AREVA

November 11, 2013
NRC:13:082

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

Response to a Request for Additional Information Regarding EMF-92-116(P)(A), Revision 0, Supplement 1, Revision 0

Ref. 1: Letter, Pedro Salas (AREVA NP Inc.) to Document Control Desk (NRC), "Request for Review and Approval of EMF-92-116(P)(A), Revision 0, Supplement 1, Revision 0, 'Generic Mechanical Design Criteria for PWR Fuel Designs'," NRC:11:117, December 19, 2011.

Ref. 2: Letter, Joseph Golla (NRC) to Pedro Salas (AREVA NP Inc.), "Request for Additional Information Re: AREVA Topical Report EMF-92-116(P)(A), Revision 0, Supplement 1, Revision 0, 'Generic Mechanical Design for PWR Fuel Design' (TAC No. ME7962)," October 18, 2013.

AREVA NP Inc. (AREVA NP) requested the NRC review and approval of Topical Report EMF-92-116(P)(A), Revision 0, Supplement 1, Revision 0, "Generic Mechanical Design Criteria for PWR Fuel Designs" dated December 2011 in Reference 1. The NRC provided a Request for Additional Information (RAI) in Reference 2. Responses to Questions 1.a, 1.b, 2.a and 4 of the NRC RAI (Reference 2) are provided in Attachment A to this letter. A schedule to provide a response to Question 3 in the RAI will be provided no later than January 31, 2014.

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. Proprietary and non-proprietary versions of Attachment A are enclosed.

This letter contains one commitment. A schedule to provide a response to Question 3 in the RAI will be provided no later than January 31, 2014.

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

Sincerely,

Pedro Salas, Director
Regulatory Affairs
AREVA NP Inc.

AREVA NP INC.

Enclosures:

1. Proprietary Version of Attachment A "Response to RAI on EMF-92-116(P)(A) Revision 0, Supplement 1 Revision 0"
2. Non-Proprietary Version of Attachment A "Response to RAI on EMF-92-116(P)(A) Revision 0, Supplement 1 Revision 0"
3. Notarized Affidavit

cc: J.   A.   Golla
        Project 728

AFFIDAVIT

COMMONWEALTH OF VIRGINIA   )
) ss.

CITY OF LYNCHBURG   )

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

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

3.   I am familiar with the AREVA NP information contained in the document NRC:13:082, "Response to a Request for Additional Information Regarding EMF-92-116(P)(A), Revision 0, Supplement 1, Revision 0," dated November 2013 and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

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

5.   This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document 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 NP to determine whether information should be classified as proprietary:

(a)   The information reveals details of AREVA NP'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 NP.

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

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

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

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

8.   AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.
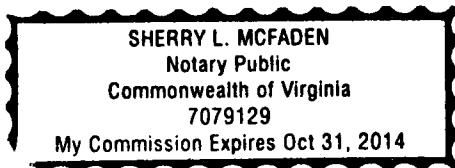
9.   The foregoing statements are true and correct to the best of my knowledge, information, and belief.

SUBSCRIBED before me this __11th__

day of __November__ 2013.

Sherry L. McFaden
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 10/31/2014
Reg.#7079129

Attachment A:
Response to RAI on EMF-92-116PA Revision 0, Supplement 1 Revision 0

Questions 1 through 4 Background

The following information is required to assess whether or not the applicant has demonstrated that the fuel system design will meet the criteria in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, General Design Criteria (GDC) for Nuclear Power Plants, GDC-10 "Reactor Design," GDC-27 "Combined Reactivity Control Systems Capability," and GDC-35 "Emergency Core Cooling." Regulatory guidance for the review of fuel system designs is provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP), Section 4.2, "Fuel System Design." The objectives of the fuel system safety review are to provide assurance that:

a. The fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs),

b. Fuel system damage is never so severe as to prevent control rod insertion when it is required,

c. The number of fuel rod failures is not underestimated for postulated accidents, and

d. Coolability is always maintained.

GDC 10 establishes specified acceptable fuel design limits (SAFDLs) that should not be exceeded during any condition of normal operation, including the effects of AOOs. The SAFDLs are established to ensure that fuel is not damaged.

SRP 4.2 discusses all fuel failure criteria and the below questions are based on these criteria:

Question 1 SRP 4.2 Acceptance Criteria 1.B.iv – Overheating of Fuel Pellets

Question 1.a

Please discuss the methodology that AREVA uses in its reload process to ensure that [

] with regards to fuel melt. Also, describe how this process continues to be valid as

[

]

Response 1.a

The AREVA NP, Inc (AREVA) methodology used during reload analyses so that [

]

The process used is:

Figure 1-1 Example of Once Burnt Fuel FCM Limit Verification

Question 1.b

Please provide a revised Figure 6 with the burnup extended to [   ] and ensure the
response to 1.a. above accounts for the maximum expected penalty.

Response to 1.b.

EMF-92-116PA, Supplement 1, Section 2.8 describes the analytical method used to calculate
RODEX2 fuel centerline melt (FCM) temperature [   ]
The analysis is based on the approved COPERNIC methodology for FCM limit generation in
Reference 1, Section 12.3 and the approved setpoint methods from Reference 2, Appendix A and
Reference 3, Appendix A which uses the RODEX2 code to determine the FCM limits in terms of
Linear Heat Generation Rate (LHGR).

The setpoint methodology for the calculation of FCM limits was specifically designed [

]

<u>Combined Impact and Extension to High Burnup</u>

To demonstrate the conservatism of the RODEX2 FCM limits at [

]

The revised COPERNIC results for a Westinghouse 15x15 UO_2 rod are plotted in Figure 1-2, with the original results from Figure 6 in EMF-92-116PA, Supplement 1. The RODEX2 results with [

]

The "Revised COPERNIC" FCM limits agree well with the sample problems presented in Figures 12-28, 12-29, 12-30, 12-31, 12-32 and 12-33 in Reference 1. The similarity in both the magnitude and burnup dependence (i.e. slope) of the predicted FCM limits demonstrates consistency of the method and results. The "Original COPERNIC" results are [

]
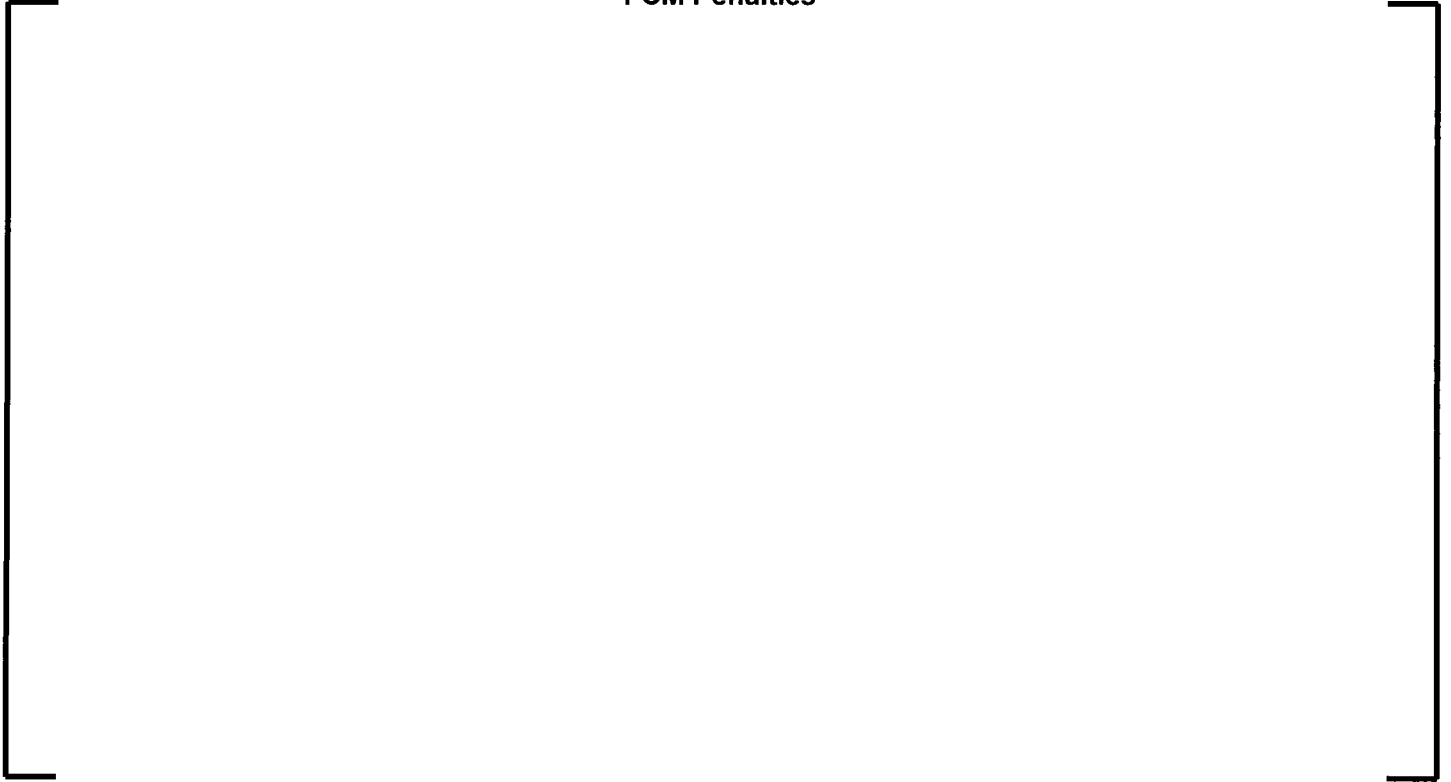
The results indicate the significant level of conservatism present in the penalty factors in EMF-92-116PA, Supplement 1 and confirm that [


]

References
1. BAW-10231(P)(A), Revision 1, "COPERNIC Fuel Rod Design Computer Code," January 2004.
2. EMF-1961(P)(A), Revision 0, "Statistical Setpoint/Transient Methodology for Combustion Engineering Type Reactors," July 2000.
3. EMF-92-081(P)(A), Revision 1, "Statistical Setpoint/Transient Methodology for Westinghouse Type Reactors, Siemens Power Corporation," February 2000.

Table 1-1 Conservative Adjustments in the Original COPERNIC Analyses for FCM Penalties

Figure 1-2 W15 UO₂ Results
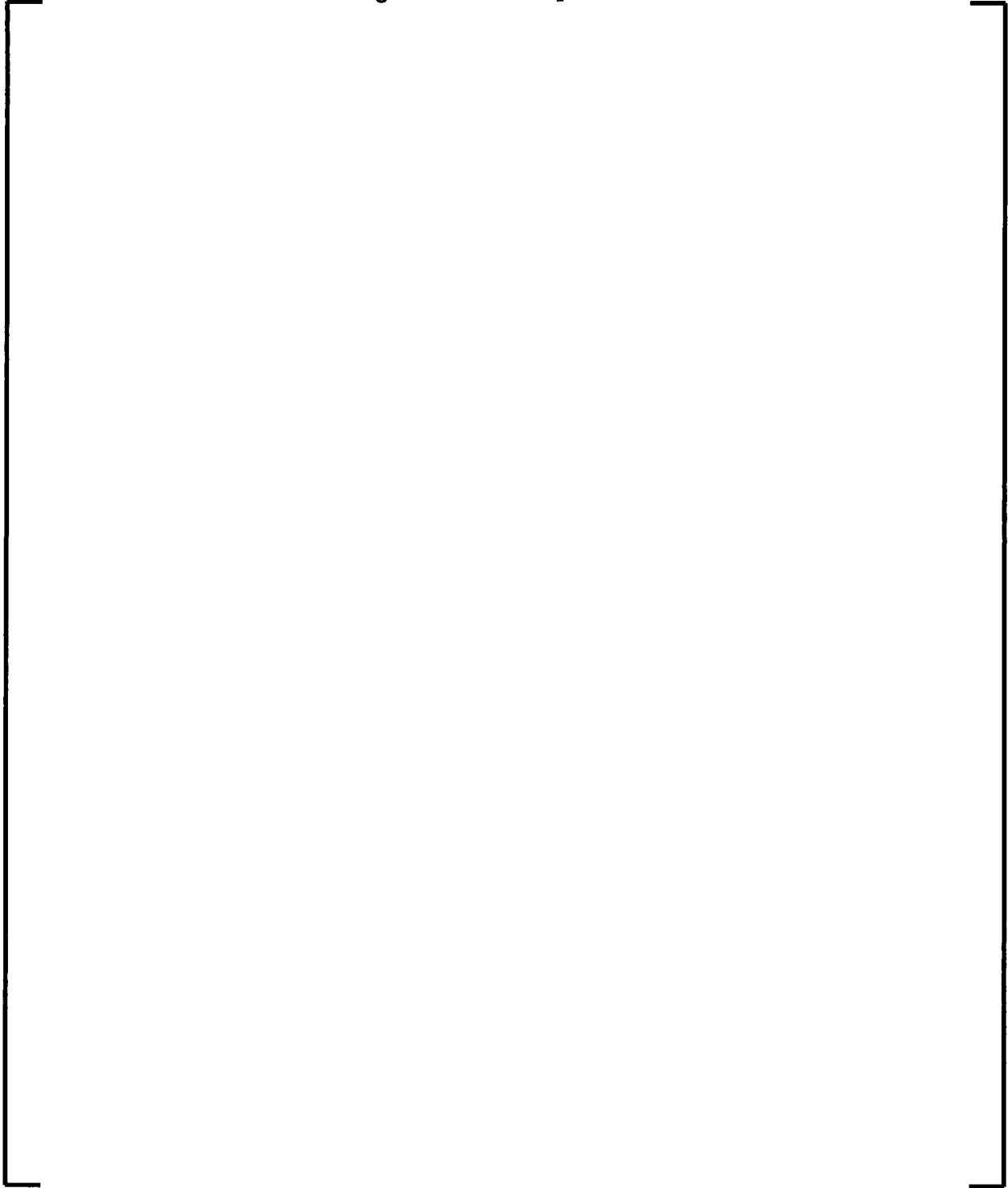
Question 2 SRP 4.2 Acceptance Criteria 1.B.vi – Pellet Cladding Interaction

Question 2.a

Please provide additional detail about the process that was used to determine the [

] in steady-state strain. This information is necessary to expand upon the statements made in the topical report and was presented to NRC staff during the Audit held in Lynchburg, July 9-11, 2013.

Response 2.a

Before calculating the impact of higher fuel temperatures on the steady-state strain margins, a survey of all the fuel designs and plants supported by the RODEX2 fuel performance code was conducted to determine the reload analysis cases that result in the most limiting steady-state strains. Uprated power levels have been considered for applicable plants. Table 2 of Topical Report EMF-92-116P-A, Supplement 1 provides a summary of the reload designs that have been considered. Table 2-1 provides the nodal burnups and fuel average temperatures corresponding to the time step at which the limiting strain occurred for each of the limiting cases that were identified,. Table 2-1 also provides the nodal burnups and fuel average temperatures corresponding to the time step at end-of-life, and the time step at which the maximum fuel average temperature occurred.

For some plants, additional limiting cases were chosen because they yielded strain values that were very close to the strain value obtained from the most limiting case. For each case listed in Table 2-1, the fuel average temperature [

] This equation is conservatively used in Table 2-1 [

]

⌈   ⌉

                                                                        }

⌊   ⌋

The cases presented in Table 2-1 are plotted in Figure 2-1 [

] This value of additional thermal expansion bounds all the values calculated in
Table 2-1.

Using a curve-fit program, the following relationship can be defined –

[
                    ]   Equation 2-1

Where Bu represents the nodal burnup of the corresponding node in GWd/mtU.

Increase in steady-state cladding strain can now be calculated by [

                                                              ]

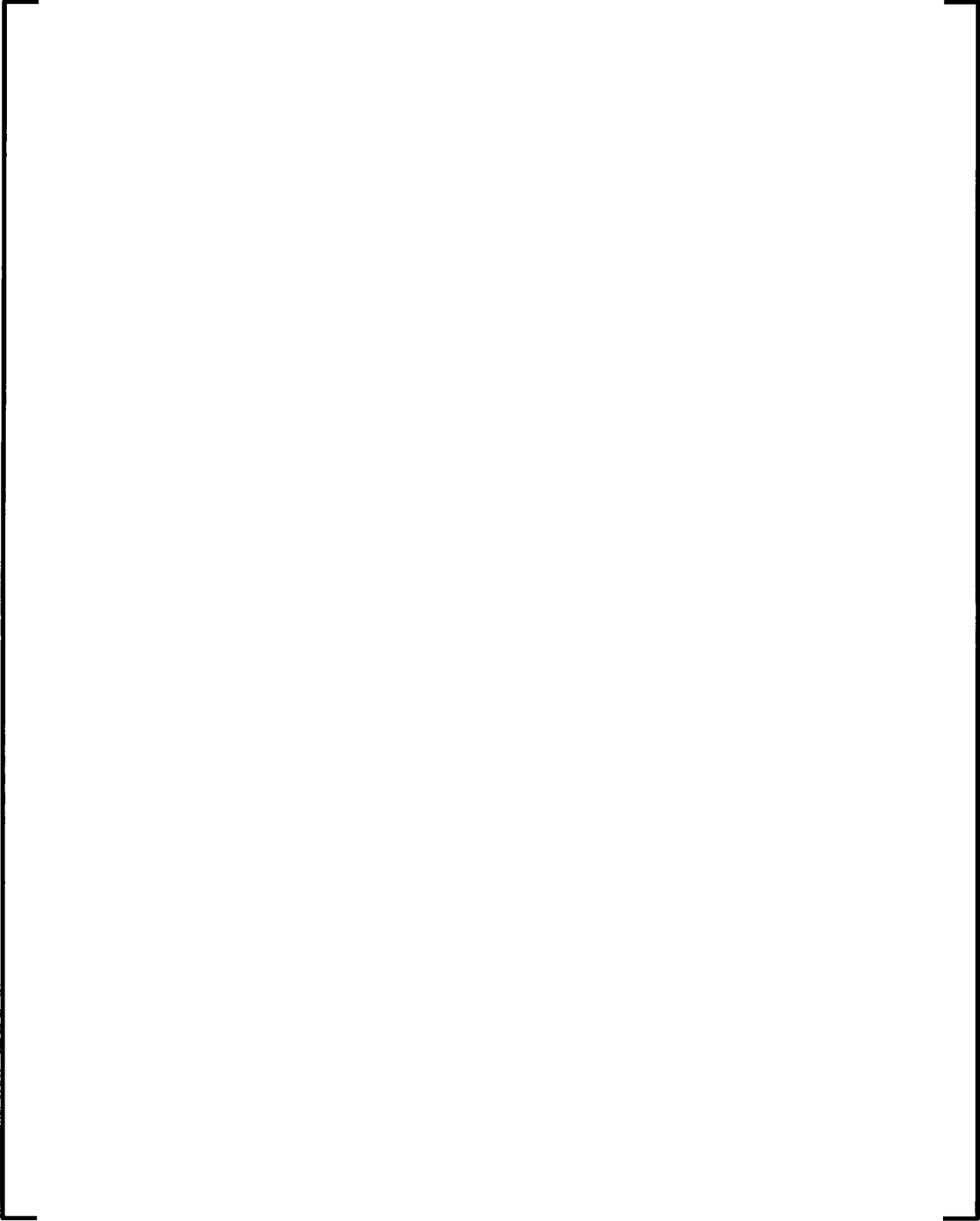A maximum increase in steady-state cladding strain can be calculated as:

[

                              ]

[   ]

The maximum steady-state strain correction calculated above will be applied to the uncorrected results obtained for licensing applications using the RODEX2 code. The correction is applicable to both Zircaloy-4 and M5® cladding. Applicability of the maximum steady-state strain correction will be verified prior to use based on the fuel design attributes listed in Table 2 of Topical Report EMF-92-116PA, Supplement 1 and the [

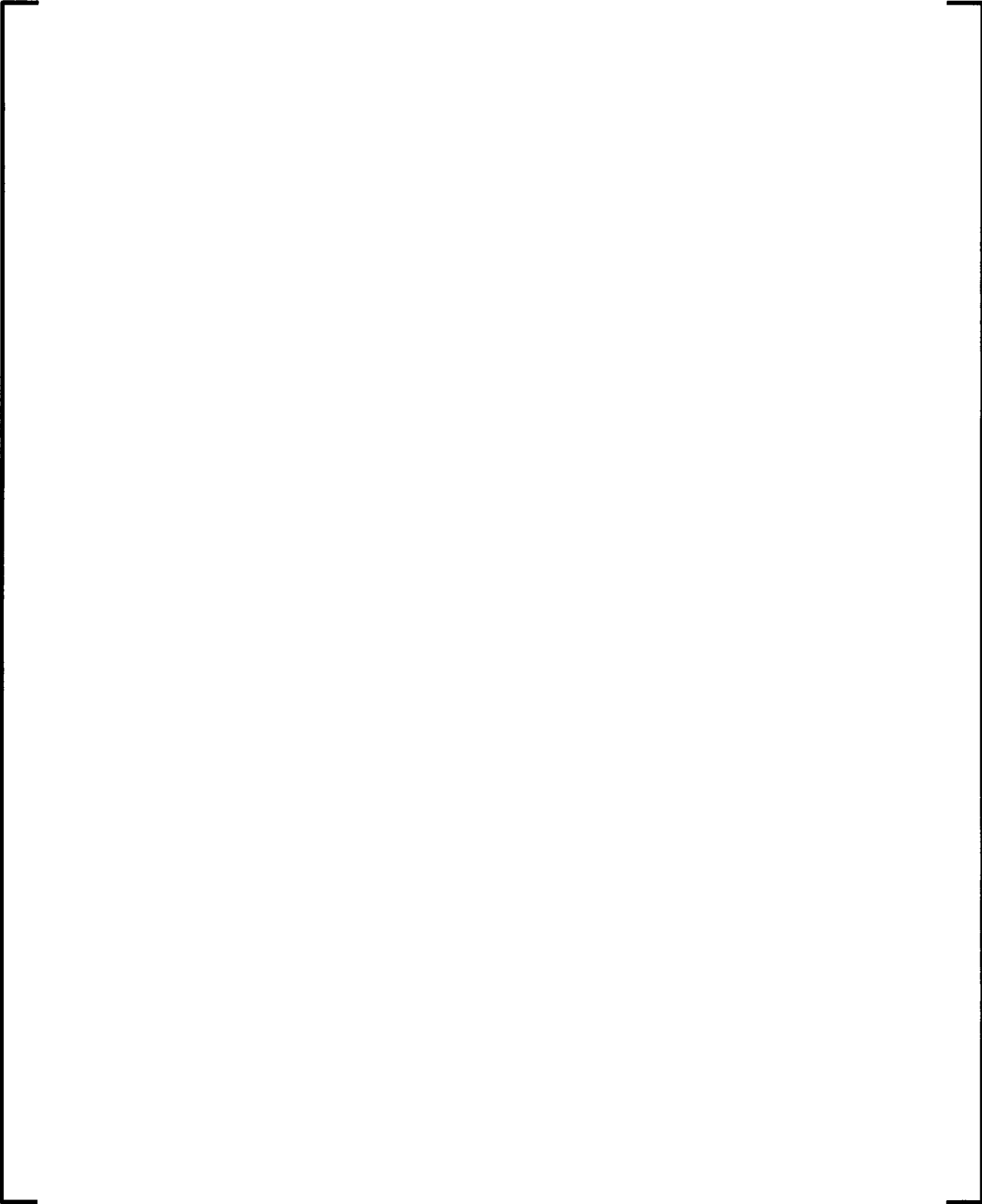   ] presented in Equation 2-1 above.

Reference

1. XN-NF-81-58(P)(A) Revision 2 and Supplements 1 and 2, "RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model," March 1984.
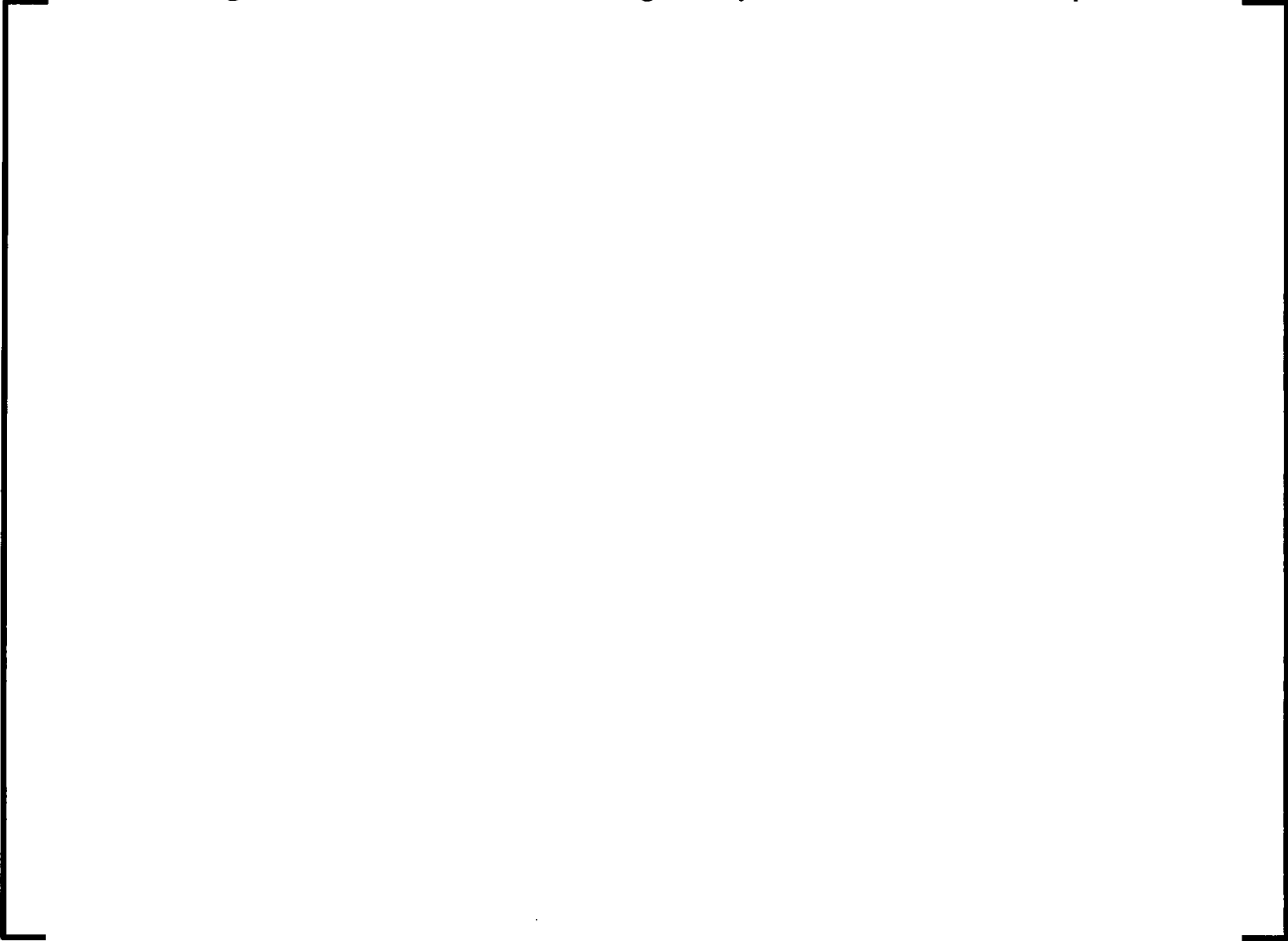
Table 2-1   Calculation of Additional Fuel Thermal Expansion

Figure 2-1   Allowable Fuel Average Temperature vs. Nodal Burnup

Question 3 SRP 4.2 Acceptance Criteria 1.A.vi – Rod Internal Pressure

Question 3.a

Based on knowledge acquired in recent licensing actions utilizing RODEX2, the staff has concerns that the RODEX2 rod internal pressure calculations may be non-conservative. Therefore, the staff performed confirmatory calculations using the NRC fuel thermal-mechanical code FRAPCON-3 as a follow up to the audit that took place July 9-11, 2013. The results of the calculations showed that [

] When FRAPCON was run using a best-estimate plus uncertainty methodology the upper tolerance limit (95/95) rod internal pressure prediction, for both cases, [   ] The results were discussed with AREVA as a continuation of the audit during several phone conversations held in August 2013.

Please provide additional justification to show that RODEX2's rod internal pressure predictions remain conservative, as used in the framework of AREVA's reload methodology. If additional RODEX2 sample cases are run to support AREVA's response, please provide the input parameters to allow the staff to model the cases using FRAPCON.

Repsponse 3.a

To be provided at a later date

Question 4

AREVA notified the NRC at the audit that took place on July 9-11, 2013 at AREVA's Lynchburg, VA facility that the topical report included an error in the identification of a UO2 rod as a gadolinia bearing rod in the [   ] database.

Please provide the details of the error and any effect that the error had on the content of the topical report. For any significant effect please provide additional justification for continued acceptability of the contents of the report

Response 4

AREVA notified the NRC during an audit in Lynchburg that Topical Report EMF 92-116PA, Supplement 1 included an error in the identification of a UO_2 test rod as a urania-gadolinia rod in the [   ] database. Section 2.0, Impact of Fuel Thermal Conductivity Degradation with Burnup on Mechanical Design Criteria, of the topical report states:

> *The benchmark results* [   ] *the*
> *extended Halden data base results shown in figure 1. The basis* [
>
>]

Following submittal of the topical report, AREVA discovered that the test rod was a UO_2 rod and not a urania-gadolinia rod as stated in the text.

The error in identifying the selected test rod as a urania-gadolinia fuel type rather than a UO_2 rod is clerical. The [   ] discussed in Section 2.0, was based on the RODEX2 benchmark predictions of [
                                    ] The expression for adjusting the fuel temperature predictions due to the lack of a burnup dependent fuel thermal conductivity model in RODEX2 remains unchanged. The adjustments applied to the mechanical design criteria affected by fuel thermal conductivity degradation are not affected.

[

] This change is discussed further below.

The benchmark results shown in Figure 1 of Topical Report EMF-92-116PA, Supplement 1 indicate that RODEX2 is conservative [

]

Figure 4-1 shows the predicted to measured fuel centerline temperatures for the RODEX2 thermal predictions in the [

]

Degradation of fuel conductivity with burnup does occur in the [

]

Figure 4-1   RODEX2-Predicted vs. Measured Fuel Centerline Temperatures for Nodal Burnups ≤ 20 GWd/mtU