ArevaEPRDCPEm Resource

From: BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
Sent: Monday, May 24, 2010 1:10 PM
To: Tesfaye, Getachew
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 365, FSAR Ch. 5 OPEN ITEM, Supplement 1
Attachments: RAI 365 Supplement 1 US EPR DC .pdf

Getachew,

AREVA NP submitted technically correct and complete responses to 5 of the 6 questions of RAI 365 on April 27, 2010 and indicated a response to the remaining question would be provided by May 28, 2010. The attached file, "RAI 365 Supplement 1 Response US EPR DC.pdf" provides a technically correct and complete response to the remaining question, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 365 Question 05.02.01.01-5. Also appended to this file are affected pages from ANP-10264NP Revision 1, U.S. EPR Piping Analysis and Pipe Support Design Topical Report which also support the response to RAI 365 Question 05.02.01.01-5.

The following table indicates the respective pages in the response document, "RAI 365 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 365 — 05.02.01.01-5c	2	3

This concludes the formal AREVA NP response to RAI 365, and there are no questions from this RAI for which AREVA NP has not provided responses.

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

From: BRYAN Martin (EXT)
Sent: Tuesday, April 27, 2010 2:33 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 365, FSAR Ch. 5 OPEN ITEM

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 365 Response US EPR DC.pdf" provides a technically correct and complete response to 5 of the 6 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 365 Questions 05.02.05-9, 05.02.05-11, and 05.02.05-14.

The following table indicates the respective pages in the response document, "RAI 365 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 365 — 05.02.01.01-5	2	4
RAI 365 — 05.02.05-9	5	5
RAI 365 — 05.02.05-10	6	6
RAI 365 — 05.02.05-11	7	7
RAI 365 — 05.03.01-14	8	8
RAI 365 — 05.03.01-15	9	9

The schedule for technically correct and complete responses to the remaining 1 question is provided below:

Question #	Response Date
RAI 365 — 05.02.01.01-5C	May 28, 2010

Martin (Marty) C. Bryan
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, March 31, 2010 3:10 PM
To: ZZ-DL-A-USEPR-DL
Cc: Wu, Cheng-Ih; Hawkins, Kimberly; Li, Chang; Segala, John; Lee, Samuel; Jenkins, Joel; Terao, David; Roy, Tarun
Subject: U.S. EPR Design Certification Application RAI No. 365(4317,4318,4319), FSAR Ch. 5 OPEN ITEM

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on February 3, 2010, and discussed with your staff on March 2, 2010. Draft RAI Questions 05.02.01.01-5a was modified as a result of that discussion, and the staff has added 05.02.01.01-5b and 05.02.01.01-5c to address similar concerns that was not part of that discussion. The questions in this RAI are OPEN ITEMS in the safety evaluation report for Chapter 5 for Phases 2 and 3 reviews. As such, the schedule we have established for your application assumes technically correct and complete responses prior to the start of Phase 4 review. For any RAI that cannot be answered prior to the start of Phase 4 review, it is expected that a date for receipt of this information will be provided 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: 1443

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From: BRYAN Martin (EXT)

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Response to

Request for Additional Information No. 365(4317, 4318, 4319), Revision 0

3/31/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 05.02.01.01 - Compliance With the Codes and Standards Rule, 10 CFR 50.55a
SRP Section: 05.02.05 - Reactor Coolant Pressure Boundary Leakage Detection
SRP Section: 05.03.01 - Reactor Vessel Materials
Application Section: Chapter 5

QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)
QUESTIONS for Balance of Plant Branch 2 (ESBWR/ABWR) (SBPB)
QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

Question 05.02.01.01-5:

OPEN ITEM

Follow-up to RAI 51, Question 05.02.01.01-3

A. The applicant did not address how 10 CFR 50.55a(b)(1)(ii) is satisfied for the U.S. EPR design. The staff noted that the code of record for U.S. EPR design is the 2004 Edition of ASME code, and the piping stress analysis and seismic design are performed in accordance with the 1993 Addenda to the 1992 Edition to meet the requirement of 10 CFR 50.55a(b)(1)(iii). However, the use of either the 2004 Edition or the 1993 Addenda is disallowed by 10 CFR 50.55a(b)(1)(ii). AREVA is requested to provide the technical basis of how 10 CFR 50.55a(b)(1)(ii), "weld leg dimensions" is addressed while using the 2004 Edition and 1993 Addenda.

B. 10 CFR 50.55a requires that the Code edition and addenda to be applied to ASME Class 1, 2 and 3 piping and components must be determined by the rules of the ASME Section III paragraph NCA-1140(2), which disallows use of Code Edition and Addenda in the Design Specifications that is (a) earlier than three years prior to the date the construction permit application is docketed or (b) earlier than the latest Edition and Addenda endorsed by the regulatory authority at the time the construction permit application is docketed. This requirement is not satisfied by the code of record for U.S. EPR. For instance, the code used for U.S. EPR DC is the 2004 Edition with no Addenda while COL application date for Calvert Cliffs 3 and 4 is March 13, 2008. This implies a violation of NCA-1140(2)(a). To resolve the issue, ASME approved a Code Case N-782 in January 2009 which allows that the Code Edition and Addenda endorsed in a design certified or licensed by the regulatory authority may be used for systems and components as an alternative rule to NCA-1140(2)(a) and (2)(b). However, 10 CFR 50.55a requires that the optional ASME Code cases must be those listed in the NRC Regulatory Guide (RG) 1.84 that is incorporated by reference in paragraph 50.55a (b)(4). Code Case N-782 is not listed for acceptance in Revision 34 of RG 1.84. In order to apply the alternative rule to requirements of NCA-1140, the applicant is requested to provide justification for inclusion of Code Case N-782 in U.S. EPR DCD in accordance with 10 CFR 50.55a(3)(i) and (ii).

C. In its response to RAI 51, AREVA confirmed that the base code for USEPR design of piping systems, components and their supports is the 2004 Edition with no Addenda of the ASME Section III Code. As a result, AREVA is requested to revise its topical reports to base on the 2004 Edition for consistency with the EPR design as it relates to Code Edition and Addenda of U.S. EPR design certification. It is noted that if other Code Editions and Addenda than the 20004 Edition must be used for design of EPR safety related components, AREVA is requested to provide justification to reconcile the use of the other Code Edition and Addenda to the requirements of the 2004 Edition in accordance with NCA-1140 and 10 CFR 50.55a (a)(3). The staff notes that Section 3.12 of USEPR DCD identifies the Code Edition and Addenda by referring to the topical report ANP-10264NP where the 2001 Edition with the 2003 Addenda is used for design and analysis of piping and its supports. This implies that there are two Code Editions used by a USEPR Design. AREVA is also requested to discuss how the use of multiple code editions and addenda for a DCD design to satisfy the Section III Subsection NCA-1140(a)(1) which states that all items of a nuclear power plant may be constructed to a

single Code Edition and Addenda, or each item may be constructed to individually specified Code Editions and Add

Response to Question 05.02.01.01-5:

(Note: responses to Parts a and b of this question were provided in the original RAI response)

c. AREVA NP has revised Topical Report (TR) ANP-10264NP to change the 2001 Edition with the 2003 Addenda to the 2004 Edition with no Addenda for design and analysis of piping and supports. The revised pages from this TR are enclosed. Additionally, the following sections from U.S EPR FSAR Tier 2 will be revised to reflect this revision to ANP-10264NP:

- U.S. EPR FSAR Tier 2, Table 1.6-1.
- U.S. EPR FSAR Tier 2, Section 3.9.2.
- U.S. EPR FSAR Tier 2, Section 3.9.3.
- U.S. EPR FSAR Tier 2, Section 3.12.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 1.6-1, Section 3.9.2. Section 3.9.3, and Section 3.12 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

Table 1.6-1—Reports Referenced
Sheet 1 of 4

Report No. (See Notes 1, 2, and 3)	Title	Date Submitted to NRC	FSAR Section Number(s)
ANF-89-060P-A ANF-89-060NP-A Supplement 1	Generic Mechanical Design Report High Thermal Performance Spacer and Intermediate Flow Mixer	3/28/91	4.2
ANP-10263P-A ANP-10263NP-A	Codes and Methods Applicability Report for the U.S. EPR	11/06/07	4, 5.1, 15, 16, and 19
ANP-10264NP-A	U.S. EPR Piping Analysis and Pipe Support Design Topical Report	11/07/08	3.6, 3.7, 3.8, 3.9, 3.10, 3.12, App. 3A, and App. 3C
ANP-10264NP Revision 1	U.S. EPR Piping Analysis and Pipe Support Design Topical Report	5/10	3.9 and 3.12
ANP-10266-A	AREVA NP Inc. Quality Assurance Plan (QAP) for Design Certification of the U.S. EPR Topical Report	06/18/07	7.1, 17.1, 17.2, 17.3, 17.5, 18.1, 18.7, and 18.11
ANP-10268P-A ANP-10268NP-A	U.S. EPR Severe Accident Evaluation Topical Report	2/26/08	6.2.5, 15.4, 19.1, and 19.2
ANP-10269P-A ANP-10269NP-A	The ACH-2 CHF Correlation for the U.S. EPR Topical Report	3/10/08	4.4, 5, 7, 15, and 19
ANP-10272	Software Program Manual TELEPERM XS™ Safety Systems Topical Report	12/21/06	7.1 and 7.6
ANP-10273P ANP-10273NP	AV42 Priority Actuation and Control Module Topical Report	11/28/06	7 and 16
ANP-10275P-A ANP-10275NP-A	U.S. EPR Instrument Setpoint Methodology Topical Report	2/26/08	7 and 16
ANP-10278P ANP-10278NP Revision 1	U.S. EPR Realistic Large Break Loss of Coolant Accident Topical Report	01/10 ~~3/26/07~~	6.2 and 15
~~ANP-10279~~	~~U.S. EPR Human Factors Engineering Program Topical Report~~	~~1/29/07~~	~~3.4, 7.1, 13.1, and 18~~
ANP-10309P ANP-10309NP ~~ANP-10281P~~ ~~ANP-10281NP~~	U.S. EPR Digital Protection System ~~Topical~~Technical Report	~~3/27/07~~11/24/09	3.1.3, 4.6, 7, 19.1, and 8.1
ANP-10282P ANP-10282NP	POWERTRAX/E Online Core Monitoring Software for the U.S. EPR Technical Report	11/27/07	4.4

05.02.01.01-5

3.12 ASME Code Class 1, 2, and 3 Piping Systems, Piping Components, and their Associated Supports

3.12.1 Introduction

This section addresses the design of the piping systems and piping supports used in Seismic Category I, Seismic Category II, and non-safety-related systems. The information in this section is primarily supported by AREVA NP Topical Report ANP-10264NP-A (~~Reference 1~~References 1 and 2). This topical report focuses on Seismic Category I and Seismic Category II systems, but also addresses the interaction of non-seismic piping with Seismic Category I piping. Further supporting information is provided in Sections 3.7.2, 3.7.3, 3.9.1, 3.9.2, 3.9.3, 3.13, and 5.2.

05.02.01.01-5

3.12.2 Codes and Standards

Applicable codes and standards for piping and pipe supports are detailed in Section 2.0 and in Section 6.1 of ~~Reference 1~~References 1 and 2.

3.12.3 Piping Analysis Methods

3.12.3.1 Experimental Stress Analysis Methods

05.02.01.01-5

Experimental stress analysis methods are not used in lieu of analytical methods for Seismic Category I piping.

3.12.3.2 Modal Response Spectrum Method

The uniform support response spectrum method used in the analyses for piping systems is addressed in Section 4.2 of Reference 1.

3.12.3.3 Response Spectra Method (or Independent Support Motion Method)

The independent support motion response spectrum method is addressed in Section 4.2 of Reference 1.

3.12.3.4 Time History Method

Section 4.2.3 of Reference 1 addresses the time history methods used in the analyses of piping systems. Additional information is given in Section 3.7.2.

3.12.3.5 Inelastic Analysis Method

Inelastic analysis will not be used to qualify piping for the U.S. EPR design.

3.12.3.6 Small Bore Piping Method

As noted in Reference 1, small bore piping is defined as ASME Class 1 piping that is 1 inch NPS and smaller and Class 2, Class 3 and QG D piping that is 2 inch NPS and

3.12.6 Piping Support Design Criteria

3.12.6.1 Applicable Codes

05.02.01.01-5

Section 2.0 and Section 6.1 of ~~Reference 1~~References 1 and 2 address the applicable codes, code cases, and standards for the U.S. EPR piping supports.

3.12.6.2 Jurisdictional Boundaries

Section 6.2 of Reference 1 addresses the jurisdictional boundaries for pipe supports.

3.12.6.3 Loads and Load Combinations

Section 3.12.5.3 addresses loads and load combinations for pipe supports.

3.12.6.4 Pipe Support Baseplate and Anchor Bolt Design

Section 6.4 of Reference 1 addresses the design of pipe support baseplates and anchor bolts.

3.12.6.5 Use of Energy Absorbers and Limit Stops

Section 6.5 of Reference 1 addresses energy absorbers for pipe supports and gapped rigid supports (limit stops).

3.12.6.6 Use of Snubbers

Section 6.6 of Reference 1 addresses the use of snubbers in the piping design.

3.12.6.7 Pipe Support Stiffnesses

Section 6.7 of Reference 1 addresses the consideration of pipe support stiffnesses in the piping analyses and also provides support deflection criteria.

3.12.6.8 Seismic Self-Weight Excitation

Section 6.8 of Reference 1 addresses the consideration of seismic excitation of pipe supports in the analyses of the supports.

3.12.6.9 Design of Supplementary Steel

Section 6.9 of Reference 1 addresses the design of supplemental steel used in piping supports.

3.12.6.10 Consideration of Friction Forces

Section 6.10 of Reference 1 addresses consideration of pipe-to-pipe support friction forces in the analyses of pipe supports.

3.12.6.11 Pipe Support Gaps and Clearances

Section 6.11 of Reference 1 addresses pipe support gaps and clearances used in the design of pipe supports.

3.12.6.12 Instrumentation Line Support Criteria

Section 6.12 of Reference 1 addresses instrumentation line support design criteria.

3.12.6.13 Pipe Deflection Limits

Section 6.13 of Reference 1 addresses the allowable deflections for standard pipe support components (e.g., snubbers, struts, spring hangars) that are used in the design of piping.

3.12.7 References

1. ANP-10264NP-A Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design," AREVA NP Inc., November 2008.

05.02.01.01-5

2. ANP-10264NP, Revision 1, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., May 2010~~Deleted~~.

3. EPRI Technical Report 1011955, "Management of Thermal Fatigue in Normal Stagnant Unisolable Reactor Coolant System Branch Lines (MRP 146)," EPRI Proprietary Licensed Material, Electric Power Research Institute, June 2005.

4. EPRI Technical Report 103581, "Thermal Stratification, Cycling, and Striping (TASCS)," EPRI Proprietary Licensed Material, Electric Power Research Institute, March 1994.

5. NUREG-1367, "Functional Capability Of Piping Systems," U.S. Nuclear Regulatory Commission, November 1, 1992.

Next File

Preoperational tests are intended to demonstrate that the components comprising these piping systems meet functional design requirements, that piping vibrations are within acceptable levels, and that proper allowance for thermal contraction and expansion is provided. In addition, these tests verify that integrated systems are operating correctly, that system operating procedures are correct, and that system components and safety equipment are operational prior to fuel loading. The end of hot functional testing (HFT) marks the end of Phase I testing. Before fuel loading commences, the results of preoperational tests are evaluated by plant operations and technical staff. If test acceptance criteria are not satisfied, appropriate corrective actions and retesting occurs.

Phase II – Initial Fuel Loading and Pre-Critical Testing

Initial fuel loading and pre-critical tests (refer to Section 14.2.12) are similar to Phase I tests, but occur after the initial reactor core is loaded. Phase II tests establish that the RCS vibration levels and piping reactions to transient conditions (e.g., pump starting and stopping and valve opening and closing) are acceptable. Phase II testing is completed, evaluated, and any required corrective actions taken prior to initiating Phase III (Initial Criticality and Low-Power Physics Testing). If excessive vibration levels are detected during testing, consideration is given to modifying the design specification to re-verify applicable code conformance using the measured vibration as input. If testing and subsequent analysis reveal that additional restraints are needed to reduce stresses to acceptable levels, they are installed.

As described in U.S. EPR Piping Analysis and Pipe Support Design (Reference 2), the U.S. EPR uses snubbers to support piping systems that require free thermal movement but restrained movement due to dynamic loadings. The proper installation and operation of snubbers is verified through visual inspections, hot and cold position measurements, and observation of thermal movements during Phase I and II startup testing. Section 3.9.6 provides the preservice testing (PST) and inservice testing (IST) requirements for snubbers. The IST program incorporates Phase I and II startup testing. Snubber use and locations are determined using the analytical methods presented in Reference 2, as described in Section 3.9.6.

3.9.2.1.1 Piping Vibration Details

05.02.01.01-5

Piping vibration testing and assessment is performed in accordance with the ASME Standards and Guides for Operation and Maintenance of Nuclear Power Plants (Reference 3) including the addenda. References 2 and 6 ~~Reference 2~~ describes the code requirements, acceptance criteria, analysis methods, and modeling techniques for ASME Class 1, 2, and 3 piping and pipe supports. Reference 5 describes the comprehensive vibration assessment program for piping. The Phase I and II tests described above demonstrate that the piping systems withstand vibrations arising from Level A (Normal) loads and Level B (Upset) loads.

Analysis of the RPV internals for safe shutdown earthquake (SSE) loading uses direct step-by-step time-history analysis techniques. The SSE analysis of the RPV Isolated Model is described in Appendix 3C.

The response of the RPV internals to SSE loading are combined with their response to the safety injection line breaks by the square-root-of-the-sum-of-the-squares method. Section 3.9.3 provides the faulted load combinations considered in the stress and fatigue analyses of the RPV internals.

3.9.2.6 Correlations of Reactor Internals Vibration Tests with the Analytical Results

The results of the dynamic analysis of the RPV internals are compared to the results of preoperational tests, and this comparison verifies that the analytical model provides appropriate results. If the predicted responses differ significantly from the measured values, the vibration responses are determined with the measured forcing function as input.

3.9.2.7 References

1. ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2004.

2. ANP-10264NP-A, Revision 0, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., November 2008.

3. ASME OM-S/G-2000, "Standards and Guides for Operation and Maintenance of Nuclear Power Plants," The American Society of Mechanical Engineers, 2000.

4. Deleted.

5. ANP-10306P, Revision 0, "Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report," AREVA NP Inc., December 2009.

6. ANP-10264NP, Revision 1, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP INC., May 2010.

05.02.01.01-5

05.02.01.01-5

This section refers to U.S. EPR Piping Analysis and Pipe Support Design Topical Report (~~Reference 2~~References 2 and 7) for information related to the design and analysis of safety-related piping. This topical report presents the U.S. EPR code requirements, acceptance criteria, analysis methods, and modeling techniques for ASME Class 1, 2, and 3 piping and pipe supports. Applicable COL action items in the topical report are identified in the applicable portions of this section. The U.S. EPR design is based on the 2004 ASME Code, Section III, Division 1, with no addenda subject to the limitations and modification identified in 10 CFR 50.55a(b)(1) and the piping analysis criteria and methods, modeling techniques, and pipe support criteria described in ~~Reference 2~~References 2 and 7.

A design specification is required by Section III of the ASME Code for Class 1, 2, and 3 components, piping, supports, and core support structures. In addition, the ASME Code requires design reports for all Class 1, 2, and 3 components, piping, supports and core support structures documenting that the as-designed and as-built configurations adhere to the requirements of the design specification. A COL applicant that references the U.S. EPR design certification will prepare the design specifications and design reports for ASME Class 1, 2, and 3 components, piping, supports and core support structures that comply with and are certified to the requirements of Section III of the ASME Code. The COL applicant will address the results and conclusions from the reactor internals material reliability programs applicable to the U.S. EPR reactor internals with regard to known aging degradation mechanisms such as irradiation-assisted stress corrosion cracking or void swelling addressed in Section 4.5.2.1.

Other sections that relate to this section are described below:

- Section 3.9.6 describes the snubber inspection and test program.
- Section 3.10 describes the methods and criteria for seismic qualification testing of Seismic Category I mechanical equipment and a description of their seismic operability criteria.
- Section 3.12 describes the design of systems and components that interface with the RCS with regard to intersystem LOCAs.
- Section 3.13 describes bolting and threaded fastener adequacy and integrity.
- Section 5.2.2 describes the pressure-relieving capacity of the valves specified for RCPB.
- Section 10.3 describes the pressure-relieving capacity of the valves specified for the steam and feedwater systems.

3.9.3.1 Loading Combinations, System Operating Transients, and Stress Limits

Section 3.9.3.1.1 describes the design and service level loadings used for the design of ASME Class 1, 2, and 3 components, piping, supports, and core support structures,

used as the boundary of the models. These methods are further described in Section 5.4.3 and Figure 5-3 of Reference 2.

3.9.3.5 References

1. ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Power Plant Components," The American Society of Mechanical Engineers, 2004.

2. ANP-10264NP-A, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., November 2008.

3. ANSI Standard B16.34, "Valves-Flanged, Threaded, and Welding End," American National Standards Institute, 2004.

4. IEEE Standard 344-2004, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, June 2005.

5. ANSI Standard B31.1, "Power Piping," American National Standards Institute, 2004.

6. NUREG/CR-5416, (EGG-2571), "Technical Evaluation of Generic Issue 113: Dynamic Qualification and Testing of Large Bore Hydraulic Snubbers," U.S. Nuclear Regulatory Commission, September 1992.

05.02.01.01-5 →

7. ANP-10264NP, Revision 1, "U.S. EPR Piping Analysis and Pipe Support Design Topical Report," AREVA NP Inc., May 2010.

Revised Pages from ANP-10264NP Revision 1 U.S. EPR Piping Analysis and Pipe Support Design Topical Report

ANP-10264NP
Revision 1

U.S. EPR Piping Analysis and Pipe Support Design
Topical Report

May 2010

AREVA NP Inc.

Non-Proprietary

Nature of Changes

Revision 0

Item	Section(s) or Page(s)	Description and Justification
1.	All	This is a new document

Revision 1

Item	Section(s) or Page(s)	Description and Justification
1.	2-1 Section 2.1 3-9, Section 3.8.1 3-27, Table 3-2 8-1, Section 8.0	Changed references to the 2001 edition of the ASME Code, 2003 Addenda to the 2004 edition of the ASME Code (no addenda) in response to U.S. EPR FSAR RAI 365.
2.	2-2, Section 2.2	Added a note that code cases N-122-2, N-318-5, N-391-2, and N-392-3 have been incorporated into the 2004 edition of the ASME Code (no addenda) in response to U.S. EPR FSAR RAI 365.

Revision 1 incorporates the items identified above. The remainder of the document retains approved status associated with the Revision 0 SER.

2.0 CODES AND STANDARDS

10 CFR Part 50, Appendix A, General Design Criterion (GDC) 1 requires that structures, systems and components (SSC) important to safety must be designed to quality standards "commensurate with the importance of the safety functions to be performed." GDC 2 requires that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes and floods without the loss of their safety function. Codes and standards used to show that safety-related piping and pipe supports for the U.S. EPR meet these GDCs are identified below.

2.1 *ASME Boiler and Pressure Vessel Code*

Piping analysis and pipe support design for the U.S. EPR addressed in this topical report use the ASME Code Section III, Division 1, 2004 edition (no addenda)[2] as the base code with limitations identified in the Code of Federal Regulations, 10 CFR 50.55a(b)(1). Accordingly, the 2004 Edition of the ASME Code, no addenda, will be the design code for Class 1, 2, and 3 piping with the restriction that the treatment of dynamic loads, including seismic loads, in the pipe stress analyses will be according to sub-articles NB/NC/ND-3650 of the 1993 Addenda of the ASME Code[3]. Class 1 piping greater than one inch Nominal Pipe Size (NPS) will be analyzed to NB-3600. Class 1 piping one inch NPS and smaller and Class 1 piping meeting the requirements of NB-3630(d)(2) may be analyzed to NC-3600. Class 2 piping will be analyzed to NC-3600. Class 3 piping will be analyzed to ND-3600. Quality Group D piping will be analyzed to ASME B31.1, 2004 Edition, no addenda. Pipe supports will be designed to Subsection NF of the ASME Code, Section III, 2004 Edition, (no addenda). The requirements of ASME Section XI, 2004 Edition (no addenda) will be met in the design of piping and pipe supports.

2.2 *ASME Code Cases*

ASME Code Cases applicable to the U.S. EPR Design Certification for piping and pipe supports are as follows:

- ASME Code Case N-122-2, 'Procedure for Evaluation of the Design of Rectangular Cross Section Attachments on Class 1 Piping, Section III, Division 1.'[1]

- ASME Code Case N-318-5, 'Procedure for Evaluation of the Design of Rectangular Cross Section Attachments on Class 2 or 3 Piping, Section III, Division 1.'[1]

- ASME Code Case N-319-3, 'Alternate Procedure for Evaluation of Stresses in Butt Welding Elbows in Class 1 Piping Section III, Division 1.'

- ASME Code Case N-391-2, 'Procedure for Evaluation of the Design of Hollow Circular Cross Section Welded Attachments on Class 1 Piping, Section III, Division 1.'[1]

- ASME Code Case N-392-3, 'Procedure for Evaluation of the Design of Hollow Circular Cross Section Welded Attachments on Class 2 and 3 Piping, Section III, Division 1.'[1]

Other ASME Code Cases may be used if they are either conditionally or unconditionally approved in Regulatory Guide (RG) 1.84[4].

2.3 *Design Specification*

A design specification is required by Section III of the ASME Code[2] for ASME Class 1, 2 and 3 piping. In addition, the ASME Code requires design reports for all Class 1, 2 and 3 piping demonstrating and documenting that as-designed piping and support

[1] The above code cases have been incorporated into the 2004 ASME Code, Section III (no addenda).

3.7.2 *NRC Bulletin 88-11 (Surge Line)*

NRC Bulletin 88-11[11] requires consideration of the effects of thermal stratification on the pressurizer surge line. The surge line on the U.S. EPR will be analyzed with the RCL piping and supports. The effects of thermal stratification and striping will be evaluated as part of this analysis or it will be demonstrated that the surge line is not subjected to significant stratification/striping effects due to design features that mitigate these effects. The COL applicant will confirm that thermal deflections do not create adverse conditions during hot functional testing.

3.7.3 *NRC Bulletin 88-08 (Unisolable piping due to leaking valves)*

Unisolable sections of piping connected to the RCL will be evaluated to determine if thermal stratification and striping caused by a leaking valve are plausible, as discussed in NRC Bulletin 88-08 [12]. Contributions to fatigue from thermal stratification and striping will be considered where it is determined that these phenomena are plausible.

3.8 *Design and Installation of Pressure Relief Devices*

3.8.1 *Design and Installation Criteria*

The design and installation of safety valves and relief valves for overpressure protection are performed to the criteria specified in Appendix O of the ASME Code, “Rules for the Design of Safety Valve Installations,” 2004 Edition, (no addenda). In addition, the following additional requirements must be met:

- Where more than one relief device is placed on the same header, instantaneous stresses in the pipe and support loads are calculated using the most adverse sequence of valve openings.

- Stresses are evaluated for all components, (pipe, valves, supports, welds and connecting systems) for the most adverse valve sequence.

Table 3-2: Design Conditions, Load Combination and Stress Criteria for ASME Class 2&3 Piping

Loading Condition	Service Levels	Loads	Stress Criteria (4) (9)
Design	-	Primary Stress Loads: Pressure, Weight, Other Sustained Mechanical Loads	Equation 8 NC/ND-3652 (3)
Normal/ Upset	A/B	Occasional: Pressure, Weight, Other Sustained Mechanical Loads, Dynamic Fluid Loads (DFL)(1), Wind (7)	Equation 9U NC/ND-3653.1 (Level B Only) (6)
		Secondary Stress: Thermal Expansion, TAM	Equation 10 NC/ND-3653.2(a) (2)
		Non-Repeated Anchor Movement	Equation 10a NC/ND-3653.2(b)
		Sustained Plus Secondary Stress: Pressure, Weight, Other Sustained Mechanical Loads, Thermal Expansion, TAM	Equation 11 NC/ND- 3653.2(c) (2)
Emergency	C	Occasional Stress: Pressure, Weight, DFL (1), Tornado (7)	Equation 9E NC/ND-3654.2(a) (5)
Faulted	D	Occasional Stress: Pressure, Weight , DFL (1), SSE Inertia, Design Basis Pipe Break	Equation 9F NC/ND-3655(a) (5)
		Secondary Stress: Thermal Expansion, TAM, Seismic Anchor Movement (SSE)	$\frac{iM_c}{Z} \le MIN(3.0S_h, 2.0S_y)$ (6,8)

Notes:

1 Dynamic Fluid Loads are occasional loads such as safety/relief valve thrust, steam hammer, water hammer, or other loads associated with Plant Upset, Emergency or Faulted Condition as applicable.
2 Stresses must meet the requirements of either Equation 10 or 11, not both.
3 If, during operation, the system normally carries a medium other than water (air, gas, steam), sustained loads should be checked for weight loads during hydrostatic testing as well as normal operation weight loads.
4 ASME Boiler and Pressure Vessel Code, Section III.[2]
5 When causal relationships can be established, dynamic loads may be combined by the Square-Root-Sum-of-the-Squares (SRSS), provided it is demonstrated that the non-exceedance criteria given in NUREG-0484 is met. When the causal relationship cannot be established, or when the non-exceedance criteria given in NUREG-0484 are not met, dynamic loads must be combined by absolute sum. SSE and High Energy Line Break loads are always combined using the SRSS method.
6 OBE inertia and SAM loads are not included in the design of Class 2 & 3 piping[7].
7 Wind and tornado loads are not combined with earthquake loading.
8 M_c = Range of resultant moments due to thermal moments due to expansion and TAMs (Level A and B only) and SSE Seismic Anchor Movements (SAM). M_c is equal to the maximum moment range of either (a) the full range of thermal plus 1/2 the range of SAM, or (b) the full range of SAM. S_h is equal to the pipe material allowable stress at the operating temperature. S_y is equal to the pipe material yield stress at the operating temperature.
9 ASME Code equations and paragraph numbers refer to the 2004 Edition (no addenda) of the ASME Code. However, dynamic loads are treated in accordance with the applicable subarticles of the 1993 Addenda of the ASME Code per the limitations of 10 CFR 50.55a(b)(1).

8.0 REFERENCES

1. NUREG-0800,"Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Draft Revision 3.

2. ASME Boiler & Pressure Vessel Code, Section III, Division 1, 2004 Edition (no addenda).

3. ASME Boiler & Pressure Vessel Code, Section III, Division 1, 1992 Edition through 1993 addenda.

4. Regulatory Guide 1.84, "Design, Fabrication and Materials Code Case Acceptability, ASME Section III," Revision 33.

5. Regulatory Guide 1.29, "Seismic Design Classification," Revision 3.

6. WRC Bulletin 353, "Position Paper on Nuclear Plant Pipe Supports," May 1990.

7. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water (ALWR) Designs," July 21, 1993.

8. IEEE 344-1987, "Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

9. NUREG-1367, "Functional Capability of Piping Systems," November 1992.

10. NRC Bulletin 79-13, "Cracking in Feedwater System Piping," Revision 2.

11. NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification."

12. NRC Bulletin 88-08, with Supplement 3, "Thermal Stresses in Piping Connected to Reactor Coolant System."

13. Guideline for the Design of Buried Steel Pipe; Report by American Lifelines Alliance, 2001.

14. Seismic Response of Buried Pipes and Structural Components; ASCE Committee on Seismic Analysis of Nuclear Structures and Materials, New York, 1983.

15 ASCE Standard 4-98, “Seismic Analysis of Safety-Related Nuclear Structures and Commentary, American Society of Civil Engineers,” copyright © 2000 by the American Society of Civil Engineers

16. NUREG-0484, “Methodology for Combining Dynamic Responses,” Revision 1.

17. Regulatory Guide 1.122, "Development of Floor Design Response Spectra for Seismic Design of Floor-Supported Equipment or Components," Revision 1.