AevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Friday, July 30, 2010 3:38 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); WELLS Russell (AREVA); CORNELL Veronica (EXTERNAL AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 404, FSAR Ch. 3 OPEN ITEM, Supplement 1
Attachments: RAI 404 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the 10 Open Item questions of RAI No. 404 on June 30, 2010. The attached file, "RAI 404 Supplement 1 Response US EPR DC.pdf," provides a response to 8 of the 10 questions.

Appended to this file is the affected page of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 404 Questions 03.09.01-5, 03.09.01-7, and 03.09.01-10

The following table indicates the respective pages in the response document, "RAI 404 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 404 — 03.09.01-5	2	3
RAI 404 — 03.09.01-6	4	4
RAI 404 — 03.09.01-7	5	5
RAI 404 — 03.09.01-8	6	6
RAI 404 — 03.09.01-9	7	7
RAI 404 — 03.09.01-10	8	9
RAI 404 — 03.09.01-11	10	10
RAI 404 — 03.09.01-12	11	11

On July 1, 2010, AREVA requested a discussion with the NRC regarding the proposed response to RAI 404. The revised schedule shown below assumes the discussion with NRC occurs prior to August 15, 2010. Accordingly, the schedule for a technically correct and complete FINAL response to the remaining RAI 404 questions has been revised and is provided below.

Question #	Response Date
RAI 404 — 03.09.03-24	August 30, 2010
RAI 404 — 03.09.03-25	August 30, 2010

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: Wednesday, June 30, 2010 5:50 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); SLAY Lysa M (AREVA NP INC); WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 404, FSAR Ch. 3 OPEN ITEM

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 404 Response US EPR DC.pdf," provides a schedule for the responses to the 10 questions.

The following table indicates the respective pages in the response document, "RAI 404 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 404 — 03.09.01-5	2	2
RAI 404 — 03.09.01-6	3	3
RAI 404 — 03.09.01-7	4	4
RAI 404 — 03.09.01-8	5	5
RAI 404 — 03.09.01-9	6	6
RAI 404 — 03.09.01-10	7	7
RAI 404 — 03.09.01-11	8	8
RAI 404 — 03.09.01-12	9	9
RAI 404 — 03.09.03-24	10	10
RAI 404 — 03.09.03-25	11	11

A complete answer is not provided for the 10 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 404 — 03.09.01-5	July 30, 2010
RAI 404 — 03.09.01-6	July 30, 2010
RAI 404 — 03.09.01-7	July 30, 2010
RAI 404 — 03.09.01-8	July 30, 2010
RAI 404 — 03.09.01-9	July 30, 2010
RAI 404 — 03.09.01-10	July 30, 2010
RAI 404 — 03.09.01-11	July 30, 2010
RAI 404 — 03.09.01-12	July 30, 2010
RAI 404 — 03.09.03-24	July 30, 2010
RAI 404 — 03.09.03-25	July 30, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
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Martin.Bryan.ext@areva.com

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, June 01, 2010 9:49 AM
To: ZZ-DL-A-USEPR-DL
Cc: Wu, Cheng-Ih; Le, Tuan; Dixon-Herrity, Jennifer; Patel, Jay; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 404(4692, 4684),FSAR Ch. 3 OPEN ITEM

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 11, 2010, and discussed with your staff on June 1, 2010. No changes were made to the draft RAI as a result of that discussion. The questions in this RAI are OPEN ITEMs in the safety evaluation report for Chapter 3, Group 2 sections in Phases 2 and 3 reviews. 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: 1768

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Subject: Response to U.S. EPR Design Certification Application RAI No. 404, FSAR Ch. 3 OPEN ITEM, Supplement 1
Sent Date: 7/30/2010 3:37:49 PM
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From: BRYAN Martin (EXTERNAL AREVA)

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MESSAGE	5022	7/30/2010 3:37:52 PM
RAI 404 Supplement 1 Response US EPR DC.pdf		123505

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

Response to

Request for Additional Information No. 404, Supplement 1

6/01/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.09.01 - Special Topics for Mechanical Components
SRP Section: 03.09.03 - ASME Code Class 1, 2, and 3 Components
Application Section: 3.9

QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

Question 03.09.01-5:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-1.2:

In RAI 179, Question 03.09.01-1.2, the staff requested the applicant to provide the basis to justify not including earthquakes dynamic events at the rated operating power conditions in Table 3.9.1-1.

In a February 26, 2009, response to RAI No. 179, Question 03.09.01-1.2 (Accession Number ML090570933), the applicant stated that FSAR Tier 2, Table 3.9.1-1 provides a summary of thermal design transients. The seismic design basis is addressed in FSAR Tier 2, Section 3.7.1, "Seismic Design Parameters," Section 3.7.2, "Seismic System Analysis," and Section 3.7.3, "Seismic Subsystem Analysis." The Final Safety Evaluation Report for Topical Report ANP-10264NP-A, "Piping Analysis and Pipe Support Design Topical Report," states: "AREVA meets 10 CFR Part 50, Appendix S, requirements by designing the safety related piping systems, with a reasonable assurance to withstand the dynamic effects of earthquakes with an appropriate combination of other loads of normal operation and postulated events with an adequate margin for ensuring their safety functions." Additionally, per FSAR Tier 2, Table 3.9.3-1, the seismic inertial loads are included in the fatigue analysis of ASME Class 1 Components. The earthquake dynamic loads are included in the fatigue analysis of structures, systems, and components.

The staff notes that FSAR Tier 2, Table 3.9.3-1 provides the loading combinations and corresponding stress design criteria per ASME Service Level for ASME Class 1 components. Section 3.4 of Topical Report ANP-10264NP-A requires that the fatigue analysis be performed for all ASME Code Class 1 piping to meet 10 CFR Part 50, Appendix S requirements. However, neither Table 3.9.3-1 nor Topical Report ANP-10264NP-A provides specific requirements for fatigue evaluation regarding the number of cycles, estimated magnitude, and frequency of the reversing dynamic seismic events that may occur during the 60 years plant operation, thus the applicant is requested to provide the above information.

Response to Question 03.09.01-5:

The requested information is addressed in U.S. EPR FSAR Tier 2, Table 3.9.3-1, Note 12 which states:

> "The earthquake inertial load used in the Level B Alternating stress intensity calculations is taken as 1/3 of the peak SSE inertial load or as the peak SSE inertial load. If the earthquake inertial load is taken as the peak SSE inertial load, then 20 cycles of earthquake loading shall be considered. If the earthquake inertial load is taken as 1/3 of the peak SSE inertial load, then the number of cycles to be considered for earthquake loading shall be 300 (the equivalent number of 20 full SSE cycles as derived in accordance with IEEE Std 344)."

This Note applies to the Upset Service Condition in U.S. EPR FSAR Tier 2, Table 3.9.3-1 for the Alternating Stress Intensity (Fatigue Usage) Category for the Earthquake Inertial Load. A similar note appears in ANP-10264NP-A, Table 3-1, Note 7. Per NRC's request, a note will also be added to U.S. EPR FSAR Tier 2, Table 3.9.1-1 which will provide a link to the information regarding number of seismic cycles, estimated magnitude and frequency of reversing dynamic seismic events that may occur during the 60 years of plant operation.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 3.9.1-1 will be revised as described in the response and indicated on the enclosed markup.

Question 03.09.01-6:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-1.3:

In RAI 179, Question 03.09.01-1.3, the staff requested the applicant to provide the basis for not including the turbine stop valve closure induced loads in FSAR Tier 2, Section 3.9.1.

In a February 26, 2009, response to RAI 179, Question 03.09.01-1.3, the applicant stated that the applicant has not been able to identify a precedent in which the NRC has requested a design certification applicant to provide such information.

The staff notes that the TSV closure event has been considered to be a Service Level B fluid transient load (i.e., steam hammer loads). The applicant is requested to address why this transient due to TSV closure is not applicable to U.S. EPR design.

Response to Question 03.09.01-6:

Turbine Stop Valve (TSV) closure is included in the upset transients in U.S. EPR FSAR Tier 2, Section 3.9.1.1.2. Specifically, Upset Transient 2 is the plant response to a turbine trip (loss of load event). Turbine trip is accomplished by closure of the turbine valves (stop valves and control valves). The primary side pressures and temperature responses for this event are greater than those associated with closure of a single MSIV (i.e., Upset Transient 11). Since Upset Transient 2 currently considers turbine bypass to be unavailable, this transient is more conservative than looking at closure of the TSV by itself (with bypass remaining available).

FSAR Impact:

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

Question 03.09.01-7:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-1.4:

In RAI 179, Question 03.09.01-1.4, the staff requested the applicant to provide the basis for not considering the thermal stratification in FSAR Tier 2, Section 3.9.1.1, as it relates to the design transient in the piping design on fatigue.

In a February 26, 2009, response to RAI 179, Question 03.09.01-1.4, the applicant stated that FSAR Tier 2, Section 3.12.5.10, “Thermal Stratification,” addresses thermal stratification for the pressurizer (PZR) surge line, PZR lower head, normal spray line, auxiliary spray line, main feedwater (MFW) line, and emergency feedwater (EFW) line. The contribution of normal and upset condition stratification cycles is considered in the fatigue analysis of these piping systems. In addition, the applicant referred the staff to its August 21, 2008, response to RAI 48, Question 03.06.03-3 and Question 03.06.03-4 for more information on thermal stratification of the PZR SL.

The staff noted that the stratification has been extensively considered in the design of piping in FSAR Tier 2, Section 3.12.5.10 for fatigue analysis. However, the applicant has not defined or described the thermal stratification transient including information regarding the number of cycles for the transients and the magnitude and frequency of the transients that may occur during plant operation. Accordingly, the staff requests the applicant to provide the above information for the fatigue evaluation.

Response to Question 03.09.01-7:

Stratification transients are not separate events. They occur because of particular combinations of flow and temperature and are an inherent part of several design transients. The number of cycles for each transient is provided, therefore the number and frequency of stratification events can be derived based on the cycles of the transients in which they occur. As noted in the response to RAI 179, Question 03.09.01 1.4, the contribution of normal and upset condition stratification cycles is considered in the fatigue analysis of these piping systems. U.S. EPR FSAR Tier 2, Section 3.9.1 identifies the number of cycles for the normal and upset transients.

Therefore, the effect of thermal stratification on fatigue evaluation is considered in the design transients for the U.S. EPR. Note 4 will be added to U.S. EPR FSAR Tier 2, Table 3.9.1-1 to reflect the information in this RAI response.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 3.9.1-1 will be revised as described in the response and indicated on the enclosed markup.

Question 03.09.01-8:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-1.5:

Regarding the vibration effects on the components and piping due to acoustic resonance stated in NRC RG 1.20, Revision 3, staff requested the applicant in RAI 179, Question 03.09.01-1.5 to provide the basis for not including this acoustic cyclic loading in FSAR Tier 2, Section 3.9.1.1, as it relates to cyclic loadings applying to Class 1 piping and components.

In a February 26, 2009, response to RAI 179, Question 03.09.01-1.5, the applicant referred to its February 23, 2009 response to RAI 160, Question 03.09.02-17. The response noted that acoustic resonances, such as those caused by flow past a dead leg of closed relief valves, have the characteristic that the pressure flow oscillations travel through the entire affected piping system with little attenuation.

It is noted that the vibration effects can significantly affect the fatigue cumulative factor in the case where the acoustic resonance occurs coupled with the structural frequencies. Therefore, the staff requests the applicant to confirm that the U.S. EPR is designed to ensure no acoustic resonance will occur when flow passing through the dead leg of closed relief valve or no acoustic resonance was found in the database for PWR systems.

Response to Question 03.09.01-8:

As described in Appendix A of ANP-10306P, Revision 0, “Comprehensive Vibration Assessment Program for U.S. EPR Reactor Internals Technical Report,” the U.S. EPR is designed so that there is no occurrence of acoustic resonance resulting from flow passing the entrances of dead legs of closed relief valves.

FSAR Impact:

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

Question 03.09.01-9:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-2.3:

In RAI 179, Question 03.09.01-2.3, the staff requested the applicant to provide a summary of the verification and validation (V/V) for this program including benchmark problems. The V/V information is required by Appendix B to 10 CFR 50 and should be available as requested.

Instead of providing the V/V information, the applicant stated in a February 26, 2009, response to RAI 179, Question 03.09.01-2.3, that Section 3.3.1 of the NRC FSER for Topical Report ANP-10264NP-A approved the use of the BWSPAN computer code for the U.S. EPR and specifically accepted the referenced Oconee RCL analysis methodology for steam generator replacement as part of the basis for their approval.

The staff determines that methodology for steam generator replacement using BWSPAN program does not relate to the review of the V/V information of BWSPAN, thus requests the applicant to provide the V/V information as mentioned in RAI 179, Question 03.09.01-2.3.

Response to Question 03.09.01-9:

As noted in Section 3.3.1 of the NRC Final Safety Evaluation Report for ANP-10264NP-A, the requested information is available for NRC inspection.

FSAR Impact:

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

Question 03.09.01-10:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-2.6:

ASME Code Section III requires that the cumulative damage from fatigue be evaluated for all ASME Code Class 1 piping, components, and supports. In RAI 179, Question 03.09.01-2.6, the staff requested the applicant to identify the computer programs which were used to perform the fatigue analysis and confirm these analyses for ASME Section III Class 1 components and piping for the fatigue evaluation including environmental effects in accordance with Regulatory Guide 1.207.

In a February 26, 2009, response to RAI 179, Question 03.09.01-2.6, the applicant identified computer codes ANSYS, BWSPAN, and SUPERPIPE which are used to perform the fatigue analysis for ASME Code Class 1 piping and components. The applicant also stated that as noted in FSAR Tier 2, Section 3.12.5.19, "Effects of Environment on Fatigue Design," the effects of reactor coolant environment, using the methodology described in RG 1.207, are considered when performing fatigue analyses for Class 1 piping and components.

The applicant did not address the staff's question whether the computer codes ANSYS, BWSPAN, and SUPERPIPE which perform the fatigue analysis incorporate the environmental effects on fatigue, thus the staff requests the applicant to address the information above.

Response to Question 03.09.01-10:

Computer codes ANSYS, BWSPAN and SUPERPIPE perform ASME Code in-air fatigue analysis and do not incorporate the environmental effects on fatigue per RG 1.207. The calculations for consideration of the environmental effects on fatigue are performed by post-processing the in-air fatigue results obtained from ANSYS and BWSPAN (SUPERPIPE will not be used) using MSVisualBasic programs (FatTool), ANSYS Parametric Design Language (APDL) macros and spreadsheets which are developed according to AREVA NP procedures governing development of software, macros and scripts.

FatTool is an AREVA NP developed MSVisualBasic program that is developed for the fatigue analysis of Class 1 Piping. FatTool consists of two modules, namely the In-Air and Environmentally Assisted Fatigue (EAF) modules. The EAF module is a postprocessor of the In-Air module and incorporates the effect of Light-Water Reactor environment on the fatigue resistance of piping per the requirements of RG 1.207. The analysis methodology complies with the piping stress analysis requirements in ASME B&PV Code, Section III, Division I, NB-3600 and the EAF criteria and fatigue curves provided in NUREG/CR-6909 and RG 1.207. FatTool requires input of geometry parameters, forces and moments and thermal results from structural and thermal analyses codes like BWSPAN, P91232, and ANSYS. FatTool can perform a complete fatigue analysis (In-Air and EAF) using bending moments and thermal results from the external codes mentioned above. Alternatively it can also accept In-Air fatigue results from external codes and post-process them to evaluate the EAF results.

U.S. EPR FSAR Tier 2, Section 3.9.1.2 will be revised to add a description of computer code FatTool.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.9.1.2 will be revised as described in the response and indicated on the enclosed markup.

Question 03.09.01-11:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-2.7:

Experience suggests that most structural and piping damages during seismic events were caused by the foundation and anchor movements. To prevent such damages, the staff suggested that appropriate methodologies discussed in NUREG-1061 should be used for calculating the stresses and fatigue on piping and components subjected to multiple individual support motions.

In RAI 179, Question 03.09.01-2.7, the staff requested the applicant to verify that all computer programs used for EPR design of piping that use the Independent Support Motion Response Spectrum analysis method comply with the staff position for combining mode, group (absolute sum) and direction responses, as stated in NUREG-1061, Volume 4.

In a February 26, 2009, response to RAI 179, Question 03.09.01-2.7, the applicant stated that conformance with NUREG-1061, Volume 4 was evaluated by the NRC in Section 3.2.3 of the NRC FSER for Topical Report ANP-10264NP-A.

The applicant did not address how the methodology in NUREG-1061, Volume 4 with absolute summation is appropriately incorporated in the U.S. EPR analyses when using computer codes ANSYS, BWSPAN, and SUPERPIPE in the piping analyses, thus the staff requests the applicant to address the above request.

Response to Question 03.09.01-11:

As noted in Sections 3.2.3 of the NRC Final Safety Evaluation Report for ANP-10264NP-A, the provisions of NUREG-1061, Volume 4, for using the independent support motion method of analysis will be followed for U.S. EPR piping design. This includes combining the support group responses, for each mode and each direction, using the absolute sum method of combination.

Computer codes BWSPAN and SUPERPIPE incorporate the above methodology for performing modal combinations when using independent support motions. The default method of combining group responses in ANSYS is square root sum of the squares (SRSS). The absolute sum method for support combinations is performed in ANSYS by writing appropriate ANSYS Parametric Design Language (APDL) commands to post-process the seismic responses.

FSAR Impact:

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

Question 03.09.01-12:

OPEN ITEM

Follow-up to RAI 179, Question 03.09.01-3:

In RAI 179, Question 03.09.01-3, the staff requested the applicant to discuss the stress analysis methods used to verify the design adequacy for the design of U.S. EPR components such as snubbers, pipe whip restraints, and the prototype fine motion control rod drive.

In its response to the RAI, the applicant indicated that the pipe whip restraints are designed using elastic and elastic-plastic methodologies in accordance with the guidance in SRP Section 3.6.2 and that experimental stress analysis is not used to evaluate stresses for the restraints. Regarding the stress evaluation for the snubbers, the applicant referred to its response to RAI 107, Questions 03.09.03-13 and 03.09.03-14 and the response to RAI 178, Questions 03.09.03-19 and 03.09.03-20 where it addresses the snubbers as the linear supports which may be designed by experimental analysis or load rating methods in accordance with NF-3370 and NF-3380. The applicant noted that it does not design and manufacture snubber components; they are purchased from a qualified vendor to meet ASME Code requirements. Snubber vendors provide a certified load data sheet that states the design of its snubber meets the requirements of ASME Section III, Subsections NCA and NF. ASME Section III, Subsection NF, Paragraph NF-1214, “Standard Supports” provides guidance on the design of snubbers.

The design specifications require the snubber vendor to meet the design stress criteria of the applicable ASME Code standards. The staff notes that it is the applicant’s responsibility to ensure that the vendor design of its snubbers meets the requirements of ASME Section III, Subsections NCA and NF. The applicant is request to confirm that if snubbers are designed by experimental stress analysis, they meet the provisions of Appendix II to ASME Code, Section III, Division 1, in accordance with SRP 3.9.1.II acceptance criterion.

Response to Question 03.09.01-12:

U.S. EPR FSAR Tier 2 Sections 3.12.3.1 and 3.9.1.3 and ANP-10264NP-A Section 4.1 state that experimental stress analysis is not used for Category I systems or components for the U.S. EPR. If snubbers are designed by experimental stress analysis, they will meet the provisions of Appendix II to ASME Code, Section III, Division 1, as required by NF-3370 for linear supports, in accordance with the SRP 3.9.1.II acceptance criterion.

FSAR Impact:

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

U.S. EPR Final Safety Analysis Report Markups

benchmarked against a series of LOFT experiments and against ANF-RELAP simulations.

- SUPERPIPE: Information on this computer code is provided in Section 5.1 of Reference 2.

- GTSTRUDL: Information on this computer code is provided in Section 5.1 of Reference 2.

- ROLAST: This is a one-dimensional best-estimate computer code that performs calculations of dynamic hydraulic loads for piping systems undergoing fast transients including water hammer phenomena. This AREVA NP developed code is used for single-phase flow. It can model behaviors of components such as pumps, valves, damped and undamped check valves, vessels with various boundary, and initial conditions. Typical code applications include operating and accidental fluid transient events in piping network systems such as check valve slam, rapid valve closure, pump start and stop, and pipe breaks. The code has been benchmarked to test facility data and plant data from existing nuclear power plants. Agreement between ROLAST calculations and test/measurement data has been obtained.

- S-TRAC: This AREVA NP developed computer code is based on the NRC Transient Reactor Analysis Code (TRAC Version-P) with hydraulic load calculations package added. TRAC-P is a thermal hydraulic analysis tool to calculate the transient reactor behavior of pressurized water reactors. S-TRAC features a one-, two- or three-dimensional treatment of the pressure vessel and its associated internals, a two-phase fluid non-equilibrium hydrodynamics model with a non-condensable gas field and solute tracking and a flow-regime-dependent constitutive-equation treatment. S-TRAC is used for two-phase fluid transients and multidimensional regions. Examples of code application include fluid transient loads in the reactor pressure vessel, steam generator (e.g., shroud, sparger, dryer, U-tubes), and the pressurizer relief piping system. The verification and validation of S-TRAC is based on the validation examples made for TRAC-P. Additionally, the code has been benchmarked to test facility data and plant data from existing nuclear power plants. Agreement between S-TRAC calculations and test/measurement data has been obtained.

03.09.01-10

- FatTool: FatTool is an AREVA NP developed MSVisualBasic program that is developed for the fatigue analysis of ASME Class 1 Piping. FatTool consists of two modules (i.e., the In-Air and Environmentally Assisted Fatigue (EAF) modules). The EAF module is a postprocessor of the In-Air module and incorporates the effect of Light-Water Reactor environment on the fatigue resistance of piping per the requirements of RG 1.207. The analysis methodology complies with the piping stress analysis requirements in ASME B&PV Code, Section III, Division I, NB-3600 and the EAF criteria and fatigue curves provided in NUREG/CR-6909 and RG 1.207. FatTool requires input of geometry parameters, forces and moments and thermal results from structural and thermal analyses codes like BWSPAN, P91232 and ANSYS. FatTool can perform a complete fatigue analysis (In-Air and EAF) using bending moments and thermal results from the external codes mentioned above. Alternatively it can also accept In-Air fatigue results from external codes and post-process them to evaluate the EAF results.

As addressed in Reference 2, there are three representative calculations from the analyses for the U.S. EPR design certification to be used in the benchmark program. These calculations utilize the piping analysis codes identified in Section 5.1 of Reference 2. As noted in Reference 2, pipe stress and support analysis will be performed by a COL applicant that references the U.S. EPR design certification. A COL applicant that references the U.S. EPR design certification will either use a piping analysis program based on the computer codes described in Section 3.9.1 and Appendix 3C or will implement a U.S. EPR benchmark program using models specifically selected for the U.S. EPR.

3.9.1.3 Experimental Stress Analysis

No experimental stress analysis methods are used for Category I systems or components.

3.9.1.4 Considerations for the Evaluation of the Faulted Condition

Section 3.9.3 describes the analytical methods used to evaluate stresses for Seismic Category I systems and components subjected to faulted condition loading.

3.9.1.5 References

1. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear ~~Power Plant~~Facility 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. Deleted.

4. BAW-10164P-A, Revision 6, “RELAP5/MOD2-BAW – An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analyses,” AREVA NP Inc., June 2007.

Table 3.9.1-1—Summary of Design Transients
Sheet 2 of 2

Category	Transient ID	Transient Description	Number of Occurrences
Emergency	1	~~Loss of Offsite Power~~LOOP with Natural Circulation Cooldown	~~<25[2]~~1
	2	Long-Term Turbine Trip without TBS Station	3
	3	SG Tube Failure (one tube)	1
		~~Small Primary Side Leak (SBLOCA)~~	
	4	Small Secondary Side Break/Relief Valve Opening ~~Leak~~	1
	5	Faulty Opening of one PZR Safety Valve	1
	6	RCS Pressurization between Hot and Cold Shutdown	2
Faulted	1	Primary Side Break (LB-LOCA)	1
	2	Main Steam Line Break	1
	3	MFW Line Break	1
	4	Small Primary - Side Break (Small Break LOCA) ~~External Induced Transient~~	1
	5	RCP Locked Rotor	1
	6	Control Rod Ejection	1
Testing	N/A~~1~~	~~Individual Component~~RCS Hydrostatic Tests	10~~3 for each component~~
	~~2~~	~~System Hydrostatic Test prior to Normal Operation~~	~~3~~
	~~3~~	~~Hydrostatic Test following Plant Operation~~	~~4~~

Notes:

1. Additional shutdowns to cold shutdown are included for the partial trip and reactor trip transients.

2. Although the U.S. EPR will be operated as a base-loaded plant, the reference U.S. EPR design provides robust features for the effects of load follow. Similarly, the structural design and analysis of the RCS, RCS components, RCS component internals, and systems ancillary to the RCS account for the effects of load follow.

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3. The number, magnitude, and frequency of reversing dynamic seismic transient events corresponding to the Upset Level Service Condition to be used for fatigue analysis are evaluated per Note 12 of Table 3.9.3-1. ~~The total number of strong stress cycles for emergency events is less than 25.~~

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4. Stratification transients are not separate events. They occur because of particular combinations of flow and temperature and are an inherent part of several design transients. The contribution of normal and upset condition stratification cycles is

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considered in the fatigue analysis of piping systems. Note 8 to Table 3.9.3-1 addresses general and local thermal stresses resulting from system operating transients (i.e., pressure and thermal transients).