## ArevaEPRDCPEm Resource

**From:** BRYAN Martin (EXT) [Martin.Bryan.ext@areva.com]
**Sent:** Friday, June 11, 2010 4:14 PM
**To:** Tesfaye, Getachew
**Cc:** NOXON David B (AREVA NP INC); COLEMAN Sue H (AREVA NP INC); SANDERS Harris I (AREVA NP INC); PATTON Jeff (AREVA NP INC); WILLIFORD Dennis C (AREVA NP INC); ROMINE Judy (AREVA NP INC); SALM Robert (AREVA NP INC); SZYMCZAK William J (AREVA NP INC)
**Subject:** Draft Response to U.S. EPR Design Certification Application RAI No. 289, FSAR Ch. 19, Supplement 3
**Attachments:** RAI 289 Supplement 3 Response US EPR DC- Draft.pdf

Getachew,

Attached is a draft for RAI 289 Supplement 3. Earlier today RAI 289 Supplement 2 provided a revised final response date of July 21, 2010 for RAI 289. Let me know if addtional interactions with the staff on this document are needed, or if we can submit it as final.

Thanks,

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

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**From:** BRYAN Martin (EXT)
**Sent:** Friday, June 11, 2010 4:05 PM
**To:** 'Tesfaye, Getachew'
**Cc:** DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); NOXON David B (AREVA NP INC)
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 289, FSAR Ch. 19, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 289 on February 17, 2010. AREVA NP submitted Supplement 1 to the response on May 24, 2010, providing an updated schedule for the response.

The schedule for RAI 289 Question 19-328 is being revised to allow time to interact with the NRC on the draft response. The schedule for technically correct and complete responses to the remaining 2 questions has been changed and is provided below:

| Question # | Supplement Date (providing FSAR Markup) |
|---|---|
| RAI 289 — 19-328 | July 21, 2010 |
| RAI 289 — 19-329 | October 15, 2010 |

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
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**From:** BRYAN Martin (EXT)
**Sent:** Monday, May 24, 2010 4:49 PM
**To:** 'Tesfaye, Getachew'
**Cc:** DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); NOXON David B (AREVA NP INC)
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 289, FSAR Ch. 19, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 289 on February 17, 2010.

As agreed with the NRC, the schedule for RAI 289 Question 19-328 is being revised to allow more time to discuss the proposed response with the NRC. A telecon was originally scheduled for May 19, 2010 to discuss the proposed responses, but it had to be rescheduled. The schedule for technically correct and complete responses to the remaining 2 questions has been changed and is provided below:

| Question # | Supplement Date (providing FSAR Markup) |
|---|---|
| RAI 289 — 19-328 | June 21, 2010 |
| RAI 289 — 19-329 | October 15, 2010 |

Sincerely,

Martin (Marty) C. Bryan
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**From:** DUNCAN Leslie E (AREVA NP INC)
**Sent:** Wednesday, February 17, 2010 4:47 PM
**To:** 'Tesfaye, Getachew'
**Cc:** DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); ROMINE Judy (AREVA NP INC); NOXON David B (AREVA NP INC)
**Subject:** Response to U.S. EPR Design Certification Application RAI No. 289, FSAR Ch. 19

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 289 Response US EPR DC.pdf," provides the schedule for technically correct and complete responses to these questions.

The following table indicates the respective pages in the response document, "RAI 289 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

| Question # | Start Page | End Page |
|---|---|---|
| RAI 289 — 19-328 | 2 | 2 |
| RAI 289 — 19-329 | 3 | 3 |

The schedule for technically correct and complete responses to these questions is provided below.

| Question # | Response Date |
|---|---|
| RAI 289 — 19-328 | May 24, 2010 |
| RAI 289 — 19-329 | October 15, 2010 |

Sincerely,

Les Duncan
Licensing Engineer
**AREVA NP Inc.**
An AREVA and Siemens Company
Tel: (434) 832-2849
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**From:** Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
**Sent:** Thursday, September 10, 2009 9:02 AM
**To:** ZZ-DL-A-USEPR-DL
**Cc:** Clark, Theresa; Phan, Hanh; Fuller, Edward; Mrowca, Lynn; Chowdhury, Prosanta; Colaccino, Joseph; ArevaEPRDCPEm Resource
**Subject:** U.S. EPR Design Certification Application RAI No. 289 (3500), FSARCh. 19

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on August 28, 2009, and on September 4, 2009, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The questions in this RAI are considered potential open items 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 question 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:** 1541

**Mail Envelope Properties** (BC417D9255991046A37DD56CF597DB71067ECDAE)

**Subject:** Draft Response to U.S. EPR Design Certification Application RAI No. 289, FSAR Ch. 19, Supplement 3
**Sent Date:** 6/11/2010 4:14:17 PM
**Received Date:** 6/11/2010 4:14:21 PM
**From:** BRYAN Martin (EXT)

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| **Files** | **Size** | **Date & Time** |
|---|---|---|
| MESSAGE | 5565 | 6/11/2010 4:14:21 PM |
| RAI 289 Supplement 3 Response US EPR DC- Draft.pdf | 420742 | |

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

**Response to**

**Request for Additional Information No. 289, Supplement 3**

**9/10/2009**

**U. S. EPR Standard Design Certification**
**AREVA NP Inc.**
**Docket No. 52-020**
**SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation**
**Application Section: 19**

**QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1 (AP1000/EPR Projects) (SPLA)**

**Question 19-328:**

POTENTIAL OPEN ITEM

(Follow-up to Question 19-257) At the August 6, 2009, public meeting on unresolved issues related to U.S. EPR Final Safety Analysis Report (FSAR) Chapter 19, the staff discussed the probabilistic risk assessment (PRA) assumption that the AV42 priority modules are not subject to common-cause failure (CCF). The instrumentation and controls (I&C) staff has not reached a conclusion on the testability of the AV42 design, which is cited as support for the exclusion of CCF in item 7 of FSAR Table 19.1-108. In addition, this item states that "[s]oftware CCF is not a concern" without addressing CCFs that could result from manufacturing, maintenance, or other errors. The staff observes that, if a CCF occurred, manual and automatic actuation of components in various systems could be affected. Please provide further justification for excluding both software and hardware CCFs of the AV42 modules from the PRA. As needed, please revise the assumptions and insights in FSAR Chapter 19 to reflect potential failure modes of the modules.

**Response to Question 19-328:**

As presented in Reference 1, the AV42 is no longer the priority module in the U.S. EPR system architecture. Priority and actuator control (PACS) is implemented on a per actuator basis. Every actuator has its own set of electronic modules dedicated to PACS functionality. With the revised design these functions are allocated to two separate modules: a safety related priority module (SPLM-PC1x) and a non-safety communication module. Also submitted with References 1 and 2 were FSAR mark-ups that described the revised architecture for the PACS. CCFs addressed in this response are applicable to the priority module only.

The priority module hardware design is implemented on a printed circuit board comprised of two subsystems, A and B, with identical hardware. Logic functions for priority and monitoring are distributed among subsystems A and B. Each subsystem is based on a programmable logic device (PLD) fitted to fulfill the assigned tasks. See AREVA Technical Report ANP-10310P, “Methodology for 100% Combinatorial Testing of the U.S. EPR TM Priority Module Technical Report” (Reference 3) for a more detailed description of the priority module.

U.S EPR PRA CCF evaluations are based on the methodology presented in NUREG/CR-5485 (Reference 5). NUREG/CR-5485 describes the identification of failure causes and coupling mechanisms, which are further defined in NUREG/CR-6268 (Reference 6).

Failure causes associated with the priority modules can be broken down into software- and hardware-related causes. For software CCF, DI&C-ISG-04 and BTP 7-19 provide methods for testing to eliminate the consideration of CCF. Reference 3 outlines the methodology of 100 percent combinatory testing to preclude PLD-based priority module software CCF.

This report explains the test methodology based on a practical example, using the SPLM1-PC10 priority control module which is implemented as a dedicated instance of the SPLM1 programmable logic module of the TELEPERM XS (TXS) equipment platform.

The example provided in this technical report explains the required functions of the test machine and the overall test process. The creation of the test vectors is based on a spreadsheet implementation of the PC-10’s logic, the report includes examples of outputs from the existing

test machine. The test results critical to safety functions will be manually verified, since the test is implemented through an automatic test generator.

Successful completion of the 100 percent combinatory testing as described above demonstrates that no error has been introduced by the design tool in software implementation phase and that software-related CCF are not credible.

Hardware-related CCF are evaluated based on the five basic coupling mechanisms identified in NUREG/CR-6268:

- Quality.
- Design.
- Maintenance.
- Operations.
- Environment.

For the priority modules, each of these coupling mechanisms are discussed in terms of the defenses that exist to prevent or mitigate any associated CCF.

**Quality and Design**

In terms of quality and design, the priority module lifecycle is subject to the TXS platform quality assurance standards and the TXS platform design process as described in EMF-2110(NP)(A), "TELEPERM XS: A Digital Reactor Protection System" (Reference 4). This process includes independent third party reviews, which form an important part of the design verification and validation process.

Priority module hardware design is manifested by a hardware qualification program, including analytical assessment of conservative design (critical load analysis). It is verified by assessing the operating experience of SPLM-module and modules of similar design. SPLM1, the first member of this family, has an accumulated operating time for 147 installed modules, of approximately 209 years, without any failures (data as of December 2009). Many other applications using this module are currently in the design or integration test field and will have accumulated significant operating time before the U.S. EPR goes into operation.

Software design is verified through life cycle, external assessment and 100 percent proof of design testing.

**Maintenance**

Maintenance related common cause coupling factors are eliminated by the fact that the priority module does not require post installation service or maintenance. The functions on the priority module are implemented in solid state logic gate arrays and are non-user programmable.

**Operations**

Defenses against operations-related CCF include the following:

- Safety-related operator commands to the priority module are administered through the safety automation system and the protection system before being processed in the module logic.
- Priority modules execute priority based on unchangeable programmed logic.
- Local testing at the control panel does not alter the functionality of the module.

**Environment**

For defense against environment-related CCF, the equipment used in the PACS is qualified environmentally, seismically, and for electromagnetic interference (EMI) and radio frequency interference (RFI) conditions in accordance with the environmental qualification program described in U.S. EPR FSAR Tier 2, Section 3.11. The priority modules are installed inside PACS panels in four divisions, with one set of modules dedicated to a single actuator. Each division is located in a corresponding Safeguard Building (SB). The SBs are physically separated around the primary containment. Environmental conditions are controlled separately in each SB. PACS panels will remain in a mild environment during design basis events. The design provides for independence between the four divisions of the PACS, and between the PACS and interfacing non-safety systems. The characteristics of this independence are physical separation, electrical isolation, and communications independence, as described in U.S. EPR FSAR Tier 2, Section 7.1.

**Conclusions and PRA Sensitivity**

It is concluded that the priority modules are not susceptible to CCF. PACS 100 percent combinatorial testing demonstrates that the priority modules in PACS are not subject to software-related CCF. In addition, the priority modules are not susceptible to hardware-related CCF because of the following:

- The priority modules are subject to the TXS platform quality assurance standards and the TXS platform design process.
- The functions on the priority module are implemented in solid state logic gate arrays, are non-user programmable, and require no post-installation service or maintenance.
- The priority modules reside in a mild environment during design basis events, and are qualified for environmental, seismic, and EMI/RFI conditions.
- The priority modules have physical separation and independence between redundant trains.

However, to quantify the uncertainty associated with this assumption, a sensitivity analysis has been performed to assess the impact of the design change to the new priority module and the impact of including priority module CCF. Modeling and data associated with the new priority module are modified in the current PRA model. CCF groups are created for all priority modules associated with redundant trains of the same system and function. The beta factor CCF methodology was used with a beta factor of 0.005. The impact on internal event core damage frequency (CDF) is assessed. This sensitivity case results in a 14 percent increase in internal event CDF.

U.S. EPR FSAR Tier 2, Table 19.1-108, Item 7 will be revised to remove references to the AV42 module and to reflect the conclusions of this response.

**References**

1. Letter, Sandra M. Sloan (AREVA NP Inc.) to Document Control Desk (NRC), "Conversion of ANP-10281P, 'U.S. EPR Digital Protection System Topical Report' to 'ANP-10309P, 'U.S. EPR Digital Protection System Technical Report'," NRC:09:119, November 24, 2009.
2. Letter, Sandra M. Sloan (AREVA NP Inc.) to Document Control Desk (NRC), "U.S. EPR FSAR Tier 1 Changes Related to ANP-10309P, 'U.S. EPR Digital Protection System Technical Report'," NRC:09:122, December 4, 2009.
3. ANP-10310P, Revision 0, "Methodology for 100% Combinatorial Testing of the U.S. EPR TM Priority Module Technical Report," AREVA NP, Inc., October 2009.
4. EMF-2110(NP)(A), Revision 1, "TELEPERM XS: A Digital Reactor Protection System," Siemens Power Corporation, July 2000.
5. NUREG/CR-5485, "Common-Cause Failures in Probabilistic Risk Assessment," U.S. Nuclear regulatory Commission, November 1998.
6. NUREG/CR-6268, "Common-Cause Failure Database and Analysis System: Event Data Collection, Classification, and Coding," U.S. Nuclear regulatory Commission, September 2007.

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Table 19.1-108 will be revised as described in the response and indicated on the enclosed markup.

# U.S. EPR Final Safety Analysis Report Markups

**Table 19.1-108—U.S. EPR PRA Based Insights**
**Sheet 3 of 6**

| No | U.S. EPR PRA Based Insight | Disposition |
|---|---|---|
| 7 | **The ~~AV42~~ priority module is not susceptible to CCF**<br>PACS 100 percent combinatorial testing demonstrates that the priority modules in PACS are not subject to software-related CCF. In addition, the priority modules are not susceptible to hardware-related CCF because of the following:<br>• The priority modules are subject to the TXS platform quality assurance standards and the TXS platform design process.<br>• The functions on the priority module are implemented in solid state logic gate arrays, are non-user programmable, and require no post-installation service or maintenance.<br>• The priority modules reside in a mild environment during design basis events, and are qualified for environmental, seismic, and EMI/RFI conditions.<br>• The priority modules have physical separation and independence between redundant trains.<br>~~Software CCF is not a concern for the AV42 priority module because the safety-related functions contain neither software nor an operating system. The AV42 uses a programmable logic device; the functions on the module are implemented in solid state logic gate arrays and are non-user programmable. The AV42 is 100% testable before installation. The device also undergoes rigorous physical testing and qualification (environmental, electrical, seismic, radiation, electromagnetic interference, and radio frequency interference). The AV42 module is designed with features to ensure independence between the safety-related and non-safety-related circuits.~~ | Tier 2, Section 7.1.1.2.1 |
| 8 | **Risk of losing all instrumentation is negligible**<br>The human machine interface (HMI) design includes both SICS and PICS systems for operator monitoring and controls. Consequently the risk of losing all instrumentation is negligible relative to the human error probability. | Tier 2, Section 7.1.1.3.1; Tier 2, Section 7.1.1.3.2 |
| 9 | **Floods caused by a break in ~~a system with very large flooding potential (ESWS or DWS)~~the ESWS are assumed to be contained below ground level of the affected ~~buildings (~~SB~~ or FB)~~.**<br>Bases for this assumption are following:<br>1. ~~Those systems are~~The ESWS is automatically isolated if the building sump detects a large flooding event<br>2. Expansive time is needed to flood a building up to ground level, so operator isolation is likely to succeed if automatic isolation failed. | Tier 1, Section 2.1.1; Tier 2, Section 3.4.3.1; ~~Tier 2, Section 3.4.3.3;~~ Tier 2, Section 3.4.3.4; ~~Tier 2, Section 3.4.3.5~~Tier 2, Section 9.2.1.3.5; Tier 2, Section 9.3.3.3 |