

## ArevaEPRDCPEm Resource

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**From:** WELLS Russell (AREVA) [Russell.Wells@areva.com]  
**Sent:** Thursday, April 14, 2011 2:00 PM  
**To:** Tesfaye, Getachew  
**Cc:** WILLIFORD Dennis (AREVA); BENNETT Kathy (AREVA); DELANO Karen (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3, Supplement 4  
**Attachments:** RAI 445 Supplement 4 Response US EPR DC.PDF

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 445 on October 29, 2010. Supplement 1 was submitted to the NRC on January 27, 2011, Supplement 2 on February 25, 2011, and Supplement 3 on March 23, 2011 to revise the schedule. The attached file, "RAI 445 Supplement 4 Response US EPR DC.pdf" provides a technically correct and complete final response to 3 of the 13 questions.

Appended to this file are affected pages of the U.S. EPR New and Spent Fuel Storage Rack Technical Report, TN-Rack.0101, in redline-strikeout format which support the response to RAI 445 Question 03.08.04-24.

The following table indicates the respective pages in the response document, "RAI 445 Supplement 4 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 445 — 03.08.04-23	2	3
RAI 445 — 03.08.04-24	4	5
RAI 445 — 03.08.04-25	6	6

To allow additional time to interact with NRC staff, the schedule for a technically correct and complete response to Question 03.08.04-20 has been changed and is provided below. The schedule for a technically correct and complete response to the remaining questions is unchanged as provided below.

Question #	Response Date
RAI 445 — 03.08.04-15	April 28, 2011
RAI 445 — 03.08.04-16	April 28, 2011
RAI 445 — 03.08.04-17	April 28, 2011
RAI 445 — 03.08.04-18	April 28, 2011
RAI 445 — 03.08.04-19	April 28, 2011
RAI 445 — 03.08.04-20	<b>May 31, 2011</b>
RAI 445 — 03.08.04-21	April 28, 2011
RAI 445 — 03.08.04-22	April 28, 2011
RAI 445 — 03.08.04-26	April 28, 2011
RAI 445 — 03.08.04-27	April 28, 2011

*Sincerely,*

*Russ Wells*  
*U.S. EPR Design Certification Licensing Manager*

**AREVA NP, Inc.**

3315 Old Forest Road, P.O. Box 10935

Mail Stop OF-57

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Phone: 434-832-3884 (work)

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Fax: 434-382-3884

[Russell.Wells@Areva.com](mailto:Russell.Wells@Areva.com)

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**From:** WELLS Russell (RS/NB)

**Sent:** Wednesday, March 23, 2011 10:53 AM

**To:** 'Tesfaye, Getachew'

**Cc:** WILLIFORD Dennis (RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)

**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 445 on October 29, 2010. Supplement 1 was submitted to the NRC on January 27, 2011 and Supplement 2 on February 25, 2011 to revise the schedule. To allow additional time to interact with NRC staff, the schedule has been revised.

The schedule for technically correct and complete responses has been revised and is provided below:

<b>Question #</b>	<b>Response Date</b>
RAI 445 — 03.08.04-15	<b>April 28, 2011</b>
RAI 445 — 03.08.04-16	<b>April 28, 2011</b>
RAI 445 — 03.08.04-17	<b>April 28, 2011</b>
RAI 445 — 03.08.04-18	<b>April 28, 2011</b>
RAI 445 — 03.08.04-19	<b>April 28, 2011</b>
RAI 445 — 03.08.04-20	April 15, 2011
RAI 445 — 03.08.04-21	<b>April 28, 2011</b>
RAI 445 — 03.08.04-22	<b>April 28, 2011</b>
RAI 445 — 03.08.04-23	<b>April 28, 2011</b>
RAI 445 — 03.08.04-24	<b>April 28, 2011</b>
RAI 445 — 03.08.04-25	<b>April 28, 2011</b>
RAI 445 — 03.08.04-26	<b>April 28, 2011</b>
RAI 445 — 03.08.04-27	<b>April 28, 2011</b>

*Sincerely,*

*Russ Wells*

*U.S. EPR Design Certification Licensing Manager*

**AREVA NP, Inc.**

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**From:** WELLS Russell (RS/NB)  
**Sent:** Friday, February 25, 2011 10:15 AM  
**To:** 'Tesfaye, Getachew'  
**Cc:** BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BRYAN Martin (External RS/NB); WILLIFORD Dennis (RS/NB)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 445 on October 29, 2010. Supplement 1 was submitted to the NRC on January 27, 2011 to revise the schedule. To allow additional time to interact with NRC staff, the schedule has been revised.

The schedule for technically correct and complete responses has been revised and is provided below:

Question #	Response Date
RAI 445 — 03.08.04-15	<b>March 29, 2011</b>
RAI 445 — 03.08.04-16	<b>March 29, 2011</b>
RAI 445 — 03.08.04-17	<b>March 29, 2011</b>
RAI 445 — 03.08.04-18	<b>March 29, 2011</b>
RAI 445 — 03.08.04-19	<b>March 29, 2011</b>
RAI 445 — 03.08.04-20	April 15, 2011
RAI 445 — 03.08.04-21	<b>March 29, 2011</b>
RAI 445 — 03.08.04-22	<b>March 29, 2011</b>
RAI 445 — 03.08.04-23	<b>March 29, 2011</b>
RAI 445 — 03.08.04-24	<b>March 29, 2011</b>
RAI 445 — 03.08.04-25	<b>March 29, 2011</b>
RAI 445 — 03.08.04-26	<b>March 29, 2011</b>
RAI 445 — 03.08.04-27	<b>March 29, 2011</b>

Sincerely,

*Russ Wells*

*U.S. EPR Design Certification Licensing Manager*

**AREVA NP, Inc.**

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**From:** BRYAN Martin (External RS/NB)  
**Sent:** Thursday, January 27, 2011 12:11 PM  
**To:** 'Tesfaye, Getachew'

**Cc:** DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); WILLIFORD Dennis (RS/NB)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 445 on October 29, 2010. To allow additional time to finalize the responses and interact with NRC staff, the schedule has been revised. The response for RAI 445, Question 03.08.04-20 has been revised to allow time to complete additional analyses and provide the results in order to address NRC concerns.

The schedule for technically correct and complete responses has been revised and is provided below:

<b>Question #</b>	<b>Response Date</b>
RAI 445 — 03.08.04-15	<b>February 28, 2011</b>
RAI 445 — 03.08.04-16	<b>February 28, 2011</b>
RAI 445 — 03.08.04-17	<b>February 28, 2011</b>
RAI 445 — 03.08.04-18	<b>February 28, 2011</b>
RAI 445 — 03.08.04-19	<b>February 28, 2011</b>
RAI 445 — 03.08.04-20	<b>April 15, 2011</b>
RAI 445 — 03.08.04-21	<b>February 28, 2011</b>
RAI 445 — 03.08.04-22	<b>February 28, 2011</b>
RAI 445 — 03.08.04-23	<b>February 28, 2011</b>
RAI 445 — 03.08.04-24	<b>February 28, 2011</b>
RAI 445 — 03.08.04-25	<b>February 28, 2011</b>
RAI 445 — 03.08.04-26	<b>February 28, 2011</b>
RAI 445 — 03.08.04-27	<b>February 28, 2011</b>

Sincerely,

Martin (Marty) C. Bryan  
U.S. EPR Design Certification Licensing Manager  
AREVA NP Inc.  
Tel: (434) 832-3016  
702 561-3528 cell  
[Martin.Bryan.ext@areva.com](mailto:Martin.Bryan.ext@areva.com)

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**From:** BRYAN Martin (External RS/NB)  
**Sent:** Friday, October 29, 2010 4:03 PM  
**To:** 'Tesfaye, Getachew'  
**Cc:** DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); WILLIFORD Dennis (RS/NB)  
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 445 Response US EPR DC.pdf" provides a schedule since a technically correct and complete response to the 13 questions can not be provided at this time.

The following table indicates the respective pages in the response document, "RAI 445 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

<b>Question #</b>	<b>Start Page</b>	<b>End Page</b>
RAI 445 — 03.08.04-15	2	3
RAI 445 — 03.08.04-16	4	4
RAI 445 — 03.08.04-17	5	5
RAI 445 — 03.08.04-18	6	6
RAI 445 — 03.08.04-19	7	8
RAI 445 — 03.08.04-20	9	9
RAI 445 — 03.08.04-21	10	10
RAI 445 — 03.08.04-22	11	11
RAI 445 — 03.08.04-23	12	12
RAI 445 — 03.08.04-24	13	13
RAI 445 — 03.08.04-25	14	14
RAI 445 — 03.08.04-26	15	15
RAI 445 — 03.08.04-27	16	16

A complete answer is not provided for the 13 questions. The schedule for a technically correct and complete response to these questions is provided below.

<b>Question #</b>	<b>Response Date</b>
RAI 445 — 03.08.04-15	January 27, 2011
RAI 445 — 03.08.04-16	January 27, 2011
RAI 445 — 03.08.04-17	January 27, 2011
RAI 445 — 03.08.04-18	January 27, 2011
RAI 445 — 03.08.04-19	January 27, 2011
RAI 445 — 03.08.04-20	January 27, 2011
RAI 445 — 03.08.04-21	January 27, 2011
RAI 445 — 03.08.04-22	January 27, 2011
RAI 445 — 03.08.04-23	January 27, 2011
RAI 445 — 03.08.04-24	January 27, 2011
RAI 445 — 03.08.04-25	January 27, 2011
RAI 445 — 03.08.04-26	January 27, 2011
RAI 445 — 03.08.04-27	January 27, 2011

Sincerely,

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 702 561-3528 cell  
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**From:** Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]  
**Sent:** Friday, October 01, 2010 10:05 AM

**To:** ZZ-DL-A-USEPR-DL

**Cc:** Xu, Jim; Hawkins, Kimberly; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource

**Subject:** U.S. EPR Design Certification Application RAI No. 445 (5083), FSARCh. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on September 16, 2010, and on September 30, 2010, you informed us that the RAI is clear and no further clarification is needed. You also pointed out that the staff has inadvertently included proprietary information in some of the questions. As a result, Draft RAI Questions 03.08.04-17, 03.08.04-18, 03.08.04-19, 03.08.04-20, and 03.08.04-26 were modified. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,  
Getachew Tesfaye  
Sr. Project Manager  
NRO/DNRL/NARP  
(301) 415-3361

**Hearing Identifier:** AREVA\_EPR\_DC\_RAIs  
**Email Number:** 2848

**Mail Envelope Properties** (1F1CC1BBDC66B842A46CAC03D6B1CD41043A7F76)

**Subject:** Response to U.S. EPR Design Certification Application RAI No. 445, FSAR Ch. 3, Supplement 4  
**Sent Date:** 4/14/2011 2:00:26 PM  
**Received Date:** 4/14/2011 2:00:36 PM  
**From:** WELLS Russell (AREVA)

**Created By:** Russell.Wells@areva.com

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"WILLIFORD Dennis (AREVA)" <Dennis.Williford@areva.com>  
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"BENNETT Kathy (AREVA)" <Kathy.Bennett@areva.com>  
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Tracking Status: None  
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Tracking Status: None  
"RYAN Tom (AREVA)" <Tom.Ryan@areva.com>  
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Tracking Status: None

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<b>Files</b>	<b>Size</b>	<b>Date &amp; Time</b>
MESSAGE	11052	4/14/2011 2:00:36 PM
RAI 445 Supplement 4 Response US EPR DC.PDF		122110

**Options**  
**Priority:** Standard  
**Return Notification:** No  
**Reply Requested:** No  
**Sensitivity:** Normal  
**Expiration Date:**  
**Recipients Received:**

**Response to**

**Request for Additional Information No 445, Supplement 4**

**10/01/2010**

**U. S. EPR Standard Design Certification**

**AREVA NP Inc.**

**Docket No. 52-020**

**SRP Section: 03.08.04 - Other Seismic Category I Structures**

**Application Section: 3.8.4**

**QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)**



**Question 03.08.04-23:**

The Technical Report follows the guidance provided by SRP 3.8.4 (Reference 1) for the analysis and design of the fuel storage racks. Subsection II.4 of SRP 3.8.4 indicates that the validity of any computer programs used in the design and analysis of structures should be verified in accordance with the procedures in Subsection II.4.E of SRP Section 3.8.1. The Technical Report states that most of the analyses were done utilizing commercial computer codes. To ensure compliance with 10 CFR 50, Appendix A, GDC 1, as it relates to SSCs being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed, and with the guidance in SRP 3.8.4, identify all computer codes used in the analyses and clarify whether the validation documents for these computer codes are in compliance with SRP 3.8.1, Subsection II.4.E.

**Response to Question 03.08.04-23:**

The following computer codes are used in the analyses:

## 1. ANSYS.

ANSYS computer program is a large-scale, general purpose computer program used for several classes of engineering analyses which include elastic, plastic, and buckling analyses with small and large deflections. The large variety of element types available gives ANSYS the capability to analyzing 2D and 3D structures with a variety of contact definitions.

ANSYS has been validated by AREVA Transnuclear Inc (TN) in accordance with its Quality Assurance (QA) Procedure. The TN QA program is in compliance with 10 CFR 50, 10 CFR 52, and NQA-1-2008/2009a. The validation of ANSYS meets the criteria in SRP 3.8.1, Subsection II.4.F.

## 2. LS-DYNA.

LS-DYNA is an explicit general purpose finite element program for nonlinear dynamic analysis for 3-Dimensional structures. LS-DYNA features include the ability to handle large deformation, finite rotation, sophisticated material models, and complex contact conditions among multiple components with lagrangian and eulerian dynamics.

LS-DYNA has been validated by TN in accordance with its QA Procedure. The TN QA program is in compliance with 10 CFR 50, 10 CFR 52, and NQA-1-2008/2009a. The validation of LS-DYNA meets the criteria in SRP 3.8.1, Subsection II.4.F.

## 3. RASCALS.

RASCALS generates artificial time histories compatible with a specified input target response spectrum. The spectral matching methodology begins with actual recordings of earthquake motions and successively alters their Fourier amplitude spectra until their response spectra match the target spectra.

RASCALS has been validated by TN in accordance with its QA Procedure. The TN QA program is in compliance with 10 CFR 50, 10 CFR 52, and NQA-1-2008/2009a. The validation of RASCALS meets the criteria in SRP 3.8.1, Subsection II.4.F.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Technical Report Impact:**

AREVA Technical Report TN-Rack.0101 will not be changed as a result of this question.

**Question 03.08.04-24:**

10 CFR 50, Appendix A, GDC 1, requires that SSCs important to safety shall be designed to quality standards commensurate with the importance of the safety functions to be performed. In addition, Section I.2 of SRP 3.8.4, Appendix D, specifies that for spent fuel racks: "Construction materials should conform to American Society of Mechanical Engineers, (ASME), Boiler and Pressure Vessel Code, (Code), Section III, Division 1, Subsection NF." In this regard, the FSAR needs to clarify the application of the ASME Code to New and Spent Fuel Storage Racks, and the Technical Report needs to provide more information on compliance with Regulatory Guide (RG) 1.124 and the use of RG 1.60 when utilizing the ASME Code, as discussed below.

- a. Table 2.2.8-1 of the FSAR indicates that Section III of the ASME Code does not apply to New and Spent Fuel Storage Racks. Explain why not.
- b. When utilizing the ASME Code, Section III, Subsection NF, are all of the applicable provisions in NRC Regulatory Guide, 1.124, Rev. 1, also satisfied? This should be clearly stated in the Technical Report and the FSAR. Also, since RG 1.60 was included as a reference, explain how it was used and correct the published year of RG 1.13, Rev. 2 in Section 1.3 of the Technical Report.

**Response to Question 03.08.04-24:**

- a) The designation "N/A" in U.S. EPR FSAR Tier 1, Table 2.2.8-1 under "ASME Code Section III" indicates that the ASME Code Section III design commitments (3.4, 3.5, 3.6, 3.7, and 3.9) and corresponding ITAAC are not applied to the new and spent fuel storage racks. It does not indicate that ASME Code Section III is not applied in the design of the fuel racks. The application of ASME Code Section III to the fuel racks is addressed in U.S. EPR FSAR Tier 2, Section 9.1.2 and Technical Report TN-Rack.0101.

U.S. EPR FSAR Tier 2, Section 14.3.2 describes the selection process for the certified design material in U.S. EPR FSAR Tier 1, Chapter 2. The selection process uses two distinct, parallel approaches. The first approach uses specific equipment classification criteria and identifies those safety-significant features credited to comply with 10 CFR Parts 20, 50, 52, 73, or 100. For safety-related piping systems, 10 CFR 50.55a requires application of ASME Section III. Therefore, safety-related piping and components have ASME Code Section III design commitments and ITAAC in U.S. EPR FSAR Tier 1. 10 CFR 50.55a does not have a corresponding requirement for the fuel racks, and no ASME Code Section III design commitment is required in U.S. EPR FSAR Tier 1. The second selection approach uses assumptions and insights from key safety and integrated plant safety analyses and did not identify the application of ASME Code Section III to the fuel racks as a safety-significant feature for inclusion in U.S. EPR FSAR Tier 1 certified design material.

- b) Technical Report TN-Rack.0101, Table 3-1 has been updated to reflect the added limits provided in Regulatory Guide 1.124, Revision 2. Regulatory Guide 1.60 was used to determine the project response spectra because it is incorporated by reference into NUREG 800, which is referenced in methodology descriptions provided in Technical Report TN-Rack.0101, Chapter 3 and appendices. The project methodology implicitly includes Regulatory Guide 1.60.

The reference listing of Regulatory Guide 1.13 in Technical Report TN-Rack.0101, Section 1.3 has been corrected to show the publication date as March 2007.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Technical Report Impact:**

AREVA Technical Report TN-Rack.0101, Section 1.3 and Table 3-1 will be revised as described in the response and indicated on the enclosed markup.

**Question 03.08.04-25:**

The Technical Report presents the analysis and design of the fuel storage racks. However, there is insufficient information regarding materials, quality control, and special construction techniques, as well as in-service examination of the racks. The staff notes that 10 CFR 50, Appendix B requires compliance with quality assurance criteria for nuclear power plants. In addition, Section I.7 of SRP 3.8.4, Appendix D, states that "The applicant should describe materials, quality control procedures, and any special construction techniques; the sequence of installation of the new fuel racks (...)." Therefore:

- a. Provide the information regarding materials, quality control procedures, any special construction techniques, and the sequence of installation of the new fuel racks.
- b. Explain what provisions are given for performing the in-service examination of the rack, as indicated in 10 CFR 50.55a(g)(3) for ASME Class 3 component supports.

**Response to Question 03.08.04-25:**

- a) The requested information regarding materials is provided in Table 03.08.04-15-1 and Table 03.08.04-15-2 of the response to Question 03.08.04-15.

There are no special construction techniques required in the fabrication of the rack modules. The fabrication and quality control procedures used in the fabrication are in accordance with the requirements of ASME Code, Subsection NF.

The installation of the racks into the pool may be performed in any sequence which best suits the erection contractor because there is no fuel present that would require special control of rack placement for criticality concerns.

- b) The in-service inspection examination of the rack modules is limited to verifying the continuing efficacy of the poison material. To accomplish this function, a sampling tree will be installed in the pool as described in Technical Report TN-Rack.0101, Chapter 6.

**FSAR Impact:**

The U.S. EPR FSAR will not be changed as a result of this question.

**Technical Report Impact:**

AREVA Technical Report TN-Rack.0101 will not be changed as a result of this question.

# TN-Rack.0101 Markups

Chapter 5: Provides the criticality evaluation for all proposed uses of the fuel storage racks and demonstrates compliance with 10 CFR 50.68;

Chapter 6: Describes the qualification and acceptance testing, both short and long term, for the metal matrix composite (MMC) poison material and testing for the installed rack modules;

Chapter 7: Discusses the material selection and compatibility for the Spent Fuel Rack Modules.

### 1.3 Applicable Regulations, Codes and Standards

The applicable regulations, codes and standards used in the design and fabrication of the fuel storage racks are as follows:

- 1.3-1. 10 CFR 50, Appendix A, General Design Criteria for Nuclear Power Plants, latest edition.
- 1.3-2. 10 CFR 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants.
- 1.3-3. 10 CFR 20.1101 (b), Radiation Protection Programs.
- 1.3-4. 10 CFR 50.68, Criticality Accident Requirements. RAI 03.08.04-24b
- 1.3-5. Regulatory Guide -1.13, Rev. 2, March 2007, Spent Fuel Storage Facility Design Basis.
- 1.3-6. Regulatory Guide 1.26, Rev. 4, March 2007, Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants.
- 1.3-7. Regulatory Guide 1.60, Revision 1, Design Response Spectra for Seismic Design of Nuclear Power Plants.
- 1.3-8. Regulatory Guide 1.61, Revision 1, Damping Values for Seismic Design of Nuclear Power Plants.
- 1.3-9. Regulatory Guide 1.92, Revision 2, Combining Modal Responses and Spatial Components in Seismic Response Analysis.
- 1.3-10. Regulatory Guide 8.8, Rev. 3, June 1976, Information Relevant to Maintaining Occupational Radiation Exposure as Low as is Reasonably Achievable.
- 1.3-11. Spent Fuel Project Office Interim Staff Guidance – 9, Rev. 1, “Storage of Components Associated with Fuel Assemblies.”
- 1.3-12. NUREG 0800, Standard Review Plan, March 2007.
- 1.3-13. NRC Memorandum SECY-93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactors (ALWR) Designs,” July 21, 1993.
- 1.3-14. NUREG/CR-0612, Control of Heavy Loads at Nuclear Power Plants, July 1980.
- 1.3-15. NUREG/CR-6801, Recommendations for Addressing Axial Burnup in PWR Burnup Credit Analyses, Mar 2003.
- 1.3-16. NUREG/CR-6665 ORNL/TM-1999/303 Review and Prioritization of Technical Issues Related to Burnup Credit for LWR Fuel Prepared by C. V. Parks, M. D. DeHart, and J. C. Wagner.

**Table 3-1**  
**Linear Type Support**  
(Part 1 of 2)

RAI 03.08.04-16a-e  
& 03.08.04-24b

Service Level	Stress/Stress Intensity Limits	Reference	Notes
<b>Support Component</b>			
Design, Level A	<p><i>Tension:</i> <math>F_t = \min(0.60S_y, 0.5S_u)</math></p> <p><i>Shear:</i> <math>F_v = 0.40 S_y</math></p> <p><i>Compression:</i> (Ferritic) <i>F<sub>a</sub></i> given by</p> <p><math>&lt; C_c</math> Eq. 4 for Kl/r</p> <p><math>&gt; C_c</math> Eq. 5 for Kl/r</p> <p><math>&gt; 120</math> Eq. 6 for Kl/r (Austenitic) <i>F<sub>a</sub></i> given by</p> <p><math>\leq 120</math> Eq. 6a for Kl/r</p> <p><math>&gt; 120</math> Eq. 6b for Kl/r</p> <p><i>Bending:</i> (compact section) <math>F_b = \min(0.66S_y, 0.55S_u)</math> (doubly symmetric member with bending about minor axis)</p> <p><math>F_b = \min(0.75S_y, 0.63S_u)</math> (box type member)</p> <p><math>F_b = \min(0.6S_y, 0.5S_u)</math> (rectangular tubular section about minor axis)</p> <p><math>F_b = \min(0.66S_y, 0.55S_u)</math></p> <p><i>Combined Stress:</i> Eq. 20, 21 and 22</p> <p><i>Bearing:</i> <math>0.90 S_y</math></p>	NF-3360 NF-3320	(1), (2), (3), (6), (7)
	Level B, C	Same as for Level A increased by stress limit factor $K_m$	NF-3321.1 Table NF-3523(b)-1
Level D (Elastic Analysis)	<p><i>Tension:</i> <math>\min(1.2S_y, 0.7S_u)</math></p> <p><i>Shear:</i> <math>\min(0.72 S_y, 0.42S_u)</math></p> <p><i>Compression:</i> <math>(2/3)F_a</math></p> <p><i>Bending:</i> <math>F_b</math> is as for Level A increased by 1.11</p> <p><i>Combined Stress:</i> Given by F-1334.4 and F-1334.5</p>	Appendix F-1334	(1), (7)



**Table 3-1**  
**Linear Type Support**  
**(Part 2 of 2)**

<p>Level D (Plastic Analysis)</p>	<p>Membrane and Bending: (Ferritic): <math>P_m \leq 0.7S_u</math> (Austenitic): <math>P_m \leq \max(S_y + (S_u - S_y)/3, 0.7S_u)</math> (All): <math>P_m</math> (or <math>P_L</math>) + <math>P_b \leq 0.9S_u</math> Pure Shear: <math>0.42S_u</math> Compression: <math>(2/3)F_a</math>                      <i>increased</i> by <math>\min(2, 1.167S_u/S_y)</math>      <i>if <math>S_u &gt;</math></i> <math>1.2S_y</math> <math>1.4</math>                              <i>if <math>S_u \leq</math></i> <math>1.2S_y</math></p>	<p>F-1344 F-1341 F-1334.3</p>	<p>(4), (5)</p>
<p><b>Support Weld</b></p>			
<p>Design, Levels A, B and C</p>	<p>Full Penetration Groove Weld: Same as base metal  Partial Penetration Groove/Fillet Weld: (i) Normal compression – same as base metal (ii) Shear stress on fillet weld, normal tension on partial pen. Groove weld, shear stress on plug/slot weld – <math>0.3x F_{u, weld\ metal}</math></p>	<p>NF-3266 NF-3256 Table NF-3324.5(a)-1</p>	
<p>Level D</p>	<p>Partial Penetration Groove/Fillet Weld: Level A allowable stresses can be increased by <math>\min(2, 1.167S_u/S_y)</math>      <i>if <math>S_u &gt;</math></i> <math>1.2S_y</math> <math>1.4</math>                              <i>if <math>S_u \leq</math></i> <math>1.2S_y</math></p>	<p>F-1334</p>	

General Note:

(1) Bearing and secondary stresses need not be considered for Level D service condition

Notes:

(1) Elastic analysis shall be used based on maximum stress theory

(2)  $S_u$  is on net effective area

(3) Equations refer to NF-3322

(4) Plastic analysis for Level D implies plastic system and component analysis.

(5)  $P_m$ : General primary membrane stress intensity

$P_L$ : Local primary membrane stress intensity

$P_b$ : Primary bending stress intensity

$F_a$ : Buckling stress determined by either (i) comprehensive stability analysis or (ii) (3/2) allowable load given by equations of F-1334.3 for ferritic steel

(6) For  $P_b$ , other conditions specified in NF-3322.1 must be specified

(7) Incorporates provisions of Reg. Guide 1.124 Rev2, 2007