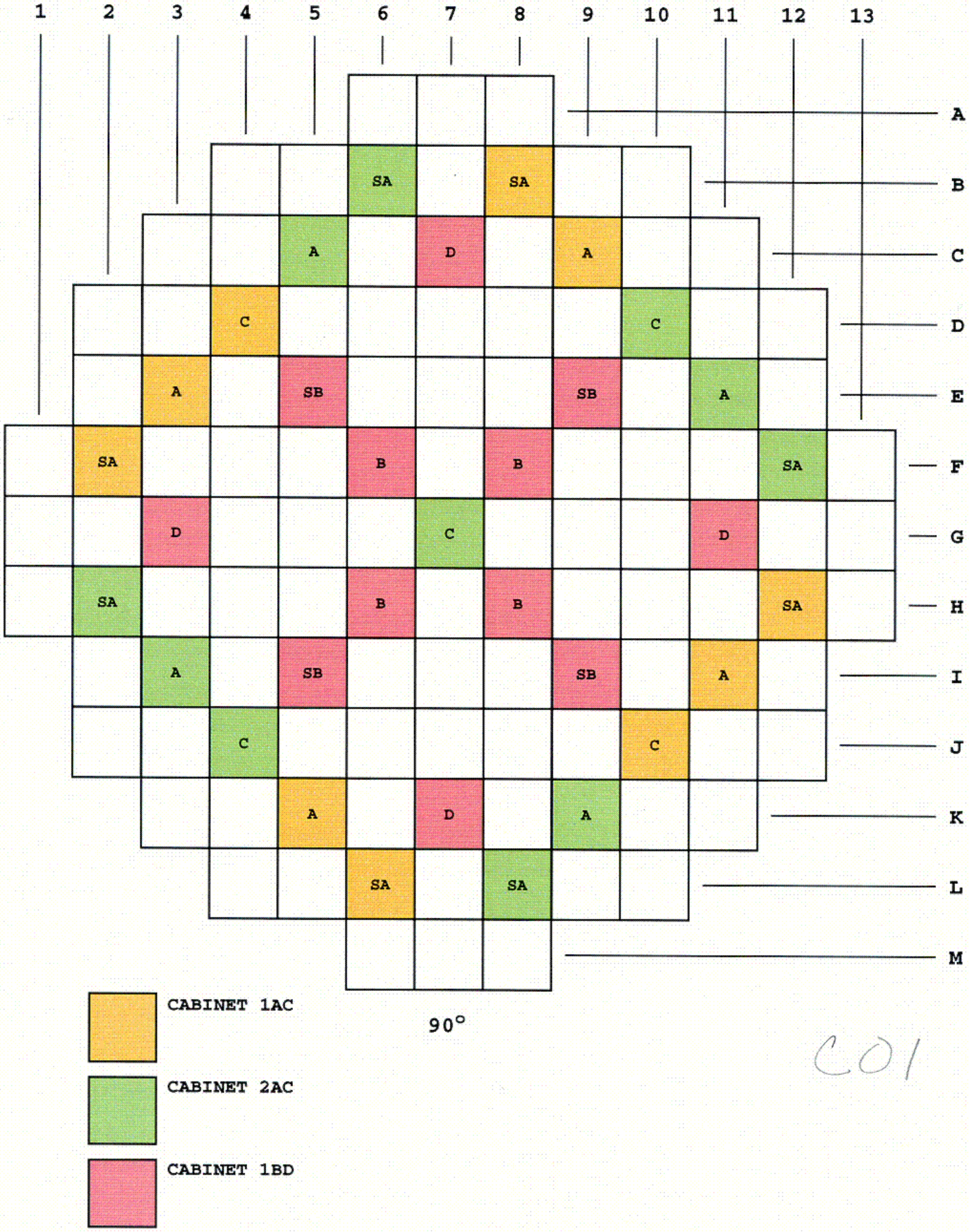

Figure 3.2 Point Beach Units 1 and 2 Control Rod Insertion Limits

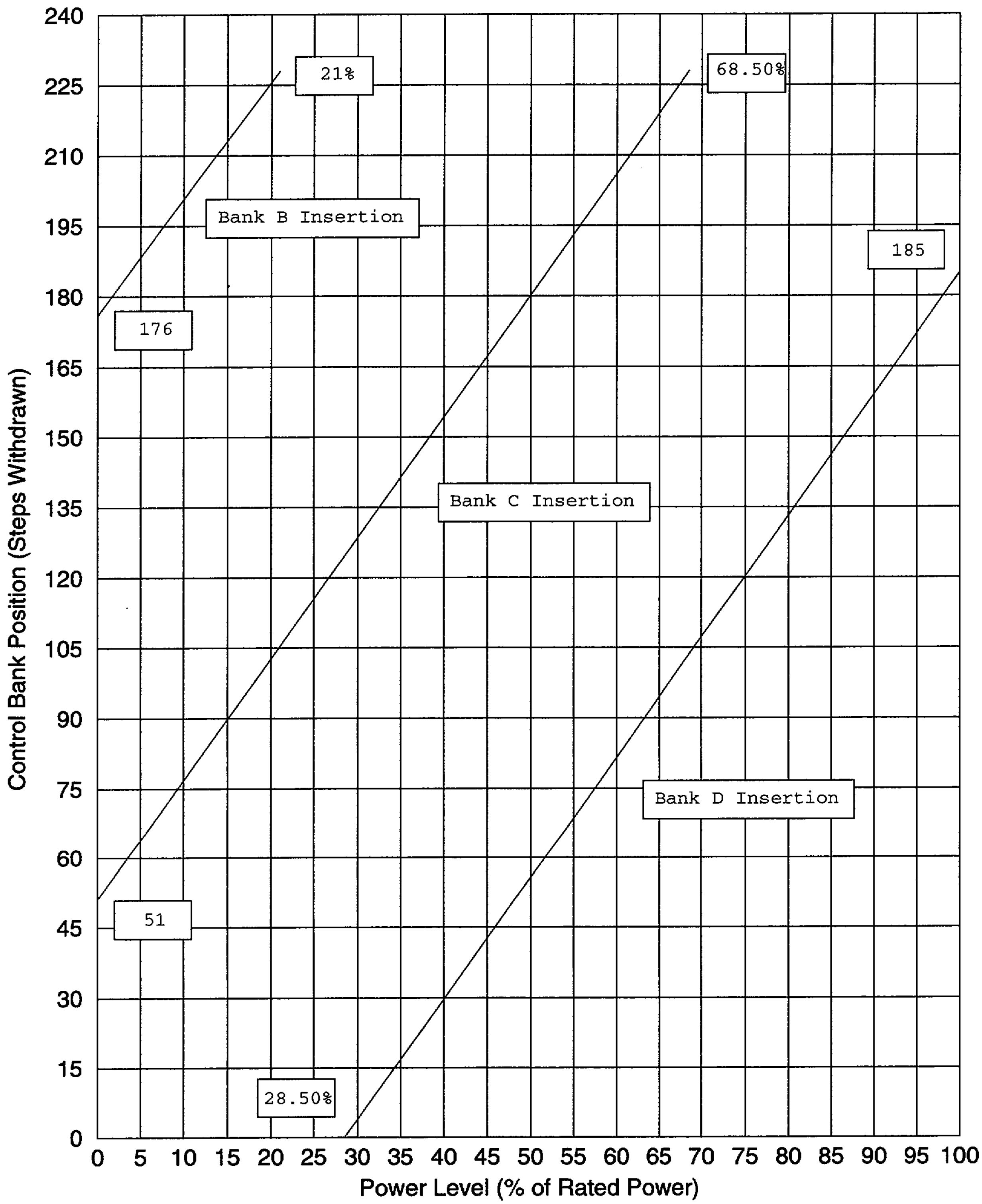

Figure 3.3 Permissible Increase in Rod Misalignment Vs. Available $F^N_{\Delta H}$ and F_Q Margin for >85% RTP and Bank Demand <215 Steps

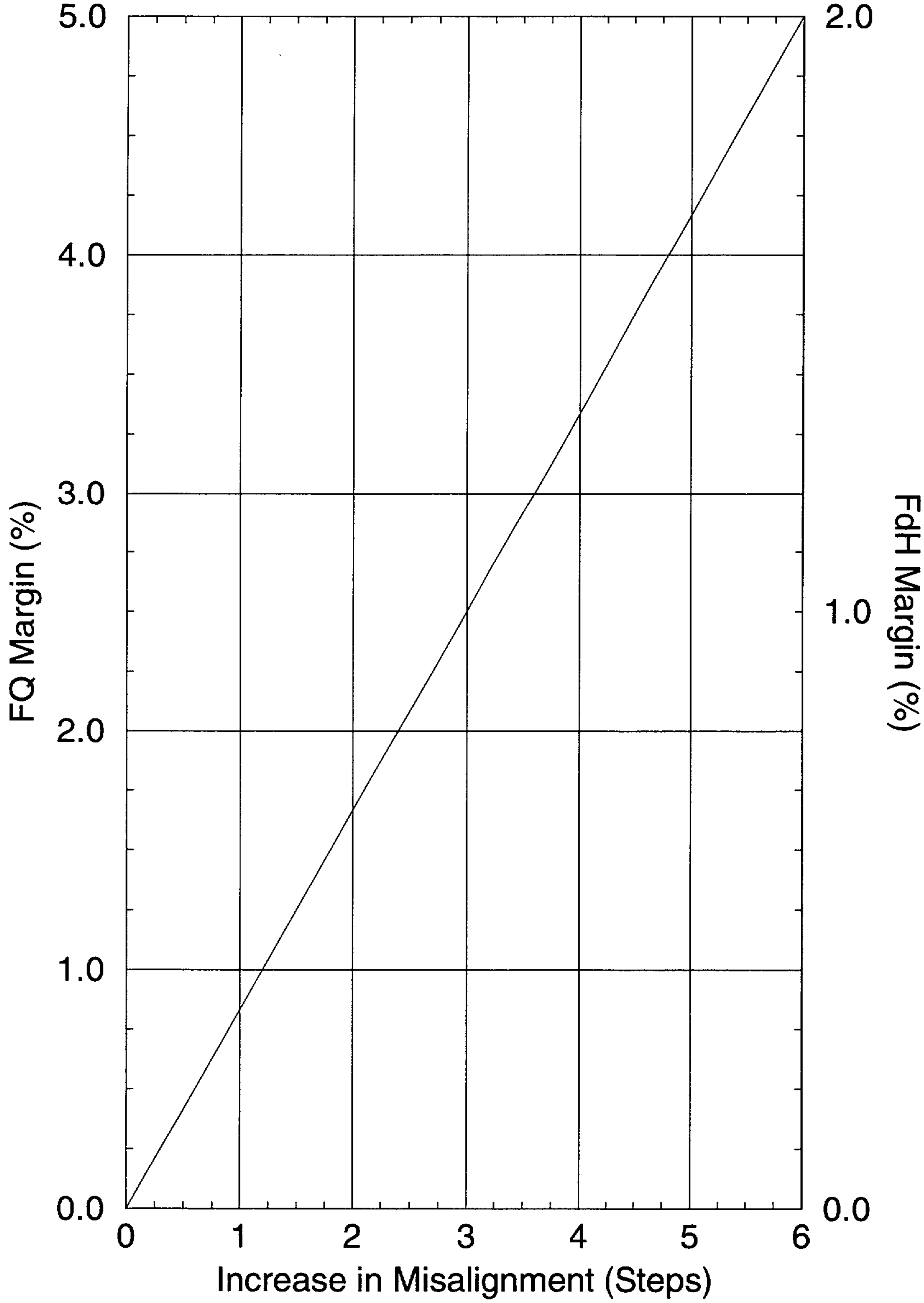

Figure 3.4: Permissible Increase in Rod Misalignment Vs. Available $F^N_{\Delta H}$ and F_Q Margin for >85% RTP and Bank Demand ≥ 215 Steps

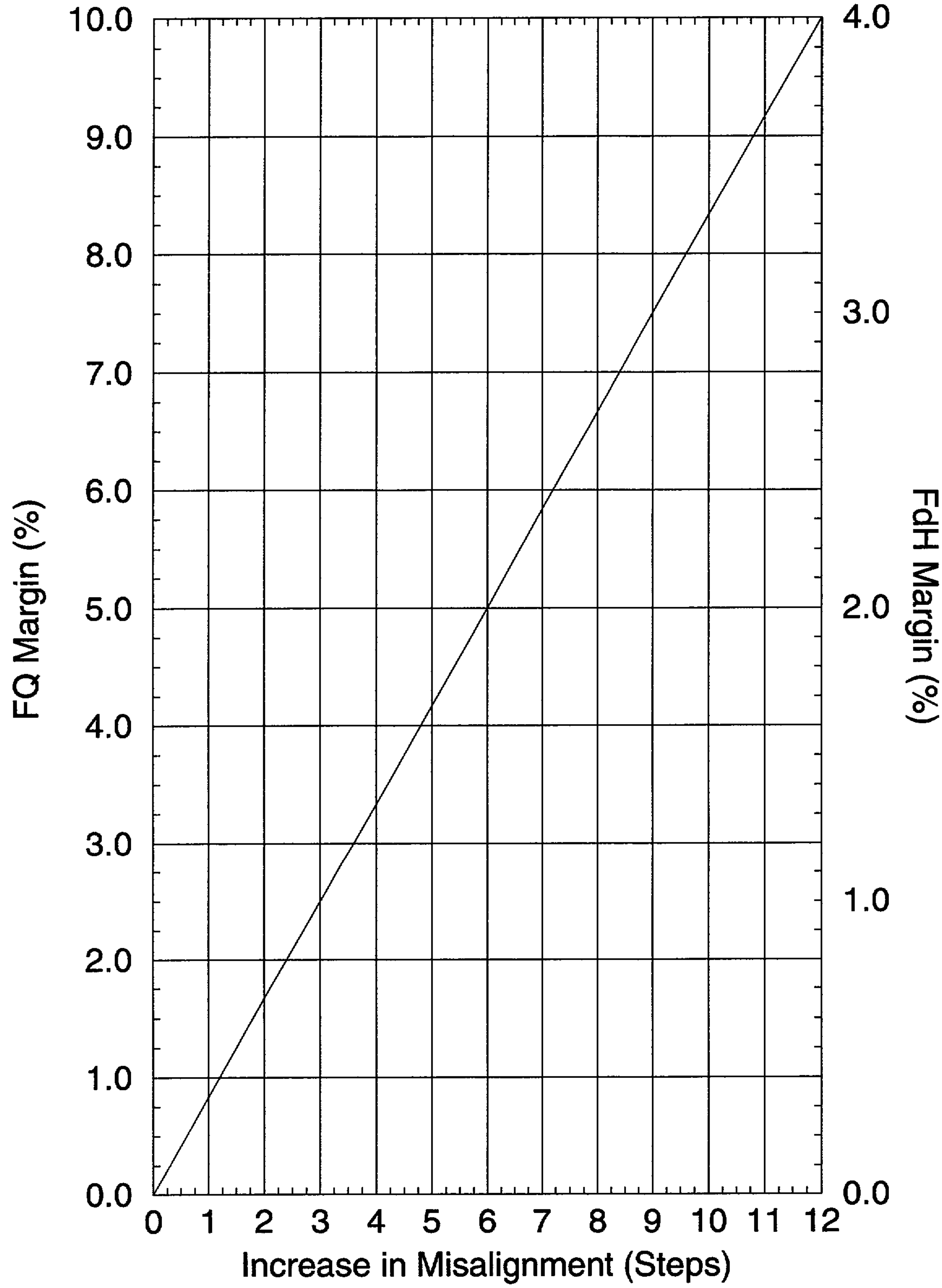

Table 3.2: Summary of Misalignment Cases Analyzed; Change in Peak $F_{\Delta H}$ and F_Q for Increased Misalignment Beyond ±12 Steps Indicated

Power, Indicated Misalignment, No. Points	Peak	Distribution Function	Mean ($\bar{x}$), %	Std. Dev. (σ), %	95/95 Value, %	Max. % (Case No.)
HFP ±18 [ ]a,c	$F_{\Delta H}$	Extreme Value	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
	F_Q	Extreme Value	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
Part Power ±24 (85% RTP) [ ]a,c	$F_{\Delta H}$	Beta	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
	F_Q	Normal	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
Part Power ±24 (50% RTP) [ ]a,c	$F_{\Delta H}$	Beta	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
	F_Q	Beta	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
HFP ±15 [ ]a,c	$F_{\Delta H}$	Normal	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
	F_Q	Weibull	[ ]a,c	[ ]a,c	[a,c	[ ]a,c
HFP ±24 (≥215 steps) [ ]a,c	$F_{\Delta H}$	Beta	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c
	F_Q	Logistic	[ ]a,c	[ ]a,c	[ ]a,c	[ ]a,c

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 1 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q a,c
1	BOL	HFP	Current	A	D at 185			
2	MOL	HFP	Current	A	D at 185			
3	EOL	HFP	Current	A	D at 185			
4	BOL	HFP	Current	D	D at 185			
5	MOL	HFP	Current	D	D at 185			
6	EOL	HFP	Current	D	D at 185			
7	BOL	HFP	Current	A	D at 205			
8	EOL	HFP	Current	A	D at 205			
9	BOL	HFP	Current	A	D at 185			
10	EOL	HFP	Current	A	D at 185			
11	BOL	HFP	Current	D	D at 185			
12	EOL	HFP	Current	D	D at 185			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 2 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
13	BOL	HFP	Current	A	D at 185	[		] a,c
14	EOL	HFP	Current	A	D at 185			
15	BOL	HFP	Current	D	D at 185			
16	EOL	HFP	Current	D	D at 185			
17	BOL	HFP	Current	C	D at 185			
18	EOL	HFP	Current	C	D at 185			
19	BOL	HFP	Current	E/F	D at 200			
20	EOL	HFP	Current	E/F	D at 200			
21	BOL	HFP	Current	E	D at 200			
22	EOL	HFP	Current	E	D at 200			
23	BOL	HFP	Current	E/F	D at 185	]		]

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 3 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
24	EOL	HFP	Current	E/F	D at 185			
25	BOL	HFP	Current	E	D at 185			
26	MOL	HFP	Current	E	D at 185			
27	EOL	HFP	Current	E	D at 185			
28	BOL	HFP	Current	A	ARO			
29	EOL	HFP	Current	A	ARO			
30	BOL	HFP	Current	A	ARO			
31	EOL	HFP	Current	A	ARO			
32	BOL	HFP	Current	A	D at 185			
33	EOL	HFP	Current	A	D at 185			
34	BOL	HFP	Current	A	ARO			
35	EOL	HFP	Current	A	ARO			

a,c

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 4 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
36	BOL	HFP	Current	A	ARO			a,c
37	EOL	HFP	Current	A	ARO			
38	BOL	HFP	Current	A	D at 185			
39	EOL	HFP	Current	A	D at 185			
40	BOL	HFP	Current	A	ARO			
41	EOL	HFP	Current	A	ARO			
42	BOL	HFP	Current	A	ARO			
43	EOL	HFP	Current	A	ARO			
44	BOL	HFP	Current	A	D at 185			
45	EOL	HFP	Current	A	D at 185			
46	BOL	HFP	Current	A	ARO			
47	EOL	HFP	Current	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 5 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
48	BOL	HFP	Current	A	D at 185			a,c
49	EOL	HFP	Current	A	D at 185			
50	BOL	HFP	Current	A	ARO			
51	EOL	HFP	Current	A	ARO			
52	BOL	HFP	Current	A	D at 185			
53	EOL	HFP	Current	A	D at 185			
54	BOL	HFP	Current	A	ARO			
55	MOL	HFP	Current	A	ARO			
56	EOL	HFP	Current	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 6 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
57	BOL	HFP	Current	A	ARO			
58	MOL	HFP	Current	A	ARO			
59	EOL	HFP	Current	A	ARO			
60	BOL	HFP	Current	A	D at 185			
61	EOL	HFP	Current	A	D at 185			
62	EOL	HFP	Current	A	ARO			
63	BOL	HFP	Current	A	ARO			
64	MOL	HFP	Current	A	ARO			
65	EOL	HFP	Current	A	ARO			

a,c

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 7 of 16)

a,c

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
66	BOL	HFP	Current	A	ARO			
67	EOL	HFP	Current	A	ARO			
68	BOL	HFP	Current	A	D at 185			
69	EOL	HFP	Current	A	D at 185			
70	BOL	HFP	Current	A	ARO			
71	EOL	HFP	Current	A	ARO			
72	BOL	HFP	Current	A	ARO			
73	EOL	HFP	Current	A	ARO			
74	BOL	HFP	Current	A	D at 185			
75	EOL	HFP	Current	A	D at 185			
76	BOL	HFP	Current	A	ARO			
77	EOL	HFP	Current	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 8 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
78	BOL	HFP	Current	A	ARO			a,c
79	MOL	HFP	Current	A	ARO			
80	EOL	HFP	Current	A	ARO			
81	BOL	HFP	Current	A	D at 185			
82	EOL	HFP	Current	A	D at 185			
83	BOL	HFP	Current	A	ARO			
84	MOL	HFP	Current	A	ARO			
85	EOL	HFP	Current	A	ARO			
86	BOL	HFP	Current	A	D at 185			
87	MOL	HFP	Current	A	D at 185			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 9 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q a,c
88	EOL	HFP	Current	A	D at 185			
89	BOL	HFP	Current	A	ARO			
90	EOL	HFP	Current	A	ARO			
91	BOL	HFP	Current	A	D at 185			
92	EOL	HFP	Current	A	D at 185			
93	BOL	HFP	Current	A	ARO			
94	MOL	HFP	Current	A	ARO			
95	EOL	HFP	Current	A	ARO			
96	BOL	HFP	Current	A	D at 185			
97	MOL	HFP	Current	A	D at 185			
98	EOL	HFP	Current	A	D at 185			
99	BOL	HFP	Current	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 10 of 16)

a,c

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
100	EOL	HFP	Current	A	ARO			
101	BOL	HFP	Current	A	D at 185			
102	EOL	HFP	Current	A	D at 185			
103	BOL	HFP	Current	A	ARO			
104	EOL	HFP	Current	A	ARO			
105	BOL	HFP	Current	A	D at 185			
106	EOL	HFP	Current	A	D at 185			
107	BOL	HFP	Current	A	ARO			
108	EOL	HFP	Current	A	ARO			
109	BOL	HFP	Current	A	D at 185			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 11 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
110	EOL	HFP	Current	A	D at 185			
111	BOL	HFP	Current	A	ARO			
112	MOL	HFP	Current	A	ARO			
113	EOL	HFP	Current	A	ARO			
114	BOL	HFP	Current	A	D at 185			
115	MOL	HFP	Current	A	D at 185			
116	EOL	HFP	Current	A	D at 185			
117	BOL	HFP	Future	A	D at 185			
118	EOL	HFP	Future	D	D at 185			
119	EOL	HFP	Future	E/F	D at 185			
120	EOL	HFP	Future	E	D at 185			
121	EOL	HFP	Future	A	ARO			

a,c

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 12 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
122	EOL	HFP	Future	A	D at 185			a,c
123	EOL	HFP	Future	A	D at 185			
124	BOL	HFP	Future	A	ARO			
125	EOL	HFP	Future	A	ARO			
126	BOL	HFP	Future	A	D at 185			
127	EOL	HFP	Future	A	D at 185			
128	BOL	HFP	Future	A	ARO			
129	2000	HFP	Future	A	ARO			
130	MOL	HFP	Future	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 13 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
131	EOL	HFP	Future	A	ARO	[		] a,c
132	BOL	HFP	Future	A	ARO			
133	2000	HFP	Future	A	ARO			
134	MOL	HFP	Future	A	ARO			
135	EOL	HFP	Future	A	ARO			
136	BOL	HFP	Future	A	D at 185			
137	EOL	HFP	Future	A	D at 185			
138	EOL	HFP	Future	A	ARO			
139	EOL	HFP	Future	A	ARO			]
140	EOL	HFP	Future	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 14 of 16)

a,c

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
141	BOL	HFP	Future	A	ARO			
142	2000	HFP	Future	A	ARO			
143	MOL	HFP	Future	A	ARO			
144	EOL	HFP	Future	A	ARO			
145	EOL	HFP	Future	A	D at 185			
146	EOL	HFP	Future	A	D at 185			
147	BOL	HFP	Future	A	ARO			
148	2000	HFP	Future	A	ARO			
149	MOL	HFP	Future	A	ARO			
150	EOL	HFP	Future	A	ARO			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 15 of 16)

a,c

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
151	BOL	HFP	Future	A	D at 185			
152	2000	HFP	Future	A	D at 185			
153	MOL	HFP	Future	A	D at 185			
154	EOL	HFP	Future	A	D at 185			
155	EOL	HFP	Future	A	ARO			
156	EOL	HFP	Future	A	D at 185			
157	BOL	HFP	Future	A	ARO			
158	2000	HFP	Future	A	ARO			
159	MOL	HFP	Future	A	ARO			
160	EOL	HFP	Future	A	ARO			
161	BOL	HFP	Future	A	D at 185			

Table 3.3: Summary of 18 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 16 of 16)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rod(s) Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
162	2000	HFP	Future	A	D at 185	[		
163	MOL	HFP	Future	A	D at 185			
164	EOL	HFP	Future	A	D at 185			]
(*)	Signifies that plots of peaking factors and increases due to additional steps of misalignment are included in the Appendix of this report.							

Table 3.4: Summary of 24 Step Indicated Part-Power Rod Misalignment Cases Analyzed (Sheet 1 of 5)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 3 Steps	
							$F^N_{\Delta H}$	F_Q a,c
165	EOL	85%	Current	D	D at 146			
166	EOL	85%	Current	A	D at 146			
167	BOL	85%	Current	C	D at 146			
168	EOL	85%	Current	E/F	D at 146			
169	EOL	85%	Current	A	ARO			
170	EOL	85%	Current	A	ARO			
171	EOL	85%	Current	A	ARO			
172	EOL	85%	Current	A	ARO			
173	EOL	85%	Current	A	ARO			
174	BOL	85%	Current	A	ARO			

Table 3.4: Summary of 24 Step Indicated Part-Power Rod Misalignment Cases Analyzed (Sheet 2 of 5)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 3 Steps	
							$F^N_{\Delta H}$	F_Q
175	MOL	85%	Current	A	ARO			a,c
176	EOL	85%	Current	A	ARO			
177	EOL	85%	Current	A	ARO			
178	EOL	85%	Current	A	D at 185			
179	EOL	85%	Current	A	D at 146			
180	EOL	85%	Current	A	ARO			
181	EOL	85%	Current	A	ARO			
182	EOL	85%	Current	A	D at 185			
183	EOL	85%	Current	A	D at 146			

Table 3.4: Summary of 24 Step Indicated Part-Power Rod Misalignment Cases Analyzed (Sheet 3 of 5)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 3 Steps	
							$F^N_{\Delta H}$	F_Q
184	2000	85%	Future	A	ARO			
185	EOL	85%	Future	A	ARO			
186	EOL	85%	Future	A	ARO			
187	EOL	85%	Future	A	D at 185			
188	EOL	85%	Future	A	D at 146			
189	EOL	85%	Future	A	ARO			
190	EOL	85%	Future	A	ARO			
191	MOL	85%	Future	A	D at 185			
192	MOL	85%	Future	A	D at 146			
193	EOL	85%	Future	A	ARO			

a,c

Table 3.4: Summary of 24 Step Indicated Part-Power Rod Misalignment Cases Analyzed (Sheet 4 of 5)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 3 Steps	
							$F^N_{\Delta H}$	F_Q
194	EOL	85%	Future	A	D at 185			a,c
195	EOL	85%	Future	A	D at 146			
196	EOL	85%	Future	A	ARO			
197	MOL	85%	Future	A	ARO			
198	EOL	85%	Future	A	ARO			
199	EOL	85%	Future	A	D at 185			
200	EOL	85%	Future	A	D at 146			
201	EOL	50%	Current	A	ARO			
202	MOL	50%	Current	A	ARO			
203	EOL	50%	Current	A	ARO			

Table 3.4: Summary of 24 Step Indicated Part-Power Rod Misalignment Cases Analyzed (Sheet 5 of 5)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 3 Steps	
							$F^N_{\Delta H}$	F_Q a,c
204	EOL	50%	Current	A	ARO			
205	EOL	50%	Future	A	ARO			
206	EOL	50%	Future	A	D at 185			
207	EOL	50%	Future	A	D at 185			
208	EOL	50%	Future	A	D at 56, C at 180			
209	EOL	50%	Future	A	ARO			
210	EOL	50%	Future	A	D at 56, C at 180			

Table 3.5: Summary of 15 Step Indicated Rod Misalignment Cases Analyzed (Sheet 1 of 2)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q a,c
211	BOL	HFP	Current	A	ARO			
212	EOL	HFP	Current	A	ARO			
213	BOL	HFP	Current	A	ARO			
214	EOL	HFP	Current	A	ARO			
215	EOL	HFP	Current	A	ARO			
216	EOL	HFP	Current	A	ARO			
217	EOL	HFP	Current	A	D at 185			
218	EOL	HFP	Current	A	ARO			
219	EOL	HFP	Current	A	D at 185			

Table 3.5: Summary of 15 Step Indicated Rod Misalignment Cases Analyzed (Sheet 2 of 2)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
220	EOL	HFP	Current	A	ARO			a,c
221	EOL	HFP	Current	A	D at 185			
222	BOL	HFP	Future	A	ARO			
223	EOL	HFP	Future	A	ARO			
224	BOL	HFP	Future	A	ARO			
225	EOL	HFP	Future	A	ARO			
226	EOL	HFP	Future	A	ARO			
227	EOL	HFP	Future	A	ARO			
228	EOL	HFP	Future	A	D at 185			
229	EOL	HFP	Future	A	ARO			
230	EOL	HFP	Future	A	D at 185			

Table 3.6: Summary of 24 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 1 of 3)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q a,
231	EOL	HFP	Current	A	ARO			
232	BOL	HFP	Current	A	ARO			
233	EOL	HFP	Current	A	ARO			
234	MOL	HFP	Current	A	ARO			
235	EOL	HFP	Current	A	ARO			
236	EOL	HFP	Current	A	ARO			
237	EOL	HFP	Current	A	ARO			
238	BOL	HFP	Future	A	ARO			
239	EOL	HFP	Future	A	ARO			

Table 3.6: Summary of 24 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 2 of 3)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^N_{\Delta H}$	F_Q
240	EOL	HFP	Future	A	ARO			
241	EOL	HFP	Future	A	ARO			
242	EOL	HFP	Future	A	ARO			
243	EOL	HFP	Current	A	D at 215			
244	BOL	HFP	Current	A	D at 215			
245	EOL	HFP	Current	A	D at 215			
246	MOL	HFP	Current	A	D at 215			
247	EOL	HFP	Current	A	D at 215			
248	EOL	HFP	Current	A	D at 215			

a,c

Table 3.6: Summary of 24 Step Indicated Hot Full Power Rod Misalignment Cases Analyzed (Sheet 3 of 3)

Case No.	Burnup	Power	Cycle	Failure Mechanism	Reference Bank Position	Rods Misaligned	Peaking Factor % Increase for Additional 6 Steps	
							$F^{N}_{\Delta H}$	F_Q
249	EOL	HFP	Current	A	D at 215			
250	BOL	HFP	Future	A	D at 215			
251	EOL	HFP	Future	A	D at 215			
252	EOL	HFP	Future	A	D at 215			
253	EOL	HFP	Future	A	D at 215			
254	EOL	HFP	[a]	A	D at 215			

a. (*) Signifies that plots of peaking factors and increases due to additional steps of misalignment are included in the Appendix of this report

4.0 SAFETY ANALYSIS IMPACTS

Section 3 discussed the effects of increased misalignment on the normal operation peaking factors. This section will address the effects on safety analysis inputs used for the reload safety evaluation (Reference 6).

An increase in rod misalignment does not have a significant impact on any of the moderator or Doppler reactivity coefficients or defects, nor on the reactor kinetics data. An increase in the rod misalignment also will not adversely effect the boron worths or data generated for the evaluation of boron dilution nor the boron system duty.

Many of the Condition II transients, such as rod out of position, dropped rod and single rod withdrawal are based on the motion of a control rod or control bank. These are considered fully misaligned rod transients caused by a single failure of the rod control system. Recall from Section 3.0 that a key assumption of the analysis documented in this report is that rod misalignments resulting from a SINGLE failure only need be considered, consistent with the current Westinghouse and Point Beach licensing basis. Series of [ ]^{a,c} do not need to be considered. Therefore, one does not need to assume a rod misalignment from the [ ]^{a,c} as a precondition to one of the above mentioned Condition II rod misalignment transients; such an assumption would be beyond the current Westinghouse licensing basis and overly conservative. As such, the proposed changes to the rod misalignment Tech Spec do not have an adverse impact on the safety analysis inputs for these accidents, or the DNB analysis results.

Another possible impact of the increase in the rod misalignment is an increase in the rod insertion allowance (RIA), the worth of the rods at their insertion limits or RILs. The RIA has a direct impact on the available trip reactivity and the shutdown margin (SDM) assumed in several transient analyses including steamline break. The maximum increase in the RIA, and hence largest reduction in the trip worth and SDM, would be due to an entire bank being misaligned in deeper than the RIL, consistent with failure category C described in Section 3.3. However, the available trip worth and SDM also assume that the core is subcritical with an N-1 rod configuration, where the highest individual worth rod is stuck out of the core, consistent with failure category D. As stated above, rod misalignments resulting from a SINGLE failure only need be considered, consistent with the current Westinghouse licensing basis. [ ]^{a,c}. Therefore, for the trip reactivity and SDM one does not need to assume an increase in the RIA due to [ ]^{a,c}. In addition, the reduction in available SDM due to the WSR is much greater than the worth that would be lost due to an increase in the RIA. As such, the proposed changes to the rod misalignment Tech Spec do not have an adverse impact on the available trip worth or SDM.

Safety analyses inputs that would be affected by an increase in the allowable misalignment are the rod ejection F_Q, the ejected rod worth $\Delta\rho_{EJ}$, and the available trip worth following a rod ejection accident.

To evaluate the effects of an increased rod misalignment on the rod ejection accident, a cycle depletion with [

]^{a,c}. This is a conservative assumption since Point Beach Units historically do not load follow nor operate with D bank deeply inserted.

The rod ejection parameters can be affected by an increased rod misalignment in two ways: a misalignment of any number of RIL rods during the last 30 effective full power days (EFPD) of the rodded depletion; or a misalignment of the RIL rods at HZP prior to the ejection. For the first scenario, [

]^{a,c}. For both scenarios, misalignments of individual rods, bank groups and entire banks were considered to determine the limiting effects on F_Q and $\Delta\rho_{EJ}$. Calculations were also performed for the limiting cycle, assuming either an additional 6 steps of rod misalignment during the last 30 EFPD of the HFP rodded depletion or an additional 12 steps of rod misalignment at the HZP RIL. Results of these calculations show maximum increases of [ ]^{a,c} in F_Q and [ ]^{a,c} in $\Delta\rho_{EJ}$. Again, recall that the future cycle has a feed assembly under all 4 of the RCCAs in the lead control bank D. As such, the future cycle yields larger non-misaligned values for the ejected rod F_Q and $\Delta\rho_{EJ}$. These values will be increased for conservatism. For application of this Technical Specification change, [

]^{a,c}.

5.0 CONCLUSIONS

An extension of the allowable indicated rod misalignment of ±12 steps to ±18 steps (to ±24 steps for bank demand ≥ 215 steps) may be permitted for core powers above 85% RTP as long as it is demonstrated that sufficient peaking factor margin is available. The amount of required margin is also linearly dependent upon the amount of additional misalignment desired, as shown in Figures 3.3 and 3.4, and summarized below

Power > 85% RTP, Bank Demand < 215 Steps:

Indicated Misalignment (Steps)	Additional Misalignment (Steps)	Required Margin	
		$F^N_{\Delta H}$	F_Q
12	0	0.00	0.00
13	1	0.33	0.83
14	2	0.67	1.67
15	3	1.00	2.50
16	4	1.33	3.33
17	5	1.67	4.17
18	6	2.00	5.00

Power > 85% RTP, Bank Demand ≥ 215 Steps

Indicated Misalignment (Steps)	Additional Misalignment (Steps)	Required Margin	
		$F^N_{\Delta H}$	F_Q
12	0	0.00	0.00
13	1	0.33	0.83
14	2	0.67	1.67
15	3	1.00	2.50

Indicated Misalignment (Steps)	Additional Misalignment (Steps)	Required Margin	
		$F^N_{\Delta H}$	F_Q
16	4	1.33	3.33
17	5	1.67	4.17
18	6	2.00	5.00
19	7	2.33	5.83
20	8	2.67	6.67
21	9	3.00	7.50
22	10	3.33	8.33
23	11	3.67	9.17
24	12	4.00	10.0

Indicated misalignments of up to 24 steps are also permitted for all powers of 85% RTP or less.

The analysis documented in this report has been performed such that the above mentioned excess peaking factor margin required for additional indicated rod misalignment is [ ]^{a,c}.

The analysis documented in this report is conservative and appropriate based on the following assumptions on rod insertion:

- The rod insertion limits (RILs) shown in Figure 3.2 determine the maximum bank demand position as a function of core power;
- The all rods out (ARO) demand position can be as deep as to the top of the active fuel stack for the Point Beach feed fuel assemblies.

The results of this report are also conservative and appropriate for any future change in the RILs that would reduce the maximum allowable rod insertion and for any ARO position above the top of the active fuel stack. Any future change to the RILs that would permit deeper rod insertion would also require an evaluation of the results of this report.

As part of the reload specific safety evaluation, design calculations will include the following additional conservatisms to bound the maximum increases in rod misalignment any time during the cycle:

- [
]a,c
- [
]a,c

6.0 REFERENCES

1. Shopsky, W. E., *Failure Mode and Effects Analysis (FMEA) of the Solid State Full Length Rod Control System*, WCAP-8976, Rev. 0 (Non-Proprietary Class 3), August 1977.

2. Baker, T., et. al., *Rod Control System Evaluation Program*, WCAP-13864, Revision 1-A (Non-Proprietary Class 3), November 1994.

3. Nguyen, T. Q., et. al., *Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores*, WCAP-11596-P-A (Westinghouse Proprietary), June 1988.

4. Liu, Y. S., et. al., *ANC: A Westinghouse Advanced Nodal Computer Code*, WCAP-10965-P-A (Westinghouse Proprietary), December 1985.

5. Miller, R. W. et. al., *Relaxation of Constant Axial Offset Control - FQ Surveillance Technical Specification*, WCAP-10216-P-A, Revision 1, February 1994.

6. Davison, S. L., et. al., *Westinghouse reload Safety Evaluation Methodology*, WCAP-9272-P-A, , July 1985.

APPENDIX A

This section provides some additional detail to the cases highlighted in Tables 3.3 and 3.6. These cases yielded the limiting increase in $F^N_{\Delta H}$, F_Q or both. The following figures provide the misaligned peaking factors compared to the reference non-misaligned case, and the percent differences relative to 24 steps of total misalignment (±12 steps indicated). Data in these figures are provided as a function of axial offset, covering the maximum expected range for the Point Beach Units. The data summarized in Tables 3.3 through 3.6 represents the maximum points from these figures.

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Figure A.1

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Figure A.2

Figure A.3

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Figure A.4

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Figure A.5

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Figure A.6

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Figure A.7

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Figure A.8

a,c

Figure A.9

a,c

Figure A.10

a,c

Figure A.11

a,c

Figure A.12

a,c

Figure A.13

a,c

Figure A.14

a,c

Figure A.15

a,c

Figure A.16

a,c