AREVA

Realistic Thermal-Mechanical Fuel Rod Methodology For Boiling Water Reactors
Supplement 2: Mechanical Methods Responses to NRC Request for Additional Information

BAW-10247NP-A
Supplement
2Q1NP
Revision 0

April 2017

AREVA Inc.

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Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

Contents

Figures

INTRODUCTION

AREVA is consolidating the miscellaneous mechanical methods in BAW-10247P-A, Supplement 2 (Reference I-1) which were not updated in the base topical report. As part of this consolidation effort, the most recent operating experience data is provided in order to update the correlations for fuel rod bow, fuel rod growth, and fuel assembly growth. Supplement 2 does not introduce any changes to AREVA's existing BWR methodology with the exception of the correlation updates.

BAW-10247P-A, Supplement 2 was submitted for approval to the NRC in Reference I-2. The NRC subsequently requested additional information in Reference I-3 in order to complete the review. This document supplies AREVA's responses to the NRC's request for additional information.

References:

I-1. BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

I-2. Letter, Gary Peters (AREVA, Inc.) to NRC Document Control Desk, "Request for Review and Approval of BAW-10247P-A Supplement 2P, Revision 0, Realistic Thermal Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods," April 29, 2016.

I-3. Letter, Kevin Hsueh (NRR) to Gary Peters (AREVA, Inc.), "Request for Additional Information Re: AREVA Inc. Topical Report BAW-10247P-A, Supplement 2P, Revision 0, 'Realistic Thermal Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods'," February 23, 2017.

RAI-1:

Regarding measurements supporting the rod-to-rod gap closure correlation, the topical report (TR) states that the fuel rod-to-rod gap measurements are generally performed at each span between spacer grids and for each gap. The text should be changed to indicate that each span and gap must be measured so that the correlation remains unbiased (i.e., not measuring each span and every gap could invalidate the derived 95/95 upper tolerance limit (UTL)). Revise the text describing the methodology or justify not doing so. Also, describe any changes to the measurement tool and techniques to acquire the rod bow data relative to XN-75-32(P)(A), Supplement 1.

AREVA Response RAI-1:

The text in question from Attachment A reads as follows:

Fuel rod-to-rod gap measurements are typically taken at each span between spacer grids (usually 8 spans) at mid-span for each fuel rod-to-rod gap.

This text is replaced by:

Fuel rod-to-rod gap measurements are taken at each span between spacer grids. All accessible rod-to-rod gaps are measured. Some internal locations, such as those behind the water channel, are not always accessible by the tool. It is expected that the internal rods are lower power and less likely to be limiting with respect to rod bow.

The corresponding text changes to Appendix A, Pages A-1 and A-2, of Supplement 2 are shown in Attachment 1.

If measurements are missing within a fuel assembly AREVA risks introducing bias into the calculated tolerance limit. A review of the database determined that the following fuel assemblies are missing data from at least one span:

Fuel Assembly	Exposure (MWD/kgU)	Measured spans
KG-30993L	0	2 to 8
KG-30995G	39.588	3,6,7
C776	28.225	2,3
BZ705	37.672	2 to 7
BC205	24.52	1 to 6
BC191	23.15	1,2,3,6,7

If we remove these fuel assemblies from the database, this leads to the following fitted parameters:

[ ]

The corresponding 95/95 UTL curves (see Equation A-4) are the following:

Figure 1-1: Worst span, 95/95 UTL curve

The curve obtained by removing the Fuel Assemblies bounds the original curve. The maximum difference is [ ] . This difference, which comes from the lower amount of data creating a new curve with an increased k factor (T= k•s), is negligible compared to the 20% extra margin included in the correlation presented in the topical report (Reference 1-1). Therefore, it is not necessary to change the correlation initially submitted.

The measurement tool and techniques have not changed over time.

RAI-1 Response References:

1-1 BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

RAI-2:

The various models defined in Appendices A, B, and C of the TR are based on [ ]. However, Equation A-3 includes a [ ] of Reference A-1 in the TR. This table was not meant to be used for [ ]. Reference A-1, includes information for [ ]

Furthermore, use of statistical tolerance factors for a [ ], as discussed in Reference 1, assumes: (1) the random error follows a normal distribution with mean 0 and some standard deviation, and (2) the observations to be statistically independent of each other, i.e., the correlation of y_i and y_j for i not equal to j is zero. Looking at the data in Figure A-1, "[ ] BWR Fuel Rod Bow Correlation," it appears that the assumption of statistical independence is not valid as there are distinct clusters in the data marked by vertical lines. Furthermore, it is not clear that the random error follows a normal distribution. Consequently, use of the one-sided statistical tolerance factor as described in the TR does not appear to be justified.

a. *Update Equation A-3 based on the discussion above or explain why the model remains appropriate.*

b. *Regarding Equation A-2, what are [ ] and [ ] defined as? An [ ] is specified but not used; update the equation accordingly.*

c. *Similar to Part a., update Equation B-1 or explain why the model specified by Equation B-1 remains appropriate. Also note that Figure B-1, "BWR Fuel Rod Growth Correlation for [ ] SRA Cladding," appears to show a [ ], and the tolerance factor used does not account for this. The U.S. Nuclear Regulatory Commission (NRC) staff notes that this may be caused by oversimplification of the model due to the lumping of subgroups into a single group.*

d. *Similar to Part a., update Equation C-1 or explain why the model specified by Equation C-1 remains appropriate.*

e. *The "s" term (i.e., the standard deviation) in Equations B-2 and C-2 are inconsistent with the analogous term used in the fuel rod bow model given in Equation A-2. Revise the "s" term in Equations B-2 and C-2 to be consistent with the [ ] in Equation A-2 or explain why using the standard deviation is appropriate.*

f. *Provide the data supporting the fuel rod bow, fuel rod growth, and fuel assembly growth correlations in tabular format so that the NRC staff can perform confirmatory calculations to either verify the validity of: (1) the corresponding [ ] presented in the TR, or (2) of any model updates in response to Parts a. through e. of this request for additional information. [*

]

AREVA Response RAI-2:

Contrary to what is implied in the report text, the bow and growth models are not the result of a [ ]. Instead, [ ] are presented in Appendices A, B and C which are based on [ ]. The following general approach, which was also used for model parameter uncertainties in RODEX4 (Ref. BAW-10247, Section 5.4), was employed in [ ] of the three correlations in Appendices A, B and C.

First, [

]

[redacted]

[redacted]

[

]

Specific responses to sub-questions are as follows:

AREVA Response RAI-2a:

[

]

AREVA Response RAI-2b:

Indeed, Equation A-2 is equivalent to the general equation (4) and the [

].

Page A-4 in Attachment 1, shows the revised equation A-2.

AREVA Response RAI-2c:

The same arguments as for item 'a' apply here. [

]:

[

]

Figure 2-1: Frequency Distribution of Rod Growth Residuals

AREVA Response RAI-2d:

The response to sub-part 'a' applies here as well.

AREVA Response RAI-2e:

The justification for items 'a' and 'd' applies here, too. As explained above, [

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Page A-4 in Attachment 1 shows the revision of "The standard error of the square root function with curve fitted parameters with respect to the data..." to "The standard deviation of the difference between the measured and predicted values for the entire data set...".

AREVA Response RAI-2f:

Due to the amount of supporting data, the requested data has been provided in digital format on a DVD. The DVD contains three Excel files, one file for each correlation which are labeled accordingly.

The rod bow file provides the fuel assembly ID (FA_ID) in the first column, the fuel assembly average burnup (Burnup) in MWd/kgU in the second column, and the gap closure data in the third column.

The fuel rod growth file provides the fuel assembly ID (Assy ID) in the first column, the rod number (Rod) in the second column, the fuel assembly average burnup (FA Average BU) in MWd/kgU in the third column, and the rod growth in percent in the last column.

The fuel assembly growth file provides the fuel assembly ID (Assembly ID) in the first column, the fuel assembly burnup (Assy Exposure) in MWd/kgU in the second column, and the fuel assembly growth in percent in the third column.

RAI-2 Response References:

2-1 BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

RAI-3:

The TR does not provide a discussion of how the updated rod-to-rod gap closure correlation is applied in downstream safety analysis methods -- it is only mentioned that "the rod-to-rod gap closure predicted as a function of fuel assembly exposure is used as an input to thermal limit evaluations (i.e., MCPR) for AREVA BWR fuel designs." Describe how the rod bow empirical model is used in downstream safety analyses. Consider the following NRC staff observations for additional context:

The discussion at the end of "Accepted Version of Exxon Nuclear Licensing Topical Report, XN-NF-85-67(P)(A), 'Generic Mechanical Design for Exxon Nuclear Jet Pump BWR Reload Fuel" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML081760201), Section 3.4.9, "Fuel Rod Spacing and Rod Bow" states:

[

]

Does this mean that spacings have never been reduced enough to warrant a minimum critical power ratio (MCPR) penalty? Is this still true? If so, what is the latest licensing basis that states this?

Further, TR ANP-2637, Revision 6, "BWR Licensing Methodology Compendium" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15282A224), Section 2.2.6, 'Rod Bowing,' states:

> *Rather than placing design limits on the amount of bowing that is permitted, the effects of bowing are included in the cladding overheating analysis by limiting fuel rod powers when bowing exceeds a predetermined amount. AREVA uses an approved methodology (Reference 2-9) to determine a rod-to-rod clearance closure limit below which a penalty is addressed on the MCPR and above which no reduction in MCPR is necessary. The methodology is based on empirical data (Reference 2-2) to calculate minimum end of life rod-to-rod spacing. The potential effect of this rod bow on thermal margin is negligible.*

Rod bow at extended burnup does not affect thermal margins due to the lower powers achieved at high exposure.

What approved TR describes how "the effects of bowing are included in the cladding overheating analysis by limiting fuel rod powers when bowing exceeds a predetermined amount"?

Reference 2-9 mentioned in the quoted passage above is XN-NF-82-06(P)(A), Supplement 1, Revision 2, "Qualification of Exxon Nuclear Fuel for Extended Burnup," Supplement 1, "Extended Burnup Qualification of ENC 9x9 BWR Fuel," Advanced Nuclear Fuels Corporation, May 1988. This reference does not give a formulation for the MCPR penalty that would be applied if rod-to-rod closure is greater than the 95 percent UTL given by the corresponding correlation. What approved topical report describes the MCPR penalty formulation?

AREVA Response RAI-3:

The rod bow MCPR penalty is determined [

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AREVA's BWR rod bow CPR penalty was derived using open literature data (Reference 3-4, Attachment 1). Based on this data, it was concluded that thermal margins were not substantially reduced for closures as low as 0.06 inch (59% closure). Based on the available data, a conservative model of CPR as a function of rod spacing was described (Reference 3-4, Attachment 1).

AREVA's rod bow model application to ATRIUM 10 type fuel was presented in an informational submittal to the NRC (Reference 3-1) and the application for ATRIUM 10XM fuel was presented in Reference 3-2. The CPR penalty (decrease in CPR) versus rod bow (% closure) is presented in Figure 3-1, below. To confirm the conservatism of this model, AREVA ran a critical power test on an ATRIUM-10 design test assembly

where two rods were bowed to touch (i.e. 100% gap closure). The maximum measured CPR penalty in the test was [ ] (as shown in Figure 3-1). The conservatism of the model was confirmed.

Figure 3-1: CPR Penalty vs Test Data

From Figure 3-1, the CPR penalty begins at [ ]. It is evident when examining Figure A-1 of Reference 3-5 that the rod bow impact on CPR does not begin until exposures of approximately [ ] are reached. [

].

AREVA has implemented guidelines (Reference 3-3, Section 6.4.3) to ensure the application of MCPR penalties for % gap closures above [ ]. The appropriate rod bow penalty has been included in the MCPR operating limits in MICROBURN-B2 for core monitoring.

RAI-3 Response References

3-1. EMF-95-52(P) Revision 1, Fuel Design Evaluation for Siemens Power Corporation ATRIUM™-10 BWR Reload Fuel, April 1998, transmitted to the NRC by Siemens Power Corporation Letter, "Design Evaluations for SPC ATRIUM™-9B and ATRIUM™-10 Fuel", April 8, 1998, (NRC:98:021).

3-2. ANP-3289P Revision 0, Responses to RAI from SNPB on MNGP Transition to AREVA Fuel, February 2014.

3-3. EMF-2001(P), Guidelines for BWR Safety Analysis, P110,3201, "MCPRp Limits and LHGRFACp Multipliers (Heat Flux Ratio)," AREVA NP, December 2015.

3-4. XN-NF-82-06(P)(A) Supplement 1 Revision 2, Qualification of Exxon Nuclear Fuel for Extended Burnup, Supplement 1, Extended Burnup Qualification of ENC 9x9 BWR Fuel, May 1980.

3-5. BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

RAI-4:

a. *Describe the process for fuel assembly selection when fuel rod growth measurement data is generated for the measurement database supporting the corresponding correlation to ensure that the correlation remains unbiased (i.e., inconsistent data generation could invalidate the derived [ ]). Is growth measurement data entered into the database for all fuel rods in a given fuel assembly selected for fuel rod growth measurement?*

b. *Similarly, describe the process for fuel assembly selection when internal water channel growth measurement data is generated for the measurement database supporting the corresponding correlation.*

AREVA Response RAI-4a:

Generally, fuel assemblies are not necessarily chosen for the expressed purpose of taking fuel rod growth measurements. Fuel assemblies are generally chosen for a number of reasons. For example, assemblies could be chosen because they are limiting for corrosion after water chemistry changes, or because they are useful to explore the boundary of operating experience (e.g., burnup, time, fluence, etc.) in healthy fuel exams, or just because they are lead assemblies. Therefore, any bias would be conservative, i.e., toward the measurement of assemblies viewed as limiting in some aspect. When an assembly has been chosen for fuel rod growth measurements, not all fuel rods in the assembly are always measured. However, all rods that are measured during the inspection are included in the database. The change process as described in RAI 10 will be followed when updating the growth correlations after incorporation of new measurements into the database.

AREVA Response RAI-4b:

The process for fuel assembly selection for water channel growth measurements are the same as the selection for rod growth.

RAI-5:

Is there any [ ] clad fuel rod growth data included in Figure B-1 of the TR? Including [ ] clad fuel rod growth data would be inappropriate since EMF-85-74(P)(A), Supplement 2, Revision 0, noted that fuels with [ ] and inclusion of this data could bias the data non-conservatively.

AREVA Response RAI-5:

[ ] cladding is included in the growth database, or described in Reference 5-1.

RAI 5 Response References

5-1. BAW-10247PA, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," April 2008.

RAI-6:

Regarding the fuel rod growth enhancement factor that accounts for the presence of chromia-doped fuel, the following statement is made: "[

]." It is understood that the mechanism for increased axial growth is the same; however, it is not clear that the magnitude of the effect will be the same. Provide data similar to that in Figure B-2 for SRA cladding to support the claim that the enhancement factor will be the same for fuel with either RXA or SRA cladding.

AREVA Response RAI-6:

The net rod axial growth is the combined result of irradiation growth and axial creep due to axial PCMI. As mentioned in response to RAI-7a, [

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The extension to [

].

RAI-7:

The summary regarding the BWR fuel rod growth correlation in Appendix B of the TR, states: "Based on the data and similarity in manufacturing processes, the BWR rod growth correlation is fully applicable to AREVA BWR fuel rod designs with SRA [ ] Zry-2 cladding."

a. *Has a similar correlation been developed and implemented for RXA cladding? If so, where is this discussed?*

b. *Confirm that the RODEX4 rod growth model is unaffected by the updated fuel rod growth database in the TR. For example, determination of the rod free volume depends on the rod growth model. This rod growth model, described in Section 4.2.6, "Rod Axial Elongation" of TR BAW-10247PA, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," doesn't currently include the effects of chromia-doped fuel which exhibits more rod growth compared to non-doped fuel. Also, describe any other equation constants and tuning parameters derived in the base topical report that are potentially affected by the new data provided in the TR. If AREVA believes that impacts to RODEX4 are beyond the scope of the TR review, explain where these issues have been addressed or will be addressed (e.g., in other supplements that have been previously approved or are currently under review).*

AREVA Response RAI-7a:

A similar fuel rod growth correlation for BWR RXA cladding has not been developed or implemented for application in the U.S. at this time. [

]

AREVA Response RAI-7b:

The rod growth model, mentioned in Section 4.2.6, "Rod Axial Elongation" of Reference I-1, is fully described in the RODEX4 Theory Manual, Reference 7-2. As stated in both documents, [

].

The SRA Zry-2 data that have been used for RODEX4 verification and validation are 2008 vintage and include a large fraction of the "new data" of Appendix B of Reference 7-3. This has been documented in response to RAI-20b in Reference I-1.

Moreover, as can be seen from Figure B-1 of Reference 7-3, [

].

[

].

RAI 7 Response References

7-1 BAW-10247PA, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," April 2008.

7-2 EMF-2994(P), Revision 6, "RODEX4: Thermal-Mechanical Fuel Rod Performance Code Theory Manual," February 2012.

7-3 BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

7-4 ANP-10340P, Revision 0, "Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods," April 2016.

7-5 Griffiths, M., Gilbert, R. W., and Fidleris, V., "Accelerated Irradiation Growth of Zirconium Alloys," Zirconium in the Nuclear Industry: Eighth International Symposium, ASTM STP 1023, 1989, pp. 658-677.

RAI-8:

It appears that some ATRIUM-10 data from the previously approved fuel assembly growth model in EMF-85-74(P)(A), Supplement 2, Revision 0, has been removed when comparing Figure C-1 of the TR and the figure in Reference A.2 of EMF-85-74(P)(A), Supplement 2, Revision 0. In particular, the 2 points around [ ] with values of approximately [ ] are no longer present in Figure C-1. Provide justification for why data points were removed from either the fuel assembly or fuel rod growth model development process if this is the case.

AREVA Response RAI-8:

We have performed a thorough analysis of the fuel assembly growth database and the two data points referenced above were excluded. Measurement of the same assemblies after subsequent cycles showed lower growth, and therefore the two earlier data points were deemed inaccurate. These two data points were not included in the database, or correlation. In addition, fuel rod data from these assemblies are not applicable to the U.S. BWR fuel rod growth database as they are made of RXA material.

RAI-9:

Why isn't an upper bound maximum fuel channel growth curve included in the TR as was done for the previously approved evaluation of fuel channel overlay with the lower tie plate seal spring in EMF-85-74(P)(A), Supplement 2, Revision 0? A value of [ ] was determined at a burnup of [ ] previously and it appears that the new data presented in Figure C-1 would cause a significant increase in the upper bound curve.

AREVA Response RAI-9:

In the cited reference, the [

] . As described on Page 4-7 of the supplement 2 topical report, Reference 9-1 "...only the loss of clearance between the fuel rod and the upper tie plate has the potential to affect safety margins since interference may cause additional rod bow and lead to fuel rod failures." This means that methods for evaluating other dimensional changes in the fuel assembly are not presented in this current report for NRC approval since the evaluations do not impact safety margins. For the specific evaluation of the fuel channel overlay of the lower tie plate seal spring, the safety margin calculation is reliant on having an accurate or conservative estimation of the leak rate to the bypass. The accuracy required for leak rate at end of life is so low that seal spring coverage becomes irrelevant. Analyses have shown, such as the one sent to the NRC in Reference 9-2, that the additional leakage from losing seal spring contact at end of life is not enough to affect the safety margins.

RAI-9 Response References

9-1. BAW-10247P-A, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." April 2016.

9-2. Letter, H. D. Curet (SPC) to NRC Document Control Desk, ATTN: Mr. T. E. Collins, Subject: "NRC request for Safety Assessment Related to Failed Seal Springs," ML# 9710140031, HDC:97:108, dated October 3, 1997.

RAI-10:

The update process for the models described in the TR is described in Section 5.0, "UPDATE PROCESS."

a. *Although the TR data appears to be predictable based on burnup alone, growth of SRA Zry-2 depends on factors such as the amount of cold work (i.e., manufacturing process) and the presence of hydrogen or hydrides due to corrosion. Explain why the TR correlation will be adequate to bound future fuel rod designs that may have different manufacturing processes, plant water chemistry, etc.*

b. *During the acceptance review, AREVA stated that fuel rod growth is independent of fuel design and that cladding material drives the need for different growth correlations. However, the need for an [*

],

demonstrate otherwise. Given the provided data, explain why fuel rod growth will remain independent of future fuel designs (e.g., ATRIUM 11 and other evolutions of this design that may or may not contain fuel additives). This may be covered under Section 5.0, "Update Process," of the TR.

c. *Although the section states that models will be reviewed against a growing post irradiation examination database, it does not specify with what frequency. If the frequency is too low, data may be added that could non-conservatively invalidate current models without having to submit updated models for NRC review and approval. Specify an appropriate minimum frequency.*

d. *The following statement does not contain a sufficient level of specificity: "The threshold for submittal of the growth and bow correlations is an increase of the correlation tolerance limits by one standard deviation." To fully understand the criterion, provide additional specificity. For example: (1) Provide the mathematical definition of the standard deviation being referred to and why it is appropriate (e.g., Why not use standard error?), and (2) Does the increase have to be observed over the entire burnup range, some subset of the burnup range, or something else?*

AREVA Response RAI-10a and RAI-10b:

The fuel rod growth correlations are not adequate to bound future fuel rod designs with significantly different manufacturing processes, plant water chemistry, fuel designs, or new materials. In such cases, out of pile testing and leads programs are undertaken to acquire the necessary data to support evaluation methods which are presented to the NRC for approval. The new chromia-doped fuel product is an example of such a program. However, in the absence of significant changes the current fuel rod growth correlations are adequate to bound future performance since they are based on well-populated databases with data from multiple fuel assembly designs and varying plant chemistries. The factors which affect rod growth are well known and AREVA will not introduce changes to manufacturing or operation that may result in performance that deviates from the established database without a test or demonstration program. It is possible that performance may drift over time with the accumulation of small changes in design or operation. This is monitored through the acquisition and evaluation of new post-irradiation data with modifications of the growth correlation subject to the Update Process described in Section 5.0 of the topical report.

AREVA Response RAI-10c

All post-irradiation data is reviewed as it is acquired with thresholds available to site personnel to indicate data which requires urgent review by engineering. The exam reports sent to the customer summarize the data and evaluate whether it was within expectations based on current approved models and analyses of record supporting fuel licensing. If the data is outside the predictions, an internal condition report will be created and evaluated for potential Part 21 reporting. Assuming the acquired data is within the predicted range, the database would only be reviewed annually subject to the Update Process described in Section 5.0 of the topical report.

AREVA Response RAI-10d

New measurement data, as described in response to 10c, will be added to the applicable databases. Using the same method as described in RAI-2, the new upper or lower limits supported by the updated database will be calculated. If the new limits are outside the envelope defined by the approved limits plus or minus one standard deviation, a new correlation will be submitted to the NRC for approval. This is the same threshold for resubmittal as previously approved for similar correlations used in Reference 10-1 and 10-2. If the new limits are within the envelope, then AREVA can use the updated correlation without prior approval by the NRC.

RAI-10 Response References

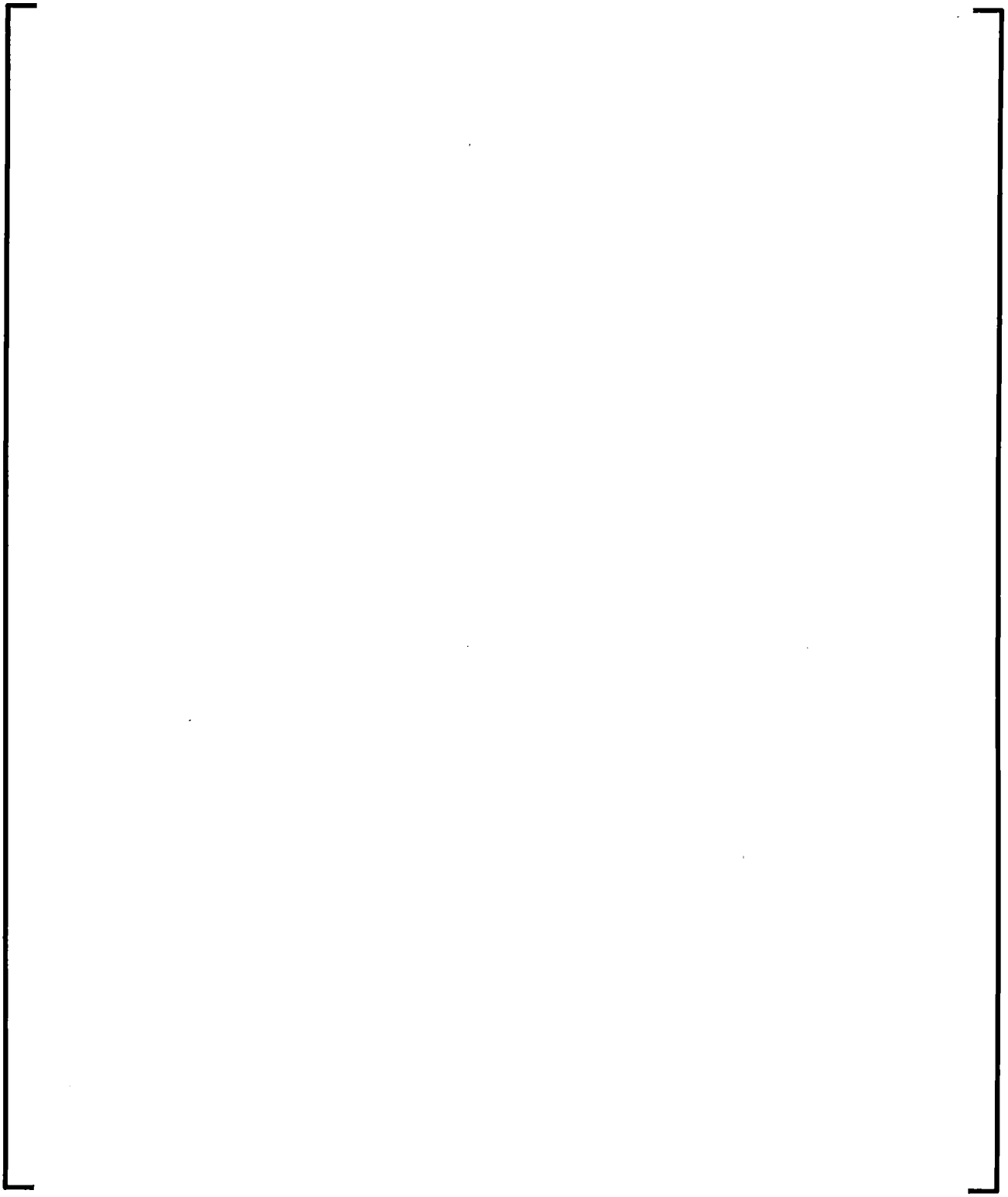
10-1. Letter from H. N. Berkow (NRC) to R. L. Gardner (AREVA), "Final Safety Evaluation for Framatome ANP (FANP), Topical Report (TR) EMF-93-177(P) Revision 1, Mechanical Design for BWR [Boiling Water Reactor] Fuel Channels, (TAC NO. MC5665)," August 23, 2005, Section 4.0 of Enclosure.

10-2. EMF-85-74(P)(A) Revision 0 with Supplement 1 (P)(A) and Supplement 2 (P)(A), RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Models, Siemens Power Corporation Nuclear Division, Richland, WA (98Feb.), Supplement 2 page A-2.

ATTACHMENT 1:

Planned Marked Up Pages For BAW-10247PA Supplement 2P Revision 0

[redacted]



[redacted]

AREVA

April 27, 2017
NRC:17:022

U.S. Nuclear Regulatory Commission
Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Response to Request for Comment on AREVA Inc. Topical Report BAW-10247PA, Revision 0, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods"

Ref. 1: Letter, Gary Peters (AREVA Inc.) to Document Control Desk (NRC), "Request for Review and Approval for BAW-10247P-A, Revision 0, Supplement 2P, Revision 0, 'Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods'," NRC:16:012, April 29, 2016.

Ref. 2: Letter, Jonathan G. Rowley (NRC) to Gary Peters (AREVA Inc.), "Request for Additional Information Re: AREVA Inc. Topical Report BAW-10247P-A, Supplement 2, Revision 0, 'Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods'," (CAC NO. MF7708), February 23, 2017.

In Reference 1, AREVA Inc. (AREVA) requested the NRC's review and approval of the topical report BAW-10247P-A, Revision 0, Supplement 2P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 2: Mechanical Methods." The NRC provided a request for additional information (RAI) in Reference 2. AREVA's response to the RAI is enclosed to this letter. Also enclosed to this letter is a DVD including data referenced in the enclosed response to the NRC's RAI 2-f.

AREVA considers some of the information contained in the enclosures to be proprietary. As required by 10 CFR 2.390(b), an affidavit is enclosed to support withholding the information from public disclosure. Proprietary and non-proprietary versions of the RAI responses are provided.

There are no new commitments within this letter or its enclosures.

AREVA INC.

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If you have any questions related to this letter please contact Mr. Morris E. Byram, Product Licensing Manager, by telephone at 434-832-4665 or by e-mail at Morris.Byram@areva.com.

Sincerely,

Gary Peters, Director
Licensing & Regulatory Affairs
AREVA Inc.

cc: J. G. Rowley
Project 728

Enclosures:

1. A Proprietary Copy of the Report, BAW-10247PA, Revision 0, Supplement 2Q1P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 1: Mechanical Methods – Responses to NRC Request for Additional Information"
2. A Non-Proprietary Copy of the Report, BAW-10247PA, Revision 0, Supplement 2Q1P, Revision 0, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 1: Mechanical Methods – Responses to NRC Request for Additional Information"
3. DVD: "Rod Bow, Fuel Assembly Growth, and Fuel Rod Growth Data Referenced in RAI 2f Response of BAW-10247PA, Rev. 0, Supp. 2 Q1P Rev. 0"
4. Notarized Affidavit

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Morris Byram. I am Manager, Product Licensing, for AREVA Inc. (AREVA) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA to determine whether certain AREVA information is proprietary. I am familiar with the policies established by AREVA to ensure the proper application of these criteria.

3. I am familiar with the AREVA information contained in the report BAW-10247PA, Revision 0, Supplement 2Q1P, Revision 0, entitled "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors Supplement 1: Mechanical Methods Responses to NRC Request for Additional Information," and the DVD files named "Fuel Assembly Growth.pdf', "Fuel Rod Growth.pdf', and "Rod Bow.pdf" referred to herein as "Documents." Information contained in these documents has been classified by AREVA as proprietary in accordance with the policies established by AREVA Inc. for the control and protection of proprietary and confidential information.

4. These documents contain information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in these documents as proprietary and confidential.

5. These documents have been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in these documents

be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA, would be helpful to competitors to AREVA, and would likely cause substantial harm to the competitive position of AREVA.

The information in these documents is considered proprietary for the reasons set forth in paragraphs 6(c), 6(d), and 6(e) above.

7. In accordance with AREVA's policies governing the protection and control of information, proprietary information contained in these documents has been made available, on a limited basis, to others outside AREVA only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Morris E Byram

SUBSCRIBED before me this 26th day of April, 2017.

Hailey M. Siekawitch

HAILEY M SIEKAWITCH
Commission Expires
NOTARY PUBLIC
Sept. 28, 2020
STATE OF WASHINGTON