ArevaEPRDCPEm Resource

From:	DUNCAN Leslie E (AREVA NP INC) [Leslie.Duncan@areva.com]
Sent:	Thursday, April 09, 2009 11:29 AM
To:	Getachew Tesfaye
Cc:	Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 191 (2228), FSARCh. 15
Attachments:	RAI 191 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 191 Response US EPR DC.pdf" provides a technically correct and complete response to 1 of the 7 questions.

The following table indicates the respective pages in the response document, "RAI 191 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 191—15.06.05-43	2	2
RAI 191—15.06.05-44	3	3
RAI 191—15.06.05-45	4	4
RAI 191—15.06.05-46	5	5
RAI 191—15.06.05-47	6	6
RAI 191—15.06.05-48	7	10
RAI 191—15.06.05-49	11	11

A complete answer is not provided for 6 of the 7 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 191—15.06.05-43	May 29, 2009
RAI 191—15.06.05-44	May 29, 2009
RAI 191—15.06.05-45	May 29, 2009
RAI 191—15.06.05-46	May 29, 2009
RAI 191—15.06.05-47	May 29, 2009
RAI 191—15.06.05-49	May 29, 2009

Sincerely,

(on the behalf of Ronda Pederson)

Les Duncan
Licensing Engineer
AREVA NP Inc.
An AREVA and Siemens Company
Tel: (434) 832-2849
Leslie.Duncan@areva.com

From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Wednesday, March 11, 2009 6:24 PM
To: ZZ-DL-A-USEPR-DL

Cc: Fred Forsaty; Shanlai Lu; Joseph Donoghue; Jason Carneal; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 191 (2228), FSARCh. 15

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on February 20, 2009, and discussed with your staff on March 3, 2009. The staff took action to review previous RAIs to determine if some of the draft questions were previously asked as suggested by AREVA during that discussion. The staff reviewed the references AREVA provided and concluded that the new RAIs were not covered by previous RAIs. Therefore, with minor modifications to draft RAI Questions 15.06.05-43, 15.06.05-44, 15.06.05-45, and 15.06.05-46, for clarification, the draft RAIs are issued as final. 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: 393

Mail Envelope Properties (F322AA625A7A7443A9C390B0567503A1D4C0F3)

Subject: Response to U.S. EPR Design Certification Application RAI No. 191 (2228), FSARCh. 15
Sent Date: 4/9/2009 11:29:08 AM
Received Date: 4/9/2009 11:29:14 AM
From: DUNCAN Leslie E (AREVA NP INC)

Created By: Leslie.Duncan@areva.com

Recipients:
"Pederson Ronda M (AREVA NP INC)" <Ronda.Pederson@areva.com>
Tracking Status: None
"BENNETT Kathy A (OFR) (AREVA NP INC)" <Kathy.Bennett@areva.com>
Tracking Status: None
"DELANO Karen V (AREVA NP INC)" <Karen.Delano@areva.com>
Tracking Status: None
"Getachew Tesfaye" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

Post Office: AUSLYNCMX01.adom.ad.corp

Files	**Size**	**Date & Time**
MESSAGE	2859	4/9/2009 11:29:14 AM
RAI 191 Response US EPR DC.pdf	32289	

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

Response to

Request for Additional Information No. 191 (2228), Revision 0

03/11/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 15.06.05 - Loss of Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary
Application Section: Ch 15

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

Question 15.06.05-43:

Addressing Regulatory Position 1.1.1.12 in Regulatory Guide RG 1.82 Revision 3 on buildup of debris at downstream flow restriction locations including coolant channel openings in the core fuel assemblies and fuel assembly inlet debris screens, Appendix A of ANP-10293 Revision 0, in its conformance assessment states that “The impact of debris clogging downstream of the ECC sump screens on … fuel assemblies is expected to be negligible. An evaluation to support this conclusion is part of the U.S. EPR design process. This issue will be further assessed based on the results of industry consensus regarding confirmation of downstream effects.”

Provide the results from such further assessments and the resolution for the U.S. EPR that considers such additional results of industry consensus regarding confirmation of downstream effects on fuel assemblies, including inlet nozzle, grid spacers, and fuel rods, in accordance with Regulatory Position 1.1.1.12 in Regulatory Guide RG 1.82 Revision 3. In this regard, provide the basis for the resolution and describe the impact of additional experimental and analytical work, including such that was carried out in addressing the resolution of GSI-191 and made available after the publication of Generic Letter GL-2004-02 on September 13, 2004, which is the most recently dated reference considered in ANP-10293 Revision 0, on the U.S. EPR FSAR and ANP-10293, if any.

Response to Question 15.06.05-43:

A response to this question will be provided by May 29, 2009.

Question 15.06.05-44:

Addressing Regulatory Position 1.1.2.3 in Regulatory Guide RG 1.82 Revision 3 on chemical reaction effects, Appendix A of ANP-10293 Revision 0, in its conformance assessment states that "The need to address the potential impact of chemical reaction with the debris sources, filter differential pressure and other downstream effects is recognized by the U.S. EPR design program. This issue will be further assessed based on the results of industry consensus regarding confirmation of downstream effects."

Provide the results from such further assessments and the resolution for the U.S. EPR that considers additional results of industry consensus regarding confirmation of downstream effects on fuel assemblies, including inlet nozzle, grid spacers, and fuel rods in accordance with Regulatory Position 1.1.2.3 in Regulatory Guide RG 1.82 Revision 3. In this respect, provide the basis for the resolution and describe the impact of additional experimental and analytical work, including such that was carried out in addressing the resolution of GSI-191 and made available after the publication of Generic Letter GL-2004-02 on September 13, 2004, which is the most recently dated reference considered in ANP-10293 Revision 0, on the U.S. EPR FSAR and ANP-10293, if any.

Response to Question 15.06.05-44:

A response to this question will be provided by May 29, 2009.

Question 15.06.05-45:

In response to requested information item 2.(d)(v) in Generic Letter GL-2004-02, Appendix B of ANP-10293 Revision 0 states that “The impact of debris clogging downstream of the ECCS sump screens on … fuel assemblies is expected to be negligible. An evaluation to support this conclusion is part of the U.S. EPR design process. This issue is to be addressed based on the results of industry consensus regarding confirmation of downstream effects.”

Provide the results from additional assessments and the resolution for the U.S. EPR based on the results of such industry consensus regarding confirmation of downstream effects on fuel assemblies, including inlet nozzle, grid spacers, and fuel rods related to requested information item 2.(d)(v) in Generic Letter GL-2004-02. In this regard, provide the basis for the resolution and explain the impact on the U.S. EPR FSAR and ANP-10293, if any.

Response to Question 15.06.05-45:

A response to this question will be provided by May 29, 2009.

Question 15.06.05-46:

Provide quantification of all types of debris generating/representing materials initially present in the U.S. EPR containment building along with sufficient evidence that the amounts assumed account in a conservative manner for any associated data uncertainties. Based on the amount and location of the identified debris generating/representing materials in the containment, determine and provide explanation of the critical LOCA conditions that will result in the maximum possible negative impact on the long-term coolability of the fuel assemblies. In particular, provide the amounts of generated debris of all possible types under the critical LOCA conditions determined, taking into account latent debris as well, and explain how the debris amounts, types, characteristics and flow conditions, along with limiting strainer response assumptions, lead to the most limiting downstream effects on the fuel. In assessing those effects, consider the impact of specific design characteristics and features of the U.S. EPR vessel and fuel assembly components, including inlet nozzle, grid spacers and fuel rods on the fluid flow and debris behavior in accounting for possible participating phenomena like chemical plate-out on fuel rod surfaces, blocking of core plates or fuel assembly inlet nozzles due to thin-bed or large fiber beds formation, localized hot spots formation due to fibers hanging up on fuel assembly grid spacer straps.

Response to Question 15.06.05-46:

A response to this question will be provided by May 29, 2009.

Question 15.06.05-47:

Provide a conservative estimate for the potential core inlet flow area blockage fraction in the U.S. EPR and assess the core cooling conditions versus the minimum core boil-off flow rate requirements. In assessing the core inlet flow area blockage, account for downstream effects associated with debris particulates, fibers and chemical reaction by-products entering into the reactor coolant system under the most limiting post-LOCA conditions in terms of debris ingress. Discus associated possible effects from potential flow blockages and formation of flow restriction patterns within the core region itself, if any.

Response to Question 15.06.05-47:

A response to this question will be provided by May 29, 2009.

Question 15.06.05-48:

The test apparatus described in ANP-10293 Revision 0 was of full vertical height and 1:20 scale ratio for the design flow rate, generated debris mass and surface area of the strainer, retaining basket and heavy floor opening. Provide numerical results demonstrating that the test apparatus and debris quantities and characteristics including size distribution were properly scaled to the U.S. EPR design characteristics and debris generation under the LOCA conditions determined as limiting from point of view of downstream effects on the fuel. Describe the preparation and preconditioning of the debris used in the tests and explain the timing and manner of debris introduction into the test fluid. Demonstrate that the test conditions were limiting in terms of maximizing the debris presence in the effluent downstream of the sump strainer.

Response to Question 15.06.05-48:

Alden Research Laboratory (Alden) reviewed the test loop scale to assess possible scale effects on the test results. The evaluation included the heavy floor area, weir and trash rack, retaining basket and break flow into the basket, trash rack opening and retaining basket screen characteristics, in-containment refueling water storage tank (IRWST) sump area, strainer design and performance, and jet simulation from the mini flow line. Alden concluded:

> *Test loop scaling is conservative. The Test Loop is likely to provide test data that are conservative in predicting the IRWST strainer performance in terms of percentage of debris transported to the strainer, blockages of the Retaining Basket Screens as well as the Strainer and the resulting head losses.*

The vertical scale of the U.S. EPR test loop is approximately 1:1 to realistically simulate turbulences introduced by the break flow. Horizontal scaling was 1:20 based on the ratio of the strainer screen size. Transport velocities and transport distances were scaled conservatively (transport velocities were higher than the 1:20 scaled velocities and transport distances were shorter than the 1:20 scaled distances). Table 15.06.05-48-1 provides the test scaling summary.

Table 15.06.05-48-1—Test Scaling Summary[1]

Parameter	Test Environment	Plant Environment	Scaling	Comments
Vertical	1	1	1:1	All vertical scaling is ~1:1
Horizontal	1	20	1:20	Horizontal scaling is ~1:20. Transport velocities and transport distances were scaled differently.
Screen Area	37.7 ft^2	753.5 ft^2	1:20	
Screen Mesh	0.083 in x 0.083 in	0.083 in x 0.083 in	1:1	

Parameter	Test Environment	Plant Environment	Scaling	Comments
Retaining Basket	34.4 ft^2	688.9 ft^2	1:20	Only one side facing the strainer is screened. The other three sides are solid.
Heavy Floor Area	64.6 ft^2	Large (greater than 20:1)	< 1:20	Area above sump where debris arrives first. Plant area would be much larger than the test area that includes additional flow obstacles
Weir (Debris Interceptor)	5.9 in	5.9 in	1:1	Vertical scaling 1:1
Trash Rack Opening Area	3.9 in x 3.9 in	3.9 in x 3.9 in	1:1	
Heavy Floor Opening Above Retaining Basket	2.48 ft^2	49.51 ft^2	1:20	
IRWST Area (Sump Area)	53.82 ft^2	5866.33 ft^2	1:109	Area of sump where retaining basket and strainer are located. Plant area is ~109 times the test area. Therefore, higher flow velocities and shorter transport distances in the test area than in the plant.
Total Flow Rates (Flow Thru Strainer)	187.56 gal/min	3755.65 gal/min	1:20	Assuming one of four trains running (100% of flow)
Flow Thru Retaining Basket	149.7 gal/min	3015.96 gal/min	1:20	Assuming one of four trains running (80% of flow)
Flow Thru Mini-Flow Line	36.98 gal/min	739.68 gal/min	1:20	Assuming one of four trains running (20% of flow)
Screen Approach Velocity	0.011 ft/sec	0.011 ft/sec	1:1	~0.01 ft/sec
Debris Quantities	1/20	1	1:20	

[1] The testing debris was equivalent to approximately 1/20 of the debris postulated for the large break loss of coolant accident, as follows:

- 62 ft^3 mineral wool
- Stainless steel jacket foils
- 5.5 lb paint chips
- 5.5 lb latent debris
- 8.3 lb microporous insulating material

Preparation and preconditioning of the debris used in the tests involved the following:

- Mineral Wool used for testing was thermally aged and mechanically fragmented using a shredder. The use of thoroughly aged mineral wool is a conservative approach applied to testing because it yields more fine fibers compared to installed mineral wool that would still contain a binder even after years of operation. This binder would reduce the amount of fine debris available for transport.

- Reflective metal insulation (RMI) used for testing consisted of metal pieces ranging in size from about 1x1 cm to 50x50 cm that were cut from 0.5 mm and 1 mm thick stainless steel sheets. The pieces were bent and formed to give them a more realistic shape. Flat stainless steel RMI foils with thickness of 0.1 mm and dimpled foils with a thickness of 0.05 mm were also used to produce pieces with a size from 1x1 cm to 15x15 cm. The foils pieces were further fragmented and about 80 percent were in pieces of about 1x1 cm to 3x3 cm.

- Paint chips used for testing were prepared by applying the paint to plastic foil, drying for seven days, removing the paint from the plastic foils, and fragmenting the paint pieces by hand. This procedure provided paint chips ranging in size from about 1x1 mm to 3x3 cm.

- Latent debris used for testing consisted of a mixture of dust and concrete particles. Concrete particles were smaller than 1 mm.

- Microporous insulating material used for testing involved reducing the Microtherm® material to a powder form.

The debris materials were mixed in a homogeneous way before being introduced at the entrance of the test loop. Mineral wool, Microtherm®, concrete dust, and paint chips were premixed before adding to the test facility. They were premixed in a stainless steel vessel with 53 ft^3 of water and equipped with three mixing devices to prevent deposition of material. The debris materials for the tests were weighed before being added in batch mode. During this procedure the debris pump was continuously running. Metal sheets were manually added to the heavy floor because they could not be pumped.

The test setup provided for limiting conditions in terms of maximizing the debris presence in the effluent downstream of the sump strainer. For the design basis accident, the emergency core cooling system (ECCS) will have at least two operable trains. The U.S. EPR GSI-191 debris mitigation features provide four separate ECCS flow return paths to the IRWST, each consisting of a weir/trash rack assembly and a retaining basket to restrict/capture debris from reaching the two ECCS strainers. The ECCS return water that passes through the four retaining baskets flows to the suction strainers of the two operating ECCS trains. To maximize the debris impact on the ECCS strainer and provide maximum challenge to the U.S. EPR debris mitigation features, the test setup provided only one ECCS return flow path, one weir/trash rack assembly, one retaining basket, and one ECCS strainer. Furthermore, the tested debris composition was conservative because the U.S. EPR design uses RMI to a larger extent than represented in the test.

Results of testing showed the U.S. EPR debris mitigation features to be effective. Reports that provide additional details are available for NRC inspection.

FSAR Impact:

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

Question 15.06.05-49:

Demonstrate that the solids concentration in the downstream water of 10 ppm at 30 minutes into the test, as reported in ANP-10293 Revision 0, is representative for the worst U.S. EPR post-LOCA conditions in terms of downstream effects on the fuel in the core. Demonstrate how this experimental evidence can be scaled and applied to evaluate potential downstream effects considering the presence of debris particulates, fibers and chemical reaction by-products in the U.S. EPR reactor coolant system under post-LOCA conditions that lead to most limiting conditions in terms of downstream effects on the fuel. Explain why the independent review of the ANP-10293 Revision 0 did not address reported observations on downstream effects.

Response to Question 15.06.05-49:

A response to this question will be provided by May 29, 2009.