AREVA

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

**Response to U.S. EPR Design Certification Application RAI No. 413, Supplement 7, Question 07.08-39**

Ref. 1: E-mail, Getachew Tesfaye (NRC) to Martin Bryan, et al (AREVA NP Inc.), "U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7," August 9, 2010.
Ref. 2: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7," September 8, 2010.
Ref. 3: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 1" November 19, 2010.
Ref. 4: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 2" December 13, 2010.
Ref. 5: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 3" January 28, 2011.
Ref. 6: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 4" February 1, 2011.
Ref. 7: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 5" February 23, 2011.
Ref. 8: E-mail, Martin Bryan (AREVA NP Inc.) to Getachew Tesfaye (NRC), "Response to U.S. EPR Design Certification Application RAI No. 413 (4772), FSAR Ch. 7, Supplement 6" February 24, 2011.

In Reference 1, the NRC provided a request for additional information (RAI) regarding the U.S. EPR design certification application (i.e., RAI No. 413). In References 2-8 AREVA NP Inc. (AREVA NP) provided a schedule indicating when the response requested in RAI No. 413, Question 07.08-39 would be provided.

Enclosed with this letter is the final response for question 07.08-39. AREVA NP considers some of the material contained in the enclosed response to be proprietary information. As required by 10 CFR 2.390(b), an affidavit is attached to support the withholding of the proprietary information from public disclosure. Proprietary and non-proprietary versions of the enclosure to this letter are provided.

**AREVA INC.**
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The following table indicates the respective pages in the enclosure that contain AREVA NP's response to the subject question.

| Question # | Start Page | End Page |
|---|---|---|
| RAI 413 07.08-39 | 2 | 30 |

The response schedule for the remaining questions is unchanged and is shown below.

| Question # | Response Date |
|---|---|
| RAI 413 07.08-13 | April 21, 2011 |
| RAI 413 07.08-17 | April 5, 2011 |
| RAI 413 07.08-19 | April 5, 2011 |
| RAI 413 07.08-21 | April 5, 2011 |
| RAI 413 07.08-22 | April 5, 2011 |
| RAI 413 07.08-26 | April 5, 2011 |
| RAI 413 07.08-27 | April 5, 2011 |
| RAI 413 07.08-28 | April 5, 2011 |
| RAI 413 07.08-29 | April 5, 2011 |
| RAI 413 07.08-32 | April 14, 2011 |
| RAI 413 07.08-35 | April 14, 2011 |
| RAI 413 07.08-38 | April 14, 2011 |
| RAI 413 07.08-42 | April 5, 2011 |

If you have any questions related to this submittal, please contact me at 434-832-2369 or by e-mail at sandra.sloan@areva.com.

Sincerely,

Sandra M. Sloan

Sandra M. Sloan
Regulatory Affairs Manager, New Plants
AREVA NP Inc.

Enclosure

cc: G. Tesfaye
Docket No. 52-020

# AFFIDAVIT

COMMONWEALTH OF VIRGINIA )
) ss.
COUNTY OF CAMPBELL )

1. My name is Sandra M. Sloan. I am Manager, Regulatory Affairs for New Plants, for AREVA NP Inc. and as such I am authorized to execute this Affidavit.

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

3. I am familiar with the AREVA NP information contained in, the enclosed "Response to U.S. EPR Design Certification Application RAI No. 413, Supplement 7, Question 7.8-39" and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

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

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information".

6. The following criteria are customarily applied by AREVA NP to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA NP's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA NP.

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

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

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

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

8. AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Sandra M. Sloan

SUBSCRIBED before me this 2nd

day of March, 2011.

Kathleen A. Bennett

Kathleen A. Bennett
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 8/31/2011
Reg. #110864

KATHLEEN ANN BENNETT
Notary Public
Commonwealth of Virginia
110864
My Commission Expires Aug 31, 2011

**Response to**

**Request for Additional Information No. 413, Supplement 7**

**8/9/2010**

**U.S. EPR Standard Design Certification**
**AREVA NP Inc.**
**Docket No. 52-020**
**SRP Section: 07.08 - Diverse Instrumentation and Control Systems**
**Application Section: ANP-10304**

**QUESTIONS for Instrumentation, Controls and Electrical Engineering 1 (AP1000/EPR Projects) (ICE1)**

**Question 07.08-39**

For Section A.2.5 of Appendix A to ANP-10304, Rev 1, describe the modeling changes, including the following:

a. A description of the model for each additional available system,

a) Any nodalization changes that were made relative to the FSAR S-RELAP5 model, and

b) Provide nodalization diagrams.

10 CFR Part 50, Appendix A, GDC 22, requires, in part, that design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protective function. The Staff Requirements Memorandum to SECY 93-087, Item II.Q, states that the vendor or applicant shall analyze each postulated common-mode failure for each event and shall demonstrate adequate diversity within the design for each of these events.

Section A.2.5 of Appendix A to ANP-10304 states that system modeling is changed to reflect available systems and expected behavior during best estimate conditions. The staff is not able to identify design descriptions that would permit sufficient understanding in order to complete the safety evaluation.

**Response to Question 07.08-39:**

**Reactor Vessel Split-Core Nodalization for non-LOCA**

The reactor vessel and core nodalization was modified for more realistic representation of asymmetric non-loss of coolant accident (LOCA) events.

Figure 07.08-39-1 shows the diversity and defense-in-depth (D3) vessel model for non-LOCA events using a split-core nodalization. This nodalization is similar to the nodalization used for the design certification in Section15.1.2—Increase in Feedwater Flow Analysis and Section 15.1.5—Post-Scram Main Steam Line Break Analyses (refer to Figure 07.08-39-2).

[ ]

**Reactor Vessel Nodalization for D3 SBLOCA**

[ ]

**Pressurizer Nodalization**

**Chemical Volume and Control System**

***Charging Flow and RCP Seal Flow Model***

The charging flow source pressure and temperature is held constant during normal power operation. However, during heatup and cooldown transients and long-term plant cooldown, the charging flow temperature must be adjusted. The nominal change in temperature between the tube and shell side of the regenerative heat exchanger is 60°F during normal single charging pump operation and 78°F during two pump operation. The charging flow temperature is, therefore, set 60°F or 78°F less than the RCS crossover leg (letdown) temperature depending on the number of charging pumps that are operating.

***Auxiliary Spray***

The CVCS provides an auxiliary spray line for the pressurizer to control reactor coolant pressure in the event that the normal spray is not functional. The charging line three-way valve, which is normally aligned for charging, allows charging flow to loops 2 and 4 to be diverted to the auxiliary spray line. Auxiliary spray is delivered at the same elevation in the pressurizer as the normal spray.

[ ]

*Letdown*

[ ]

**Detailed ECCS Models**

[ ]

**Steam Generator Swirl-Vane Separators and Dryers**

[ ]

**Steam Generator Level Indication**

[ ]

[ ]

**Steam Generator Blowdown System**

The SG blowdown flow was modeled in U.S. EPR FSAR Tier 2, Chapter 15 as part of the steam generator tube rupture (SGTR) analysis, the loss of normal feedwater flow analysis, and for the feedwater line break analysis. The SG normal blowdown flow is now a standard feature of the S-RELAP5 base deck for D3 calculations and is shown in Figure 07.08-39-9.

**Emergency Feedwater Steam Generator Level Control System**

The emergency feedwater (EFW) system supplies feedwater to the SGs to restore and maintain water level and remove decay heat following a loss of normal feedwater supplies due to design basis events. The EFW in each SG is independently controlled on both discharge pressure and flow. The discharge flow is monitored and the flow adjusted by a safety-grade flow control valve (FCV) and control system to avoid overloading the pump motor. The discharge flow is also controlled using the safety grade level control valve (LCV) to maintain the inventory at the desired level. The level setpoint is the normal SG water level (approximately 82 percent wide range level).

The EFW is actuated based on low SG level and is isolated based on high SG level. EFW signals are based on WR level instrumentation. A manual trip or a SIS and LOOP signal also actuates the system.

***EFW Water Level Control***

The water level is controlled using the EFW level control valves. When the measured SG water level is lower than the level control setpoint, the controller output will incrementally open the LCV to allow more flow to the SG. When the measured SG level is greater than the level control setpoint, the controller output will incrementally close the valve to limit flow to the SG.

The EFW level control logic for SG1 is shown in Figure 07.08-39-10. The level control setpoint is the normal SG water level (approximately 82 percent wide range level).

***EFW Actuation Modeling***

[ ]

[ ]

***High SG Level EFW Isolation***

[ ]

***Low EFW Flow EFW Isolation***

[ ]

The SG1 EFW actuation and isolation logic diagram is shown in Figure 07.08-39-11.

The SG1 EFW flow control logic is shown in Figure 07.08-39-12. The logic figure is limited to input for the SG1 portion of the EFW system because the components and control logic for the four SGs are identical with the exception of component numbering.

The control system maintains the normal flow control setpoint at 400 gpm up to a main steam line pressure of 1426 psia. At higher pressures, EFW is delivered to the SG at a reduced flow rate. [ ]

**MSRT Updates**

[ ]

Logic was added to automatically adjust the MSRCV standby position as a function of plant thermal power when the reactor is at part-power conditions.

**Turbine Bypass System**

The purpose of the turbine bypass control function is to provide automatic relief of main steam overpressure. The turbine bypass system consists of six remotely operated valves that dump steam to the three condenser shells. The valves open when steam generation exceeds consumption by the turbine. The turbine bypass valves are automatically modulated to maintain a variable main steam pressure as determined by the reactor controls. Normally, the setpoint is above operating pressure. In the case of an imbalance between core power and turbine load, excess steam is dumped to the condenser via the turbine bypass.

For normal power operation, a floating steam pressure setpoint is maintained slightly above the measured main steam pressure. As the measured pressure changes, the setpoint changes accordingly. A limitation is placed on the rate of change of the setpoint so that if the measured pressure increases at a rate greater than the limited rate of the floating setpoint, the turbine bypass valves will be opened. During normal operation, the turbine bypass valves should not open except in the case of fast load changes. The turbine bypass is controlled in a different manner than at-power operation for the following conditions: operation below 10 percent thermal power, plant heatup and cooldown, partial cooldown, and following a reactor trip. For the D3 S-RELAP5 models for non-LOCA and SBLOCA, the control logic will address the cases of normal operation, below 10 percent power operation, partial cooldown, and post reactor trip. Upon loss of external load the turbine will trip followed by a reactor trip. Steam will automatically be dumped to the condenser by the turbine bypass.

Figure 07.08-39-16 through Figure 07.08-39-20 show the S-RELAP5 control logic and trips for the TBS system for the non-LOCA model.

**Main Feedwater System Enhancements**

Figure 07.08-39-21 shows the MFW train nodalization for SG-1. The other three trains are similar.

**System Status**

In the D3 non-LOCA model, the following systems are active during transient analyses, but are not automatically enabled in the U.S. EPR FSAR Tier 2, Chapter 15 non-LOCA model:

The following systems are available for automatic actuation in the D3 non-LOCA model, but are not present in the U.S. EPR FSAR Tier 2, Chapter 15 non-LOCA model:

**Reactor Trips Simulated in the S-RELAP5 D3 non-LOCA base model**

Table 07.08-39-1 shows the Reactor Trip signals that are included in the D3 non-LOCA base deck model. This list does not include reactor trip signals associated with the Diverse Actuation System (DAS) which are optionally added to the model for DAS-related analyses. (See response to Question 07.08-41).

**ESFAS Trips Simulated in the S-RELAP5 D3 non-LOCA base model**

Table 07.08-39-2 shows the Engineered Safety Features Actuation System trip signals that are included in the D3 non-LOCA base deck model. This list does not include trip signals associated with the Diverse Actuation System (DAS) which are optionally added to the model for DAS-related analyses. (See response to Question 07.08-41).

**Setpoint Limits Simulated in the S-RELAP5 D3 non-LOCA base model**

Table 07.08-39-3 shows the setpoint limits that are included in the D3 non-LOCA base deck model.

**FSAR Impact:**

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

**Table 07.08-39-1—Reactor Trips Simulated for D3 Non-LOCA**

| Reactor Trip Signal | S-RELAP5 Trip(s) or Control Variables Specifying Setpoint |
|---|---|
| High core thermal power | [ ] |
| High ex-core neutron flux (intermediate range) | [ ] |
| High ex-core neutron flux rate-of-increase | [ ] |
| High main steam line pressure | [ ] |
| High pressurizer level | [ ] |
| High pressurizer pressure | [ ] |
| High SG level | [ ] |
| Low-low RCS loop flow (in one loop) | [ ] |
| Low main steam line pressure | [ ] |
| Low main steam line pressure relative to rate-of-decrease limit | [ ] |
| Low pressurizer pressure | [ ] |
| Low RCS hot leg enthalpy margin-to-saturation | [ ] |
| Low RCS hot leg pressure | [ ] |
| Low RCS loop flow (in two loops) | [ ] |
| Low reactor coolant pump speed | [ ] |
| Low SG level | [ ] |

**Table 07.08-39-2—ESFAS Trips Simulated for D3 Non-LOCA**

| Signal | Action(s) | S-RELAP5 Control Variable(s), Table, or Trip(s) Specifying Setpoint |
|---|---|---|
| High-high SG level | If partial main steam depressurization has been actuated, step up opening setpoint for MSRIV on that main steam line, and close MSIV on that main steam line | [ ] |
| High main steam line pressure | Open MSRIV on that main steam line, and modulate corresponding MSRCV to maintain pressure at setpoint | [ ] |
| High SG level (narrow range) | If reactor has been tripped and 10-second delay has elapsed, terminate main feedwater delivery to that SG | [ ] |
| High SG level (wide range) | Suspend emergency feedwater delivery to that SG | [ ] |
| Loss of offsite power | Start emergency diesel generators | [ ] |
| Low-low main steam line pressure | Terminate main feedwater delivery to that SG, and close MSRIV on that main steam line | [ ] |
| Low-low main steam line pressure relative to rate-of-decrease limit | Terminate main feedwater delivery to that SG | [ ] |
| Low-low pressurizer pressure | Actuate MHSI and partial main steam depressurization, and terminate blowdown of secondary-side liquid from all SGs. Also, if offsite power has been lost, actuate emergency feedwater delivery to all SGs. | [ ] |
| Low-low SG level | Actuate emergency feedwater delivery to that SG, and terminate blowdown of secondary-side liquid from that SG | [ ] |
| Low main steam line pressure | Close all MSIVs, and terminate blowdown of secondary-side liquid from all SGs | [ ] |
| Low main steam line pressure relative to rate-of-decrease limit | Close all MSIVs, and terminate blowdown of secondary-side liquid from all SGs | [ ] |
| Reactor trip | Trip turbine, and close all full-load main feedwater valves | [ ] |

**Table 07.08-39-3—Setpoint Limits in the S-RELAP5 D3 Non-LOCA Base Model**

| Signal | Action(s) | S-RELAP5 Trip(s) Specifying Setpoint |
|---|---|---|
| High-high pressurizer level | Terminate pressurizer auxiliary spray and RCS charging | [ ] |
| High pressurizer level | Maximize RCS letdown | [ ] |
| High pressurizer pressure | If pressurizer normal spray is demanded but is unavailable or insufficient, actuate pressurizer auxiliary spray | [ ] |
| High SG level | Suspend main feedwater delivery to that SG | [ ] |
| Low-low-low pressurizer level | Deenergize all pressurizer heater rods | [ ] |
| Low-low pressurizer level | Terminate letdown | [ ] |
| Low pressurizer level | Minimize letdown, and start standby charging pump | [ ] |

**Figure 07.08-39-1—D3 Nodalization of Reactor Vessel (Non-LOCA)**

**Figure 07.08-39-2—Design Certification Chapter 15 Reactor Vessel Nodalization (MSLB)**

**Figure 07.08-39-3—D3 Reactor Vessel Nodalizationfor SBLOCA**

[ ]

**Figure 07.08-39-4—D3 Non-LOCA Reactor Coolant System Nodalization**

[ ]

**Figure 07.08-39-5—SG4 Nodalization to Facilitate SGTR Analysis (Non-LOCA)**

[ ]

**Figure 07.08-39-6—D3 SBLOCA Reactor Coolant System Nodalization**

**Figure 07.08-39-7—D3 SBLOCA ECCS Nodalization Loops 1 & 2**

**Figure 07.08-39-8—D3 SBLOCA ECCS Nodalization Loops 3 & 4**

**Figure 07.08-39-9—D3 Secondary System Nodalization**

**Figure 07.08-39-10—D3 EFW Water Level Control for SG1**

**Figure 07.08-39-11—D3 EFW Actuation and Isolation for SG1**

**Figure 07.08-39-12—D3 EFW Flow Control for SG1**

[

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**Figure 07.08-39-13—SG-1 MSRT Nodalization for Design Certification Chapter 15**

[ ]

**Figure 07.08-39-14—SG-1 MSRT Nodalization for D3**

[ ]

**Figure 07.08-39-15—D3 S-RELAP5 Nodalization for Turbine Bypass System**

[ ]

**Figure 07.08-39-16—Turbine Bypass Control – Part 1**

**Figure 07.08-39-17—Turbine Bypass Control – Part 2**

**Figure 07.08-39-18—Turbine Bypass Control – Part 3**

**Figure 07.08-39-19—Turbine Bypass Control - Part 4**

**Figure 07.08-39-20—Turbine Bypass Control – Part 5**

**Figure 07.08-39-21—D3 Main Feedwater Nodalization for SG-1**