BAW-10179NP-A
Revision 8
May 2010

SAFETY CRITERIA AND METHODOLOGY FOR ACCEPTABLE CYCLE RELOAD ANALYSES

BAW-10179NP-A

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 14, 2010

Mr. Anthony Nowinowski, Manager
Owners Group Program Management Office
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: FINAL SAFETY EVALUATION FOR PRESSURIZED WATER REACTOR OWNERS GROUP TOPICAL REPORT BAW-10179P, REVISION 8, "SAFETY CRITERIA AND METHODOLOGY FOR ACCEPTABLE CYCLE RELOAD ANALYSES" (TAC NO. ME2169)

Dear Mr. Nowinowski:

By letter dated July 31, 2009, AREVA NP, Inc., on behalf of the Pressurized Water Reactor Owners Group (PWROG) submitted topical report (TR) BAW-10179P, Revision 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses," to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval for referencing in licensing actions. By letter dated December 4, 2009, an NRC draft safety evaluation (SE) regarding our approval of TR BAW-10179P, Revision 8, was provided for your review and comments. By letter dated December 22, 2009, the PWROG commented on the draft SE. The NRC staff's disposition of the PWROG's comments on the draft SE are discussed in the attachment to the final SE enclosed with this letter.

The NRC staff has found that TR BAW-10179P, Revision 8, is acceptable for referencing in licensing applications for Babcock and Wilcox designed nuclear power plants. The final SE defines the basis for our acceptance of the TR.

Our acceptance applies only to material provided in the subject TR. We do not intend to repeat our review of the acceptable material described in the TR. When the TR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this TR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC website, we request that PWROG publish accepted proprietary and non-proprietary versions of this TR within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed final SE after the title page. Also, they must contain historical review information, including NRC requests for additional information and your responses. The accepted versions shall include an "-A" (designating accepted) following the TR identification symbol.

If future changes to the NRC's regulatory requirements affect the acceptability of this TR, the PWROG and/or licensees referencing it will be expected to revise the TR appropriately, or justify its continued applicability for subsequent referencing.

Sincerely,

Thomas B. Blount

Thomas B. Blount, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure:
Final SE

cc w/encl: See next page

FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT BAW-10179P, REVISION 8

"SAFETY CRITERIA AND METHODOLOGY FOR

ACCEPTABLE CYCLE RELOAD ANALYSES"

PRESSURIZED WATER REACTOR OWNERS GROUP

PROJECT NO. 694

1.0 INTRODUCTION AND BACKGROUND

By letter dated July 31, 2009, AREVA NP, Inc. (AREVA), on behalf of the Pressurized Water Reactor Owners Group (PWROG) submitted topical report (TR) BAW-10179P, Revision 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses," (Reference 1) to the U.S. Nuclear Regulatory Commission (NRC) staff for review and approval for referencing in licensing actions.

The NRC through Generic Letter 88-16 allows the removal of cycle-dependent variables from technical specifications (TS) provided the values of these variables are determined with an NRC-approved methodology and are included in a Core Operating Limits Report (COLR). Furthermore, the NRC agreed (Reference 2) that this approach can be extended to the cycle-dependent protective and maximum allowable setpoint limits. As designer and fuel fabricator, AREVA prepares reload safety evaluations for a number of Babcock and Wilcox (B&W) – designed nuclear power plants with 177 fuel assemblies. The methodology for performing reload design evaluations is presented in topical report (TR) BAW-10179P-A, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses" (Reference 3). The utility owners, for whom AREVA performs reload safety evaluations, reference BAW-10179P-A in the Administrative Controls sections of the plant TS. The TS identify BAW-10179P-A as the NRC approved methodology for determining the limits contained in the COLR. The TS also state that the latest approved revision of BAW-10179P-A shall be specified in the COLR.

Subsequent to the submittal for approval of TR BAW-10179P-A, Revision 7, TR BAW-10164P-A, Revision 6, "RELAP5/MOD2 - B&W – An Advanced Computer Program for Light Water Reactor LOCA [loss-of-coolant-accident] and Non-LOCA Transient Analysis," was approved by the NRC for blow-down system and hot pin thermal transient analysis for B&W designed plants (Reference 4). The usage of TR BAW-10164P-A, Revision 6, is already described in TR BAW-10179P-A, Revision 7.

2.0 SUMMARY OF TOPICAL REPORT

TR BAW-10179P, Revision 8, incorporates by reference, through Appendix A, the TR BAW-10164P-A, Revision 6, into the reload methodology given in TR BAW-10179P-A, Revision 7. Appendix B of TR BAW-10179P provides a brief description of TR BAW-10164P-A, Revision 6.

ENCLOSURE

3.0 TECHNICAL EVALUATION OF THE REVISED REPORT SECTIONS

The significant difference between the Revision 8 of TR BAW-10179P, under current review, and the previously approved revision of BAW-10179P-A, Revision 7 is the incorporation, by reference, of information from the previously approved TR BAW-10164P-A, Revision 6, via Appendices A and B. Based on the previous approval of TR BAW-10164P-A, Revision 6, the NRC staff considers the information presented in the appendices and the attendant TR as acceptable.

3.1 Summary of the Key Content of the Newly Incorporated Appendices

Appendix A – Provides the reference to the relevant report that received NRC approval subsequent to the submittal of TR BAW-10179P-A, Revision 7 and is incorporated in TR BAW-10179P, Revision 8.

Appendix B – Summarizes, in tabular form, the changes incorporated into TR BAW-10164P-A, Revision 6, and points out that Revision 6 of TR BAW-10164P-A includes text changes to incorporate the NRC-approved B-HTP critical heat flux form of the departure from nucleate boiling correlation into the code TR supporting LOCA applications with AREVA Mark-B-HTP fuel designs.

3.2 Application to the Core Operating Limits Report Technical Specifications

The application of TR BAW-10179P, Revision 8, should be in compliance with NRC Generic Letter (GL) 88-16 guidance, which addresses the appropriate modifications to the Administrative Controls section of a facility's TS that are necessary to implement and use a COLR. In particular, (1) Identification of the individual specifications that address the core operating limits supported by the referenced approved TR for calculating the operating limits that have been relocated to the COLR may be included, if desired, in the Reporting Requirements of the plant TS; (2) the supported TR by TR number and title shall be provided in the Reporting Requirements of the plant TS; and (3) Specification of the TR by Number, Title, Revision Level, and Date of the approved TR shall be provided in the COLR.

4.0 CONCLUSION

The NRC staff has reviewed TR BAW-10179P, Revision 8. TR BAW-10179P, Revision 8, incorporates into the original NRC-approved TR BAW-10179P-A, Revision 7, the NRC approved TR BAW-10164P-A, Revision 6, "RELAP5/MOD2 - B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis."

On the basis of this review, the NRC staff approves the safety criteria and methodology for acceptable cycle reload analyses as documented in TR BAW-10179P, Revision 8. The application of the safety criteria and methodology for acceptable cycle reload analyses should be in compliance with NRC GL 88-16 guidance, including complete identification of the report, including revision level and date, in the COLR.

5.0 REFERENCES

1. Letter from R. L. Gardner to U. S. NRC, Subject: Request for Review and Acceptance of BAW-10179P, Revision 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis," dated July 31, 2009 (ADAMS Accession Number ML092170306).

2. Memorandum for Jose A. Calvo from David C. Fisher, Subject: Minutes of Meeting with the B&W Owners Group (BWOG) on the Technical Basis and Scope of the BWOG Core Operating Limits Report, dated July 19, 1989.

3. Letter from Ashok C. Thadani (NRC) to Joseph D. McCarthy (BWOG), Subject: Acceptance for Referencing of Licensing Topical Report BAW-10179-P, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses," dated March 16, 1993.

4. Letter from Ho K. Nieh (NRC) to Gordon Bishoff (BWOG), Subject: Final Safety Evaluation for AREVA NP, Inc., Topical Report BAW-10164P-A, Revision 6, "RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," dated June 25, 2007.

Principal Contributor: Y. Orechwa
T. Huang

Date: May , 2010

RESOLUTION OF COMMENTS ON DRAFT SAFETY EVALUATION FOR

TOPICAL REPORT BAW-10179P, REVISION 8

"SAFETY CRITERIA AND METHODOLOGY FOR

ACCEPTABLE CYCLE RELOAD ANALYSIS"

PRESSURIZED WATER REACTOR OWNERS GROUP

PROJECT NO. 694

This Attachment provides the U.S. Nuclear Regulatory Commission (NRC) staff's review and disposition of the comments made by the Pressurized Water Reactor Owners Group (PWROG) on the draft safety evaluation (SE) for topical report (TR) BAW-10179P, Revision 8. The PWROG provided its comments in a letter dated December 22, 2009, "Comments on BAW-10179 (P) Draft Safety Evaluation (PA-ASC-0545)."

Editorial changes suggested by the PWROG are noted in bold.

1. PWROG Comment (draft SE Page 1, Line 7):

Recommended modifying TR title: Change ANALYSIS to **ANALYSES**

NRC Resolution for Comment 1 on the draft SE:

The NRC staff agrees with this comment. The July 31, 2009, letter transmitting the TR states the title as "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis." The TR accompanying the transmittal letter states the title as "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses." For consistency between the titles of the SE and the actual TR, the staff made the suggested change.

2. PWROG Comment (draft SE Page 1, Lines 18):

Recommended changing "....a NRC-approved methodology...." to ".....**an** NRC-approved methodology...."

NRC Resolution for Comment 2 on the draft SE:

The NRC staff agrees with proposed wording.

3. PWROG Comment (draft SE Page 1, Line 32):

The following change is suggested: Revise "RELAP/MOD2" to "**RELAP5/MOD2**":

NRC Resolution for Comment 3 on the draft SE:

The NRC staff agrees with the proposed correction.

4. PWROG Comment (draft SE Page 1, Line 42):

The following change is suggested: Revise "BAW-10164P" to "**BAW-10164P-A**".

NRC Resolution for Comment 4 on the draft SE:

The NRC staff agrees with the proposed correction.

5. PWROG Comment (draft SE Page 2, Line 27):

The following change is suggested: Revise "analysis" to "**analyses**".

NRC Resolution for Comment 5 on the draft SE:

The NRC staff agrees with the proposed correction.

6. PWROG Comment (draft SE Page 2, Lines 37):

The following change is suggested: "…..acceptable…" should be revised to "**….Acceptable….**"

NRC Resolution for Comment 6 on the draft SE:

The NRC staff agrees with the proposed correction.

7. PWROG Comment (draft SE Page 2, Line 42):

Recommended that the date of the reference be added.

NRC Resolution for Comment 7 on the draft SE:

Reference 3 of the draft SE cited the wrong title. The NRC staff provided the correct title and date in the final SE.

8. PWROG Comment (draft SE Page 2, Line 44):

The following change is suggested: Revise "Principle" to "**Principal**".

NRC Resolution for Comment 8 on the draft SE:

The NRC staff agrees with the proposed correction.

CORRESPONDENCE

AREVA

July 31, 2009
NRC:09:082

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Request for Review and Acceptance of BAW-10179P, Revision 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis"

Ref. 1: BAW-10164P-A, Revision 6, "RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis," June 2007.

On behalf of the PWR Owners Group, AREVA NP Inc. (AREVA NP) requests the NRC's review and acceptance of topical report BAW-10179P, Revision 8, "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis," July 2009, for referencing in licensing actions. This revision consists of an appendix to BAW-10179P which is intended to provide an administrative update to the report only. Enclosed are the proprietary and non-proprietary versions of the appendix.

The appendix being provided by this letter contains no technical information to be reviewed. It is provided to incorporate BAW-10164P-A (Reference 1) into reload methodology.

AREVA NP requests that the NRC issue a Safety Evaluation Report (SER) that approves this topical report which will be used to support the B&W designed operating plants. AREVA NP requests that the NRC complete its review of the enclosed report and issue the SER by September 2009 in order to support the TMI fall outage.

AREVA NP considers some of the material contained in the enclosed documents to be proprietary. As required by 10 CFR 2.390(b), an affidavit is enclosed to support the withholding of the information from public disclosure.

If you have any questions related to this submittal, please contact Ms. Gayle F. Elliott, Product Licensing Manager at 434-832-3347 or by e-mail at gayle.elliott@areva.com.

Sincerely,

Ronnie L. Gardner

Ronnie L. Gardner, Manager
Corporate Regulatory Affairs
AREVA NP Inc.

Enclosures

cc: H. D. Cruz
Project 728
Project 694

BAW-10179NP
Revision 8
July 2009

SAFETY CRITERIA AND METHODOLOGY FOR ACCEPTABLE CYCLE RELOAD ANALYSES

BAW-10179NP

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ABSTRACT

Subsequent to the issuance of NRC Generic Letter 88-16, the B&W Owners Group (BWOG) authorized the preparation of topical report BAW-10179P-A entitled "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses." BAW-10179P-A was reviewed and approved by the NRC and is referenced in the Technical Specification reference for Core Operating Limit Report parameters for B&W-designed nuclear plants.

Since the original approval, six revisions to the report have been issued in the form of multiple appendices to incorporate additional NRC-approved codes and methods. In addition, the mechanical design code COPERNIC has received NRC approval, and a modified zero power physics testing program for B&W 177-FA plants has been incorporated. The purpose of Revision 7 was to:

1. Incorporate the appendices from Revisions 1 through 6 into the main body of the report,
2. Update the methodology to incorporate the new NRC-approved design code COPERNIC,
3. Update the methodology to incorporate the new NRC-approved statistical fuel assembly hold down methodology,
4. Provide a summary of the modified zero power physics testing program, and
5. Add clarification where needed and remove unnecessary information.
6. Provide generic guidelines on the use of limited scope high burnup lead test assemblies (LTAs) and satisfy the requirement to incorporate WCAP-15604-NP, Revision 2-A ("Limited Scope High Burnup Lead Test Assemblies) explicitly into the licensee's Technical Specifications by virtue of it being referenced in BAW-10179P-A.

The purpose of Revision 8 is to:

7. Add Appendices A and B to incorporate BAW-10164P-A, Revision 6 into reload methodology.

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LIST OF ACRONYMS

AMSAC	ATWS Mitigation System Actuation Circuitry
ANSI	American National Standards Institute
APSR	Axial Power Shaping Rod
AROCBC	All Rods Out Critical Boron Concentration
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
B_{eff}	Effective Delayed Neutron Fraction
B&W	The Babcock and Wilcox Company
BOC	Beginning-of-Cycle
BPRA	Burnable Poison Rod Assembly
BWOG	B&W Owners Group
CFM	Centerline Fuel Melt
CFR	Code of Federal Regulations
CHF	Critical Heat Flux
COLR	Core Operating Limits Report
CRA	Control Rod Assembly
CRAFT2	CRAFT2 Transient Analysis Computer Code
CRDM	Control Rod Drive Mechanism
CRG	Control Rod Group
DNB	Departure from Nucleate Boiling
DNBR	Departure from Nucleate Boiling Ratio
DSS	Diverse SCRAM System
ECCS	Emergency Core Cooling System
EFPD	Effective Full Power Days
EM	Evaluation Model
EOC	End-of-Cycle
EPRI	Electric Power Research Institute
FANP	Framatome ANP, Inc.
FFCD	Final Fuel Cycle Design
FP	Full Power (Full Rated Thermal Power)
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
GWd/mtU	Gigawatt Days per Metric Ton of Uranium
HFP	Hot Full Power
HPI	High Pressure Injection
HZP	Hot Zero Power
ID	Inner Diameter

LIST OF ACRONYMS

ITC	Isothermal Temperature Coefficient
LBB	Leak-Before-Break
LBLOCA	Large Break Loss-of-Coolant Accident
LCO	Limiting Condition for Operation
LHR	Linear Heat Rate
LOCA	Loss-of-Coolant Accident
LOCF	Loss-of-Coolant-Flow
LTA	Lead Test Assembly
MAP	Maximum Allowable Peaking
MTC	Moderator Temperature Coefficient
MWd/mtU	Megawatt Days per Metric Ton of Uranium
NRC	Nuclear Regulatory Commission
NSAC	Nuclear Safety Analysis Center
NSSS	Nuclear Steam Supply System
OBE	Operational Basis Earthquake
OD	Outside Diameter
pcm	Percent millirho (a reactivity measurement unit)
PCT	Peak Cladding Temperature
PIE	Post-Irradiation Examination
ppm	Parts Per Million
PSC	Preliminary Safety Concern
P-T	Pressure-Temperature
PV	Pressure-Velocity
RC	Reactor Coolant
RCS	Reactor Coolant System
RELAP5	RELAP5/MOD2-B&W Transient Analysis Computer Code
RIL	Rod Insertion Limit
RPD	Relative Power Density
RPS	Reactor Protection System
RTP	Rated Thermal Power
SAFDL	Specified Acceptable Fuel Design Limit
SAR	Safety Analysis Report
SBLOCA	Small Break Loss-of-Coolant Accident
SCD	Statistical Core Design
SDL	Statistical Design Limit
SDM	Shutdown Margin
SER	Safety Evaluation Report

LIST OF ACRONYMS

SGTR	Steam Generator Tube Rupture
SRSS	Square-Root-of-Sum-of-Squares
SSE	Safe Shutdown Earthquake
T_{avg}	Average Reactor Coolant Temperature
TCS	Transient Cladding Strain
TD	Theoretical Density
TDL	Thermal Design Limit
TIL	Time-in-Life (refers to burnup between 0 GWd/mtU and maximum analyzed burnup)
VLPT	Variable Low Reactor Coolant Pressure Trip
VMFT	Vessel Model Flow Test
ZPPT	Zero Power Physics Testing
4PSUT	Fourth Pump Startup Temperature
177-FA	177 Fuel Assembly

Appendix A

Additional NRC-Approved Documents

The following NRC-approved topical report was incorporated into BAW-10179P-A, Revision 8. This report received approval subsequent to the submittal of BAW-10179P-A, Revision 7 and describes codes/methodologies that replace or augment those previously described in that report. Appendix B provides a brief description of the report listed below.

1. BAW-10164P-A, Rev. 6, RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis", AREVA NP Inc., Lynchburg, Virginia, June 2007.

Appendix B

RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis – BAW-10164P-A, Revision 6

RELAP5/MOD2-B&W (topical report BAW-10164P-A Rev. 4) is the blowdown system and hot pin thermal transient code used in the BWNT LOCA EM (BAW-10192P-A) for B&W-designed plants. Usage of the code is described in BAW-10179P-A, Revision 7 (see Section 9.2). Revision 6 of BAW-10164P includes text changes to incorporate the NRC-approved B-HTP CHF form of the DNB correlation into the code topical report supporting LOCA applications with AREVA NP Mark-B-HTP fuel designs.

Revision 6 is based upon the text in the NRC-approved BWNT LOCA EM, which states that the CHF correlation used for the fuel DNB analyses will be used for the LOCA applications. Given the BWNT LOCA EM text, the NRC-approved B-HTP CHF correlation was added into RELAP5/MOD2-B&W. It has already been generically added to the BWNT LOCA EM via the 50.46 reporting process in 2003 and applied to the Mark-B-HTP LOCA applications for all B&W-designed plants. This code topical revision has been prepared to document this new CHF option and the application methods formally.

There are other minor changes described in Revision 6 of the RELAP5 code topical that include corrections to several typographical errors and user-input options for the coefficients and ranges of applications used in the general forms of the B-HTP and BWU CHF correlations. The general CHF options were added to the RELAP5 code to potentially facilitate future changes in the coefficients applied to these universal correlation forms without requiring a revision to the code topical report. These could possibly be used to accommodate minor fuel design modifications or coefficient changes related to refitting or tuning the correlations with additional DNB data that may span larger data ranges. Any future LOCA applications using the user-input coefficients for any of the CHF options would be based upon DNB methods supported by other documentation submitted to the NRC for approval.

The detailed changes incorporated into BAW-10164P-A Rev. 6, which are summarized in the following table, are based upon the NRC-approved Revision 4 of the topical. Revision 5 of BAW-10164P-A was submitted to the NRC to support a BWNT LOCA EM change that would have used RELAP5/MOD2-B&W to perform the system reflood analyses. Revision 5 was subsequently withdrawn by AREVA NP.

References

1. BAW-10164P-A, Rev. 6, "RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis", AREVA NP Inc., Lynchburg, Virginia, June 2007.

Summary of Changes Incorporated into BAW-10164P-A Rev. 6

Page	Type/Change	Item	Reason
---	Revision	Cover Page	Revision and Date
i-ii	Revision	Abstract	Revision and Date
vi	Revision	Topical Revision Record	Update topical revision. It should be noted that Rev. 5 was not approved and the associated Rev. 5 change pages are not included in Rev. 6
2.3-30	Revision	Equation for K_{gas}	Corrected indices on second summation consistent with Subroutine GASTHC
2.3-36	Revision	Description of ε_{TC}	Corrected the text to refer to the clad thermal expansion
2.3-64	Revision	Figure 2.3.3-1 c)	Additional CHF options listed
2.3-67 to 2.3-68	Revision	CHF Correlation Selection	Additional CHF options listed
2.3-78	Revision	$C1_{SE}$ Factor	Corrected units
2.3-80	Revision	CHF Correlations	Additional CHF options listed
2.3-83.1 to 2.3-83.9	Revision	CHF Correlations	Additional BWU BHTP CHF option as code convenience for use of future approved coefficients; Incorporation of approved BHTP CHF model; Additional BHTP CHF option as code convenience for use of future approved coefficients.
4-15	Revision	References	Addition of References
F-4	Revision	CHF Correlation Flags	Additional CHF options listed