ArevaEPRDCPEm Resource

From:	Pederson Ronda M (AREVA US) [Ronda.Pederson@areva.com]
Sent:	Friday, December 12, 2008 6:25 PM
To:	Getachew Tesfaye
Cc:	BENNETT Kathy A (OFR) (AREVA US); DELANO Karen V (AREVA US); WELLS Russell D (AREVA US); KOWALSKI David J (AREVA US)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 91 (1263), FSARCh. 10, Supplement 1
Attachments:	RAI 91 Supplement 1 Response US EPR DC.pdf

Getachew,

In AREVA NP Inc.'s response to RAI No. 91 on October 29, 2008, a schedule was provided for responding to the four questions. The attached file, "RAI 91 Supplement 1 Response US EPR DC.pdf" provides a technically correct and complete response to one of the four questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 91 Question 10.02-2.

The following table indicates the respective pages in the response document, "RAI 91 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 91 — 10.02-2	2	4

A revised schedule for providing technically correct and complete responses to the remaining questions is provided below:

Question #	Response Date
RAI 91 — 10.02-1	January 9, 2009
RAI 91 — 10.02-3	March 31, 2009
RAI 91 — 10.02-4	March 31, 2009

Sincerely,

Ronda Pederson
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From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, October 29, 2008 7:19 PM
To: 'Getachew Tesfaye'
Cc: DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC);

WELLS Russell D (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 91 (1263), FSARCh. 10

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 91 Response US EPR DC" states that complete answers cannot be currently provided for the four questions.

The following table indicates the respective pages in the response document, "RAI 91 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 91 — 10.02-1	2	2
RAI 91 — 10.02-2	3	3
RAI 91 — 10.02-3	4	4
RAI 91 — 10.02-4	5	5

The schedule for a technically correct and complete response to the four questions is provided below.

Question #	Response Date
RAI 91 — 10.02-1	January 9, 2009
RAI 91 — 10.02-2	December 12, 2008
RAI 91 — 10.02-3	December 12, 2008
RAI 91 — 10.02-4	December 12, 2008

Sincerely,

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, October 02, 2008 10:42 PM
To: ZZ-DL-A-USEPR-DL
Cc: Devender Reddy; John Segala; Peter Hearn; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 91 (1263), FSARCh. 10

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on September 26, 2008, and on October 2, 2008, 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 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
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 37

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Response to

Request for Additional Information No. 91 Supplement 1 (1263), Revision 0

10/2/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 10.02 - Turbine Generator
Application Section: 10.2, "Turbine Generator"

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

Question 10.02-2:

Regarding overspeed control of the main turbine-generator, FSAR Tier 2 Section 10.2.2.9, “Overspeed Protection,” describes two independent electrical over-speed trip devices are provided, each capable of quickly closing the main stop and control valves in the event of an unsafe condition. According to the FSAR, the primary electrical over-speed trip system fully closes the valves at about 110 percent of rated turbine speed, and also an independent and redundant backup electrical over-speed trip circuit is provided to fully close these valves at about 111% of rated speed. The staff finds these over-speed trip devices meet the criteria specified in Items 2.C (a mechanical overspeed trip device at 111 percent of turbine rated speed) and 2.D (an independent and redundant backup electrical overspeed trip device at 112 percent of the turbine rated speed) of SRP Subsection, “Review Procedures,” of the SRP Section 10.2. However, the FSAR does not provide adequate information to conclude that the means of preventing over-speed is from diverse sources (i.e., electrical vs. mechanical). Therefore, the NRC staff requests the applicant to address the following additional information in the FSAR, as it relates to diversity feature for overspeed control of the main turbine:

1. Provide justification for the diversity of the two electrical over-speed systems.
2. Discuss the reason(s) for using a second electrical device in lieu of a mechanical device.
3. Clarify whether or not the two systems share any common components or process inputs. If so, provide an evaluation of the impact of failures of any such components.
4. Describe the software used for the triple processors or performing trip logic actuation.
5. Explain the diversity and defense-in-depth used to defend against a common cause failure (CCF) of the triple processor functions.
6. Confirm the objectives of Test #174 correctly described.

Response to Question 10.02-2:

1. Diversity is provided in the two electrical overspeed systems. Each independent electrical overspeed trip system is designed and manufactured by a different vendor. There are no common components or process inputs between the two systems. One overspeed protection system is installed in the turbine supervisory instrumentation cubicle and the other overspeed protection system in the turbine governing control cubicle. Each cubicle provides a separate power supply to each electronic overspeed protection system.

2. Electrical overspeed trip systems are selected instead of mechanical for the following reasons:

   - Mechanical overspeed systems are subject to mechanical/hydraulic jamming requiring a specific maintenance system.

   - The mechanical overspeed trip limit value is influenced by shaft vibration.

   - The actual trip value of a mechanical overspeed trip system is uncertain and needs to be checked after an overhaul, which is time consuming. The electronic overspeed system can be tested during operation without disturbing the protection system, whereas the mechanical overspeed test requires an isolating device in order to perform the test without disturbing pressure in the safety circuit. This isolating device decreases the safety level of the system.

- The trip bolt needs to be interfaced with the tripping hydraulic circuit, requiring a hydraulic amplifier relay reducing the reliability of the system.

- There is a risk of an accident if design and maintenance of a mechanical overspeed device is not correctly implemented.

- The mechanical overspeed trip device is a single point of failure which can trip the turbine.

3. Each electrical overspeed trip system includes its own set of three sensors. The signals from the two sets of speed sensors are processed in different cabinets and by independent signal modules, up to the tripping relay. There are no common components or process inputs shared by the two systems.

4. The electronic overspeed system is part of the electronic turbine protection system acting on the main steam stop and control valves via the hydraulic tripping system. Three overspeed cards are independent from each other and each card acts directly on the associated tripping solenoid with a failsafe arrangement. Typical reaction time is 20 milliseconds (ms). Each overspeed card is tested in operation without any isolation or corruption of any other part of the system. The test is performed by changing the counting value, de-energizing the output relay and thus tripping the associated solenoid on the hydraulic trip block.

   The overspeed trip system does not use software for the trip actuation logic. Software is used to transform the analog speed signal from the speed sensor into a logic signal sent to the trip relay.

   Each overspeed system is certified according to international standard IEC 61508, “Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems, Safety Integrity Level (SIL) 3”. SIL 3 equates to a probability of failure on demand, average of $\geq 10^{-4}$ to $< 10^{-3}$.

5. Normally the turbine governor system will limit the turbine overspeed by rapid closure of the turbine control valves whenever turbine power exceeds generator output, as would exist immediately after load rejection.

   In the unlikely event that the turbine control system fails, the turbine overspeed system will limit the overspeed. The two turbine overspeed protection systems are redundant, from the speed probes to the turbine trip relays. Both the systems are supplied by different manufacturers; therefore, common cause failure can not disable both overspeed protection systems. This provides sufficient diversity and defense in depth to defend against a common cause failure of the overspeed functions.

6. U.S. EPR FSAR Tier 2, Section 10.2.2.9, Section 10.2.3.4 and Section 14.2.12.13.14, “Pre-Core Turbine Overspeed (Test #174)” will be revised to reflect two electronic overspeed trip systems.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 10.2.2.9, Section 10.2.3.4 and Section 14.2.12.13.14 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

startup curves specifying appropriate startup temperature and sufficient warm-up time.

Fracture toughness properties are calculated from material tests and can be obtained by any of the following methods:

- Testing of the actual material of the turbine rotor to establish the K_{Ic} value at normal operating temperature.
- Testing of the actual material of the turbine rotor with an instrumented Charpy machine and a fatigue precracked specimen to establish the K_{Ic} (dynamic) value at normal operating temperature. If this method is used, K_{Ic} (dynamic) is used in lieu of K_{Ic} (static) in meeting the toughness criteria.
- Estimating of K_{Ic} values at various temperatures from conventional Charpy and tensile data on the rotor material using methods are presented in J. A. Begley and W. A. Logsdon, Scientific Paper 71-1E7-MSLRF-P1 (Reference 5). This method of obtaining K_{Ic} is used only on materials which exhibit a well-defined Charpy energy and fracture appearance transition curve and are strain-rate insensitive.
- Estimating "lower bound" values of K_{Ic} at various temperatures using the equivalent energy concept developed by F. J. Witt and T. R. Mager, ORNL-TM-3894 (Reference 6).

A COL applicant that references the U.S. EPR design certification will provide applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and fracture toughness properties after the site-specific turbine has been procured.

10.2.3.3 High Temperature Properties

There is no influence on stress rupture properties because the maximum operating temperature, the basis for determining the design temperature of rotors, is below the re-crystallization and creep temperatures.

10.2.3.4 Turbine Rotor Design

The rotor of the HP/IP turbine is a welded rotor design. The rotors of the LP turbines are a welded rotor design.

The turbine assembly is designed to withstand normal operating conditions, anticipated transients, and accidents resulting in a turbine trip without loss of structural integrity. The design of the turbine assembly meets the following criteria:

- The design overspeed of the turbine is 120 percent of rated speed, which is higher than the highest anticipated speed resulting from a loss of load. The

10.02-2 ~~mechanical~~primary overspeed trip ~~device~~system fully closes the valves at about

- Automatic controls to avoid unnecessary turbine trip and to permit subsequent operation at house load (i.e., load required to run station auxiliaries) in the event of a load rejection from 100 percent load.

- Automatic controls for fast valving to rematch the TG loads following a momentary (7 Hz or less) mismatch between generator load and generator power, without loss of synchronization during load mismatch transients, up to full power.

10.2.2.8 Valve Control

The flow of main steam entering the HP turbine is controlled by four stop valves and four governing control valves. Each stop valve is controlled by an electro-hydraulic actuator, so that the valve is either fully open or fully closed. The function of the stop valves is to shut off the steam flow to the turbine when required. Actuation of the emergency trip system devices closes the stop valves.

The turbine control valves are positioned by electro-hydraulic servo actuators in response to signals from their respective flow control unit. The flow control unit signal positions the control valves for wide-range speed control through the normal turbine operating range and for load control after the TG unit is synchronized.

The reheat stop and intercept valves, located in the hot reheat lines at the inlet of the IP turbines, control steam flow to the IP turbines. During normal operation of the turbine, the reheat stop and intercept valves are fully open. The intercept valve flow control unit positions the valve during startup and normal operation and closes the valve rapidly on loss of turbine load. The reheat stop valves close completely on turbine overspeed and turbine trip.

10.2.2.9 Overspeed Protection

10.02-2

A protective trip system is provided to quickly close the main stop, control, reheat stop and intercept valves in the event of an unsafe condition or to provide overspeed protection. The system is designed to minimize false and spurious trips during normal operation and allow testing of the trip system during operation. A power load imbalance function is provided, which compares turbine and generator load and initiates an appropriate momentary ~~intercept~~control valve closure when the turbine load exceeds the generator load by a specified amount.

Two independent electrical overspeed trip devices are provided. Each independent electrical overspeed trip system is designed and manufactured by a different vendor. There are no common components or process inputs between the two systems. Each system will be installed in a separate cubicle and with separate power sources.

10.02-2

The primary electrical overspeed trip system fully closes the valves at about 110 percent of rated speed. An independent and redundant backup electrical overspeed

4.8.1 Shell side.

4.8.2 Tube side.

4.9 High pressure cooler inlet and outlet temperatures:

4.9.1 Shell side.

4.9.2 Tube side.

5.0 ACCEPTANCE CRITERIA

5.1 The CVCS performs as described in Section 9.3.4.

14.2.12.13.14 Pre-Core Turbine Overspeed (Test #174)

1.0 OBJECTIVE

1.1 (Deleted)~~To verify that the mechanical overspeed trip protects the turbine as designed.~~

10.02-2

1.2 To verify that the ~~electronic~~primary and secondary overspeed trip systems protect~~s~~ the turbine as designed.

1.3 Verify electrical independence and redundancy of non-safety-related power supplies.

2.0 PREREQUISITES

2.1 Associated instrumentation has been checked, calibrated, and is functioning satisfactorily prior to performing the test.

2.2 RCS at HZP (temperature and pressure) conditions with the corresponding RCS pressure and temperature conditions.

2.3 Turbine is operating at normal speed but not synchronized to the grid.

3.0 TEST METHOD

10.02-2

3.1 Verify that the primary ~~mechanical~~ overspeed trip is ~~operable~~functional, not bypassed.

10.02-2

3.2 Make the secondary overspeed trip not functional and verify that the primary overspeed trip remains functional.

3.3 Slowly increase turbine speed until the primary ~~electronic~~ overspeed occurs.

3.4 Verify that when the turbine trip occurs ~~and that~~ the turbine returns to turning gear.

3.5 Restore to functional the secondary overspeed trip that was previously not functional and make the primary overspeed trip that was previously tested, not functional.~~Verify that electronic overspeed trip setpoint has been temporally set to a value that is greater than the mechanical trip setpoint.~~

3.6 Verify that the secondary overspeed trip remains functional.~~Slowly increase turbine speed until electronic overspeed occurs.~~

3.7 Slowly increase turbine speed until the secondary electronic overspeed occurs.~~Verify that turbine trip occurs and that turbine returns to turning gear.~~

3.8 Verify that when the turbine trip occurs the turbine returns to turning gear.

4.0 DATA REQUIRED

4.1 ~~Actual e~~Actual primary~~lectronic~~ turbine trip setpoints.

4.2 Actual secondary turbine trip setpoint.~~Actual mechanical turbine trip setpoint.~~

10.02-2

5.0 ACCEPTANCE CRITERIA

5.1 Verification that the primary and secondary ~~electronic and mechanical~~ turbine trips occur within the design limits.

10.02-2

14.2.12.13.15 Pre-Core Safety Injection Check Valve Test (Test #175)

1.0 OBJECTIVE

1.1 To verify that the SI RCS loop check valves shall pass flow with the RCS at design pressure and temperature conditions.

1.2 To verify that the SI accumulator discharge check valve shall pass flow with the RCS at design pressure and temperature conditions.

2.0 PREREQUISITES

2.1 RCS at HZP (temperature and pressure) conditions with the corresponding RCS pressure and temperature conditions.

2.2 SI accumulators are filled and pressurized to their normal operating conditions.

3.0 TEST METHOD

3.1 Secure four of four SI accumulators by closing the discharge isolation valves.

3.2 Secure three of the four MHSI trains.

3.3 Simulate a SI signal and verify that the protection system reduces RCS pressure to the point that RCS pressure is less than that of the available MHSI pump.

3.4 Verify flow through each of the SI loop check valves as follows:

3.5 Pressurizer level increasing.

3.6 Secure the operating MHSI pump.