ArevaEPRDCPEm Resource

From:	WELLS Russell D (AREVA US) [Russell.Wells@areva.com]
Sent:	Monday, December 15, 2008 5:30 PM
To:	Getachew Tesfaye
Cc:	John Rycyna; Pederson Ronda M (AREVA US); BENNETT Kathy A (OFR) (AREVA US); DELANO Karen V (AREVA US)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 117, FSAR Ch 5
Attachments:	RAI 117 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 117 Response US EPR DC.pdf" provides technically correct and complete responses to all 8 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 117, Questions 05.04.11-5 and 05.04.11-7.

The following table indicates the respective pages in the response document, "RAI 117 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

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This concludes the formal AREVA NP response to RAI 117, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

(Russ Wells on behalf of)

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
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Cc: John Budzynski; Shanlai Lu; Joseph Donoghue; Tarun Roy; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 117 (1281, 1305),FSAR Ch. 5

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 22, 2008, and discussed with your staff on October 29, 2008. Draft RAI Question 05.02.02-1 and 05.02.02-2 were deleted and Draft RAI Question 05.04.11-3 was modified as a result of that discussion. 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
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 51

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Response to

Request for Additional Information No. 117 (1281, 1305), Revision 0

11/14/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 05.02.02 - Overpressure Protection
SRP Section: 05.04.11 - Pressurizer Relief Tank
Application Section: FSAR Ch. 5

QUESTIONS for Reactor System, Nuclear Performance and Code Review (SRSB)

Question 05.02.02-3:

Section 5.2.2.2.2, Low Temperature Overpressure Protection, states that “Two mass input events – start of four MHSI pumps with one large miniflow line closed, and both charging pumps running with control valve failed open – and one heat input event – startup of an RCP with the secondary side hotter than the primary side – were selected for analysis. The other overpressure events are bounded by the analyzed events.” What were the analytical methods used for the analyses and the justifications for the choice of scenarios that were analyzed and single failures chosen to show how they are bounding and in compliance with GDC 31at it relates to the LTOP for the U.S. EPR design?

Response to Question 05.02.02-3:

Selection of Events for LTOP Analysis

Low temperature reactor coolant pressure boundary (RCPB) overpressure events include mass input events and heat input events. The bounding events were selected from the list in U.S. EPR FSAR Tier 2, Section 5.2.2.2.2 and described in further detail below:

Mass Addition

To identify the limiting mass addition event, the potential flowrates of each source of injection were compared. The extra borating system (EBS) flowrate is smaller than injection by either the medium head safety injection (MHSI) or the chemical and volume control system (CVCS) charging pumps; therefore, EBS activation is not a limiting case. The accumulators have a fixed volume and their release into the reactor coolant system (RCS) was determined to be within the 10 CFR 50, Appendix G limits even without pressurizer safety relief valve (PSRV) actuation. Therefore, this case (i.e., accumulator injection) was not identified for analysis. The remaining cases in U.S. EPR FSAR Tier 2, Section 5.2.2.2.2 were identified for analysis using the methodology described below.

The most limiting single failure for the charging pump injection case is a failure of the overpressure protection system (i.e., a failure of one PSRV to open) where full pump flow is entering the RCS and letdown is isolated. With the miniflow lines open, the MHSI pumps provide a minimal RCS injection flow rate at pressures near the low temperature overpressure protection (LTOP) setpoints. Therefore, to produce a mass addition for the MHSI pump case, which has the potential to challenges the LTOP system, a conservative assumption was made that a MHSI miniflow line fails closed resulting in more mass addition to the RCS.

Heat Addition

To identify the limiting heat addition case, the potential heating of each source of heat injection was evaluated. The most limiting event is the event that adds energy to the RCS at the greatest rate until the time of PSRV opening. The most rapid temperature rise will cause the greatest increase in pressure after the PSRVs open.

The energy input of the pressurizer heaters is bounded by both the failure of residual heat removal (RHR) or a transient where the secondary system is initially 50ºF greater than the primary system coupled with the spurious activation of a reactor coolant pump (RCP). A conservative calculation (i.e., highest RCS temperature of RHR initiation with two RCPs running) determined the rate of RCS temperature increase resulting from a failure of the RHR system. The LTOP analysis demonstrates that the spurious activation of an RCP while the secondary system remains at an elevated temperature results in a faster rise in RCS temperature and is thus more limiting. For the heat addition cases, the most limiting single failure is a failure of the overpressure protection system (i.e., a failure of one PSRV to open).

Each selected mass addition or heat addition event was analyzed for initial RCS temperatures of 70ºF, 100ºF, 150ºF, 200ºF, and 250ºF to validate the LTOP setpoint over the entire temperature range at which the LTOP system is operable.

Analytical method

The LTOP transient analysis used RELAP5/MOD2-B&W to model the U.S. EPR nuclear steam supply system (NSSS) using the methodology in BAW-10169P-A, B&W Safety Analysis Methodology for Recirculating Steam Generator Plants (Reference 1). The model was modified as identified below to provide conservative results for LTOP scenarios.

The RELAP5/MOD2-B&W model includes a combined representation of the following components:

- Reactor.
- Reactor coolant loops and RCPs.
- Steam generators.
- Pressurizer and surge line.
- Pressurizer safety relief valves.
- Main steam piping and valves.

The four loops of the RCS are represented in a computationally efficient manner by reducing the system to two loops. One is an unmodified loop and the other represents the three remaining loops. The lumped loop was developed using the principles described in NUREG/CR-5535, RELAP5/MOD3 Code Manual Volume V: User's Guidelines (Reference 2).

The LTOP analysis uses the following conservative assumptions:

1. Mass Addition
    - RCS water solid.
    - Uncertainty added to PSRV open and close setpoints.
    - CVCS letdown isolated.
    - Most limiting single failure.
    - Maximum flow input.

- Maximum initial RCS pressure

2. Heat Addition

- RCS water solid.
- Uncertainty added to PSRV open and close setpoints.
- CVCS letdown isolated.
- Most limiting single failure.
- Maximum reactor coolant pump heat.
- Maximum initial RCS pressure.
- Residual heat removal disabled.
- Entire secondary system hotter when RCP is started.
- Minimum RCP startup time.

References for Question 05.02.02-3:

1. BAW-10169P-A, “B&W Safety Analysis Methodology for Recirculating Steam Generator Plants,” B&W Fuel Company, October 1989.

2. NUREG/CR-5535, “RELAP5/MOD3 Code Manual Volume V: User’s Guidelines,” U.S. Nuclear Regulatory Commission, August 1995.

FSAR Impact:

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

Question 05.02.02-4:

GDC 30 requires that the PSRVs, as part of the RCPB, be tested to the highest quality standards practicable. The staff also noted that the Section 5.0 Acceptance Criteria of Test # 037 Pressurizer Safety Valve refers to “Section 5.4.11.” However, Section 5.4.11 presents information related to the PZR Relief Tank. Does Section 5.4.11 contain the correct acceptance criteria reference for Test #37, or is there another section containing the criteria?

Response to Question 05.02.02-4:

See the response to RAI 98, Question 14.02-39.

FSAR Impact:

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

Question 05.04.11-2:

FSAR Tier 2 Section 5.4.11.3 states:

“Functional failure of the non-safety-related PRT and associated piping has no impact on safe plant shutdown. The PRT and associated piping are located so that:

- A failure will not preclude essential operations of safety-related systems.
- PRT rupture disks are not a missile threat to safety-related equipment.

Section 3.5 addresses protection against internally generated missiles for safety-related systems and components. Section 1.7 contains general arrangement and layout drawings for structures and systems.”

A review of Section 3.5 did not result in any reference to PRT in the context of the impact of generated missile due to PRT and associated piping failure or the missile behavior of a rupture disk. This information is needed to establish that GDC 4 is met. Where is the generation of these missiles and their impact specifically addressed and analyzed? Has there been any failure modes and effects analyses performed?

Response to Question 05.04.11-2:

SRP 5.4.11 acceptance criterion 2.E states that the location of the pressurizer relief tank (PRT) should be such that the rupture disks do not pose a missile threat to safety-related equipment. The PRT rupture disks have a bolted flange connection between the PRT discharge nozzles and the connecting heavy wall discharge piping which serve to protect against missile generation. The PRT, discharge nozzles, and piping are enclosed inside a concrete enclosure which protects surrounding equipment from potential missiles.

U.S. EPR FSAR Tier 2, Section 3.5.1.2 describes the general methodology for missile prevention and protection inside containment. General arrangement drawings of the Reactor Building are provided in U.S. EPR FSAR Tier 2, Section 3.8. Specifically, U.S. EPR FSAR Tier 2, Figure 3.8-4, Figure 3.8-12, and Figure 3.8-13 show the location of the PRT room and the surrounding concrete enclosure.

A failure modes and effects analysis (FMEA) of the PRT has determined that any single failure of the PRT and associated piping will have no consequence to plant safety.

Additionally, as described in U.S. EPR FSAR Tier 2, Table 3.2.2-1, the PRT is classified as Seismic Category II in accordance with RG 1.29 so that its failure would not impair the ability of the surrounding components to perform their safety functions.

FSAR Impact:

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

Question 05.04.11-3:

There is no reference in 5.4.11 of the potential environmental impact of PRT and associated piping failures. This information is needed to establish that GDC 4 is met. The following related concern states:

"The discharge of the rupture disks is directed towards an opening in the floor of the cubicles for RCPs two and three (RCP bunker). The discharge is routed such that any flow will not impact any safety-related components in the cubicle."

Has the harsh environmental conditions (such as temperature, humidity and radiation) that would be created by the discharge from a rupture disk of the PRT been considered as a potential impact on any safety related equipment or components in the affected area?

Response to Question 05.04.11-3:

As noted in the question, U.S. EPR FSAR Tier 2, Section 5.4.11.2 states that the discharge of a rupture disk is routed such that any flow will not impact any safety-related components. Therefore, there is no need to consider the environmental effects of the discharge from a rupture disk of the pressurizer relief tank (PRT). Additionally, SRP 5.4.11, SRP Acceptance Criterion 2, which addresses the criteria for compliance with GDC 4, does not address the potential environmental impact of the pressurizer relief tank (PRT) created by the discharge from a rupture disk. Additionally, U.S. EPR FSAR Tier 2, Appendix 3D identifies the methodology, parameters, and service conditions for environmental qualification of equipment. As described in U.S. EPR FSAR Tier 2, Appendix 3D, Figure 3D-1 the maximum EQ temperature inside the Reactor Building exceeds 400ºF which is greater than the operating temperature range for the PRT (i.e., 59ºF to 260ºF).

FSAR Impact:

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

Question 05.04.11-4:

In Section 5.4.11.1, it is stated:

"The PRT design incorporates two rupture disks that protect the PRT from overpressurization. The flow area of one rupture disk is larger than the PSRV discharge pipe and greater than what is required to handle the full flow rate of three PSRVs. The rupture disks prevent the PRT pressure from exceeding the design limits."

Please explain the purpose of the second rupture disk. Is it to add redundancy and enhance defense in depth?

Response to Question 05.04.11-4:

The second rupture disk is provided for redundancy purposes only and is not credited for prevention or mitigation of any design basis events.

FSAR Impact:

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

Question 05.04.11-5:

The FSAR Tier 2 Section 5.4.11.3 states: "Section 1.7 contains general arrangement and layout drawings for structures and systems."

A review of Section 1.7 did not result in any general arrangement and layout drawings pertaining to PRT. Please provide such drawings. Discuss how they were used to assess whether other SSCs inside containment are protected from the effects of high-energy line breaks and moderate-energy leakage cracks in the pressurizer relief system. This information is needed to establish that GDC 4 is met. (Relevant to **RAI 5.4.11-2**)

Response to Question 05.04.11-5:

See the response to RAI 117, Question 05.04.11-2 regarding the general arrangement (GA) and layout drawings pertaining to the pressurizer relief tank (PRT). U.S. EPR FSAR Tier 2, Section 5.4.11.3 will be revised to change the reference from U.S. EPR FSAR Tier 2, Section 1.7 to U.S. EPR FSAR Tier 2, Section 3.8.1.

The method of analysis for piping is described in US EPR FSAR Tier 2, Section 3.6.2, which also describes the criteria for break postulation in piping. After performing a stress analysis of the PRT piping system to determine possible pipe break locations, the GA and layout drawings are reviewed to determine if structures, systems, or components (SSC's) will be impacted by jet impingement from the postulated breaks.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 5.4.11.3 will be revised as described in the response and indicated on the enclosed markup.

Question 05.04.11-6:

The FSAR Tier 2 Section 5.4.11.5 states: “The PRT is designed with instrumentation nozzles for pressure, level and temperature measurements. The MCR alarms indicate high pressure, temperature, and high and low water levels. The instrumentation nozzles are located to allow measurements in both the liquid and gaseous phases.”

The FSAR Tier 2 Figure 5.1-4, Sheet 3 of 7, shows pressure, temperature and level instrumentation. The staff did not readily identify any additional references to the PRT instrumentation in the FSAR Tier 1 and Tier 2, including initial testing and ITAAC related to MCR alarms. Please explain

Response to Question 05.04.11-6:

In addition to U.S. EPR FSAR Tier 2, Chapter 5, the pressurizer relief tank (PRT) instrumentation is addressed in the following sections of the U.S. EPR FSAR:

- U.S. EPR FSAR Tier 2, Section 3.10 describes the qualification of mechanical and electrical equipment. PRT instrumentation sensors for pressure, level, and temperature are listed on U.S. EPR FSAR Tier 2, Table 3.10-1.

- U.S. EPR FSAR Tier 2, Section 7.5 describes information systems important to safety. PRT instrumentation for pressure, level, and temperature is listed on U.S. EPR FSAR Tier 2, Table 7.5-1.

- U.S. EPR FSAR Tier 2, Section 14.2 describes the initial plant testing program. U.S. EPR FSAR, Tier 2, Section 14.2, Test #151 verifies primary depressurization flowpaths. U.S. EPR FSAR, Tier 2, Section 14.2, Test #151, Item 4.4 measures data on PRT pressure, level, and temperature.

- U.S. EPR FSAR Tier 2, Section 18.7 describes the human system interface (HSI) design process. PRT instrumentation for pressure, level, and temperature is listed on U.S. EPR FSAR Tier 2, Table 18.7-1.

- U.S. EPR FSAR Tier 1, Section 3.4 provides design ITAAC for human factors engineering. U.S. EPR FSAR Tier 1, Section 3.4 also provides the process for selecting the minimum inventory of alarms, displays, and controls for the U.S. EPR.

FSAR Impact:

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

Question 05.04.11-7:

1. To assure completeness and accuracy of the plant design and licensing basis, one minor error and one minor inconsistency were identified in the review of FSAR Tier 2 Section 14.2.12.3.14, Pressurizer Safety Valve. Section 5.0, Acceptance Criteria states that safety valves perform as described in Section 5.4.11. The staff concluded that even though the Pressurizer Safety and Relief Valves (PSRVs) are mentioned in Section 5.4.11, their performance is addressed in Section 5.4.13, Safety and Relief Valves.

2. Also, FSAR Section 14.2 refers to the Pressurizer Safety and Relief Valves as Pressurizer Safety Valves.

Response to Question 05.04.11-7:

1. See the response to RAI 98, Question 14.02-39.

2. U.S. EPR FSAR Tier 2, Section 14.2.12.3.14 will be revised to refer to the valves as pressurizer safety relief valves. Also, see the response to RAI 98, Question 14.02-39.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 14.2.12.3.14 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

two and three (RCP bunker). The discharge is routed such that any flow will not impact any safety-related components in the cubicle.

A vacuum breaker on the pressurizer relief system piping prevents water from the PRT from being drawn through the sparger and up the relief line when steam in the relief line is condensed after a relief valve actuation.

5.4.11.3 Performance Evaluation

The PRT volume is sufficient to handle the design transient steam discharge without challenging the rupture disks and without exceeding the design pressure and temperature. The tank sizing calculation assumes an initial PRT liquid temperature of 130°F and PRT pressure of 0 psig, and a normal water volume initially in the PRT. The final PRT pressure for the design transient is less than or equal to 145 psia and the final temperature remains below the saturation temperature.

The tank design pressure of 350 psig and design temperature of 435°F provides a conservative margin above the calculated final conditions for the design transient. The rupture disks prevent the tank pressure from exceeding design conditions and can pass the combined flow rate of the three PSRVs. The PRT and rupture disks are designed for full vacuum so that the tank will not collapse if the contents are cooled following a discharge of steam without the addition of nitrogen. The PSRV and PDS valve discharge piping is designed for pressures and temperatures anticipated during design basis events.

The PSRV discharge piping is sized so that the backpressure in the discharge system does not impede the overpressure protection function. The PSRV discharge piping is restrained to prevent damage to the PSRVs in the event of a rupture. Section 3.6.2 describes the application of pipe whip restraints.

Functional failure of the non-safety-related PRT and associated piping has no impact on safe plant shutdown. The PRT and associated piping are located so that:

- A failure will not preclude essential operations of safety-related systems.
- PRT rupture disks are not a missile threat to safety-related equipment.

Section 3.5 addresses protection against internally generated missiles for safety-related systems and components. ~~Section~~ Section 3.8.1 contains general arrangement and layout drawings for structures and systems.

05.04.11-5

5.4.11.4 Inspection and Testing Requirements

The PRT is subject to testing during construction in accordance with the ASME Section VIII, Division 1. Periodic visual inspections and preventive maintenance are conducted on the PRT during plant shutdowns in accordance with industry practice.

4.4 Interlock and alarm actuation points.

5.0 ACCEPTANCE CRITERIA

5.1 The CRDM control system performs as described in Section 7.2.1.

5.2 Safety-related components meet electrical independence requirements.

14.2.12.3.14 Pressurizer Safety Relief Valves (Test #037)

05.04.11-7

1.0 OBJECTIVE

1.1 To verify the power operation setpoint of the pressurizer safety relief valves.

1.2 To verify electrical independence and redundancy of safety-related power supplies.

1.3 To verify remote manual operation of the pressurizer safety relief valves (PSRVs).

1.4 To verify vibration response of the PSRV and its relief piping is acceptable.

1.5 To verify piping displacements are acceptable.

2.0 PREREQUISITES

2.1 Construction activities on the pressurizer have been completed and associated instrumentation has been calibrated and is operating satisfactorily.

2.2 The RCS is at HZP (temperature and pressure).

2.3 Spring-operated pilot ~~Relief~~ valve ~~lifting~~ device with associated support equipment and calibration data is available.

3.0 TEST METHOD

3.1 Increase the lifting force on ~~the safety valve~~each spring-operated pilot valve, using a special ~~lifting~~pilot valve actuator test device, until the ~~safety valve~~main relief disk just starts to lift.

3.2 Determine setpoint pressure from the lifting device correlation data.

3.3 Adjust valve setpoint pressure if necessary and retest.

3.4 Verify electrical independence and redundancy of power supplies for safety-related functions.

3.5 Verify remote manual operation of each PSRV.

3.6 Verify that piping displacement and vibration data have been acquired.

4.0 DATA REQUIRED

4.1 Pressurizer pressure and temperature at time of test.