ArevaEPRDCPEm Resource

From: WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent: Friday, June 28, 2013 6:09 PM
To: Snyder, Amy
Cc: Ford, Tanya; ANDERSON Katherine (EXTERNAL AREVA); DELANO Karen (AREVA); HONMA George (EXTERNAL AREVA); LEIGHLITER John (AREVA); LEWIS Ray (EXTERNAL AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); SHEPHERD Tracey (AREVA); VANCE Brian (AREVA); NOXON David (AREVA); RITCHEY Calvin (AREVA)
Subject: Advanced Response to U.S. EPR Design Certification Application FINAL RAI No. 572, FSAR Ch. 19, Question 19-365
Attachments: RAI 572 Advanced Response Question 19-365 - US EPR DC.pdf

Amy,

Attached is an Advanced Response to RAI No.572, Question 19-365, in support of the final response date of August 9, 2013.

To keep our commitment to send a final response to this question by the commitment date, we need to receive all NRC staff feedback and comments no later than **July 26, 2013**.

Please let me know if NRC staff has any questions or if this response can be sent as final.

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: RYAN Tom (RS/NB)
Sent: Thursday, June 13, 2013 10:10 AM
To: Amy.Snyder@nrc.gov
Cc: GUCWA Len (External RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); ANDERSON Katherine (External AREVA NP INC.); WILLIFORD Dennis (RS/NB); VANCE Brian (RS/NB); NOXON David (RS/NB); Tanya Ford (Tanya.Ford@nrc.gov)
Subject: Response to U.S. EPR Design Certification Application FINAL RAI No. 572, FSAR Ch. 19, Supplement 1

Amy,

AREVA NP Inc.'s provided a schedule for the responses to the two questions of RAI 572 on April 12, 2013.

The schedule for a technically correct and complete response to question 19-365 is changed and provided below:

Question #	Advanced Response Date	Response Date
RAI 572 — 19-365	**June 28, 2013**	**August 9, 2013**

The schedule for a technically correct and complete response to question 19-364 is unchanged and provided below:

Question #	Advanced Response Date	Response Date
RAI 572 — 19-364	June 14, 2013	July 18, 2013

Sincerely,

Tom Ryan
Project Engineer
Regulatory Affairs
AREVA NP
An AREVA and Siemens company
7207 IBM Drive - CLT2B
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Phone: 704-805-2643, Cell : 704-292-5627
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From: RYAN Tom (RS/NB)
Sent: Friday, April 12, 2013 10:17 AM
To: Snyder, Amy
Cc: DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); HONMA George (EXT); NOXON David (RS/NB); WILLIFORD Dennis (RS/NB)
Subject: Response to U.S. EPR Design Certification Application FINAL RAI No. 572, FSAR Ch. 19

Amy,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 572 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the two questions cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 572 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 572 — 19-364	2	2
RAI 572 — 19-365	3	3

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

Question #	Response Date
RAI 572 — 19-364	July 18, 2013
RAI 572 — 19-365	July 18, 2013

Sincerely,

Tom Ryan
Project Engineer
Regulatory Affairs
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From: Snyder, Amy [mailto:Amy.Snyder@nrc.gov]
Sent: Thursday, March 14, 2013 9:03 AM
To: ZZ-DL-A-USEPR-DL
Cc: Pohida, Marie; Mrowca, Lynn; Ford, Tanya; Segala, John
Subject: U.S. EPR Design Certification Application FINAL RAI No. 572, FSAR Ch. 19

Attached, please find the subject requests for additional information (RAI). An advanced RAI was provided to you on February 8, 2013, and discussed with your staff on March 1, 2013. The advanced RAI was modified as a result of that discussion. On March 8, 2013, you informed us that the advanced RAI is clear and no further clarification is needed and that the RAI does not contain any proprietary information. 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 or April 12, 2013**, 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."

Thank You,

Amy

Amy Snyder, U.S. EPR Design Certification Lead Project Manager
Licensing Branch 1 (LB1)
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Hearing Identifier: AREVA_EPR_DC_RAIs
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Mail Envelope Properties (554210743EFE354B8D5741BEB695E6561A9E67)

Subject: Advanced Response to U.S. EPR Design Certification Application FINAL RAI No. 572, FSAR Ch. 19, Question 19-365
Sent Date: 6/28/2013 6:08:39 PM
Received Date: 6/28/2013 6:08:45 PM
From: WILLIFORD Dennis (AREVA)

Created By: Dennis.Williford@areva.com

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Files	**Size**	**Date & Time**	
MESSAGE	5053	6/28/2013 6:08:45 PM	
RAI 572 Advanced Response Question 19-365 - US EPR DC.pdf			246200

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

Advanced Response to

Request for Additional Information No.572, Question 19-365

3/12/2013
U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
Review Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19
SRSB Branch

Question 19-365:

The staff understands that during maintenance activities in the direct environment to the passive autocatalytic recombiners (PARs), which mainly occurs during an outage, the housing will be covered by a blanket. The blanket overlaps the entire PAR housing and will be tied at the lower end. The PARs will be tested to verify their function and required performance at the end of the outage. U.S. EPR FSAR Tier 2, Section 6.2.5.4 will be revised to describe the PAR covering during outage work.
The staff reviewed the applicant's response to RAI 19-298. With 25% availability (equivalent to 75 percent unavailability, the hydrogen mass in containment is determined to be smaller than 940kg for a transient and LOCA scenario. A containment hydrogen mass of 940kg was used as the deflagration load calculations in the shutdown Level 2 analysis. The staff noted that uncertainty in the MAAP results was not addressed in the RAI response.

Considering MAAP code uncertainty, the staff is requesting AREVA to add a risk insight to Table 19.1-108, the US EPR Risk Insights, and FSAR Section 19.1.6.3 documenting how many PARs units should be functional and available during shutdown. This risk insight should include information concerning containment locations that are sensitive to high hydrogen concentrations such as the IRWST volume.

Response to Question 19-365:

There are three purposes to this response. The first purpose is to address the number of passive autocatalytic recombiners (PARs) that should be functional and available during shutdown. The second purpose is to address the containment locations that are sensitive to high hydrogen concentrations during shutdown operations. The third purpose is to provide the risk insight to be added to Table 19.1-108 and FSAR Section 19.1.6.3.

Number of PARs to Remain Functional and Available during Shutdown

As a result of the PRA update, the mass of hydrogen used as an upper bound in the shutdown Level 2 calculation of hydrogen deflagration loads was raised from 940 kg to 1,071 kg. This higher value is based on a more conservative upper bound of the uncertainty distribution for hydrogen mass in the time frame before vessel rupture, and it was used in the examination of the limiting number of PARs that can be taken out of service without exceeding this upper bound.

A methodology similar to that described in the Response to RAI 227, Question 19-298, is used to evaluate the limiting availability of PARs units within the U.S. EPR containment. To determine the limiting availability of the PAR units for which this limit is not reached, the same two accident scenarios during shutdown described in Response to RAI 227, Question 19-298 are examined. The two cases considered, both of which are in plant operating state Ca, are: a transient and a loss of coolant accident (LOCA) scenarios.

The MAAP runs investigated in this response are: Ca_4_1c representative of a transient scenario and Ca_4_3 representative of a LOCA scenario. These cases were selected because they exhibited the highest hydrogen peaks in containment. Both of these runs use the latest revision of the MAAP parameter file.

MAAP runs with multiple fractions of the large PAR units disabled showed that with all small PARs functioning, and 25 percent efficiency applied to all of the existing large PAR units (equivalent to 75 percent unavailability), the maximum hydrogen mass in containment is determined to be smaller than 1071 kg. This is shown in Figures 19-365-1 and 19-365-2 for transient and LOCA scenarios, respectively. The hydrogen peak masses obtained with 25 percent of the large PAR units available are:

- A hydrogen peak of 905 kg for the transient scenario Ca_4_1c_27_25.
- A hydrogen peak of 796 kg for the LOCA scenario Ca_4_3_27_25.

It can be concluded from these results that the analysis of hydrogen phenomena in containment, developed in the shutdown Level 2 PRA, is applicable for a range of availability between 25 percent and 100 percent of the large PAR units. A 25 percent availability of the large PAR units is judged to be conservative; and this availability represents the boundary for the validity of the shutdown Level 2 analysis of hydrogen deflagration loads leading to containment failure.

Containment Locations that are Sensitive to High Hydrogen Concentrations during Shutdown Operations

The Level 2 PRA for shutdown states examined the susceptibility of the containment atmosphere to flame acceleration from hydrogen combustion. For each time step, and all nodes of the MAAP model, the hydrogen concentration was evaluated against the flame acceleration limit defined in the phenomenological analysis. This evaluation concluded that with 100 percent PARs availability the IRWST, the reactor pit, and the equipment rooms housing the steam generators and reactor coolant pumps are susceptible to hydrogen flame acceleration.

Risk Insight to be Added to Table 19.1-108 and FSAR Section 19.1.6.3

Based on the information presented in this response, the risk insights shown in the mark-ups to FSAR Section 19.1.6.3 and FSAR Table 19.1-108 will be added.

FSAR Impact

The U.S. EPR FSAR Tier 2, Section 19.1.6.3 and Table 19.1-108, will be revised as indicated in the enclosed mark-up.

Figure 19-365-1: Hydrogen Mass in Containment for Transient MAAP Case Ca4_1c_27_25 with 25 percent of PAR Units Available

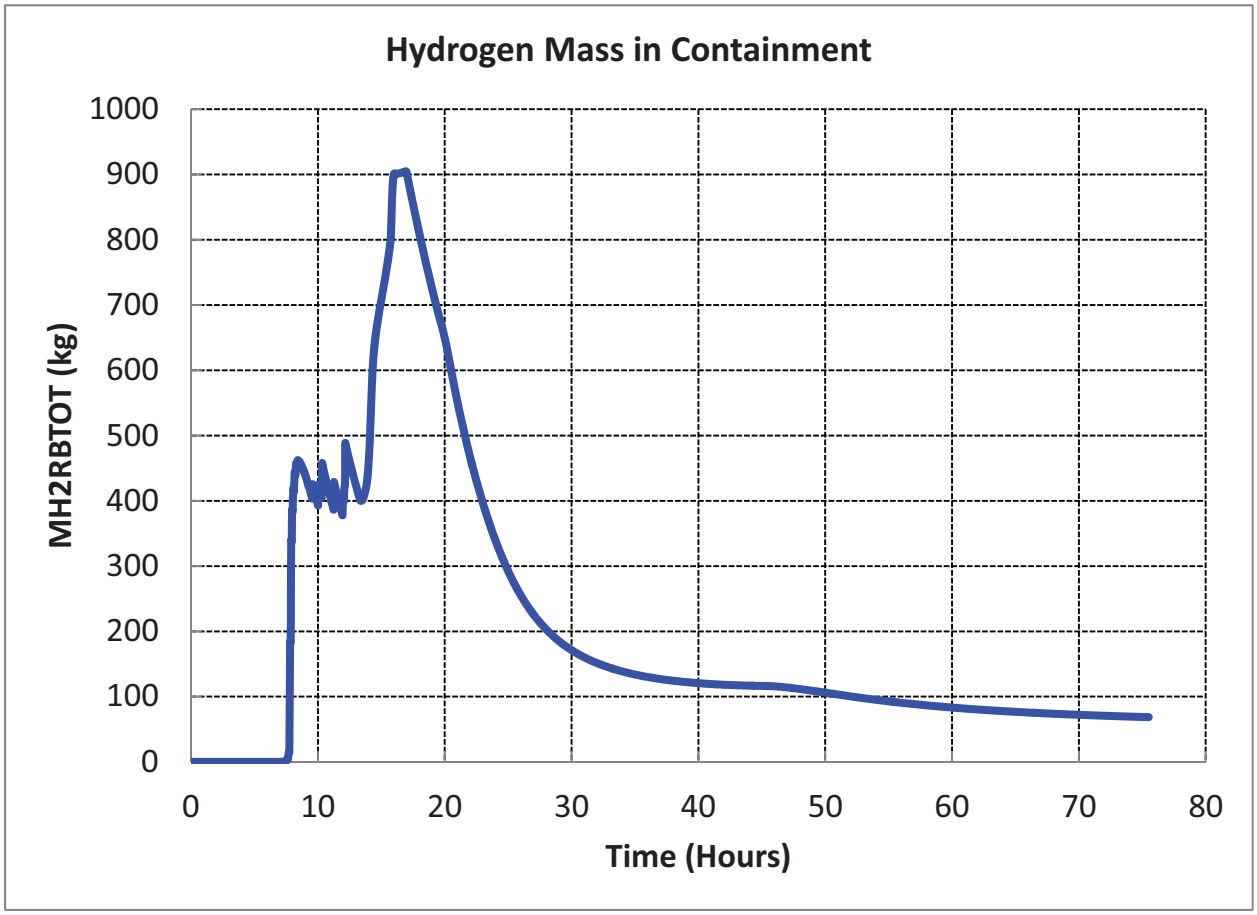
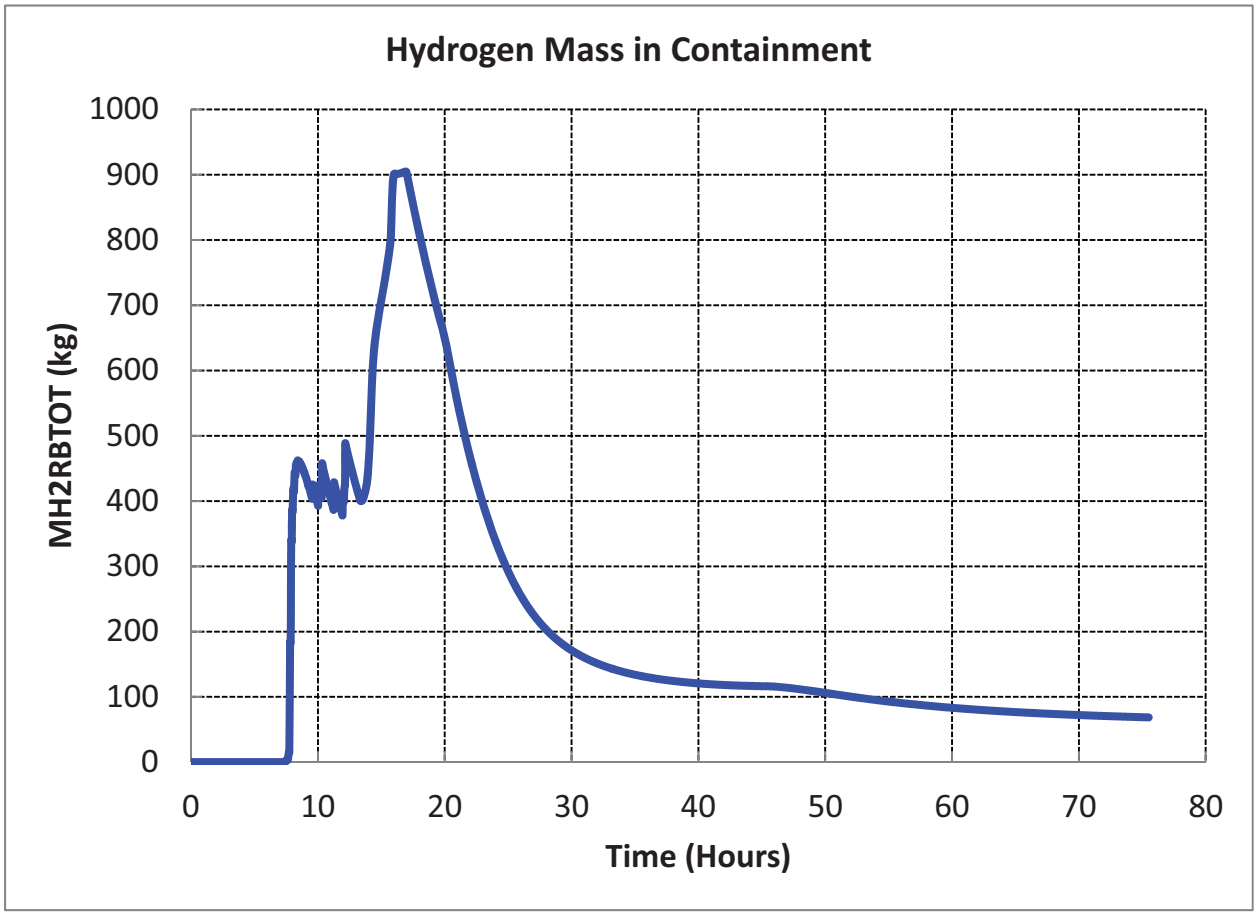


Figure 19-365-2: Hydrogen Mass in Containment for LOCA MAAP Case Ca4_3_27_25 with 25 Percent of PAR Units Available



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expected to be similar to flame acceleration loads and the flame acceleration is a pre-condition for detonation.

Assessing hydrogen deflagration loads:

A hydrogen deflagrations loads assessment was performed on a global basis based on the global AICC pressure.

Consistent with the full power study, hydrogen burning was not credited for hydrogen inventory reduction and the in-vessel hydrogen production was assessed as being in the range 30.5 percent to 65.5 percent equivalent Zircaloy oxidation.

Although induced hot leg rupture is not credited in shutdown conditions (see Section 19.1.6.3.2.1), conservatively the additional discharge of 300 kg of hydrogen due to this phenomenon was taken into account for all cases.

The baseline pressures used in assessing the probabilities of containment failure following hydrogen deflagrations were conservatively kept the same as at power.

Assessing hydrogen flame acceleration loads:

Similar to the at-power study, the analysis of local concentrations susceptibility to flame acceleration was carried out assuming the most conservative gas mixture properties including steam.

RAI 572, Question 19-365

A limiting mixture concentration for flame acceleration susceptibility (as a function of oxygen and steam concentrations) was dynamically evaluated. A comparison of the combustible gas (i.e., hydrogen and carbon monoxide) concentration against this limiting mixture concentration was conducted for the ~~27~~ fine nodalization ~~node~~ MAAP model. According to the MAAP results, flame acceleration potential existed in the IRWST ~~(containment node 2)~~, the reactor pit and the steam generator and reactor coolant pump equipment rooms~~(containment node 8) and the equipment rooms (containment nodes 4, 6, and 10)~~. To avoid an overestimation of the steam concentration in the IRWST volume and to approach more realistic conditions during shut-down, appropriate changes were made compared to the power operation model to increase the steam condensation in the IRWST volume. Additionally, a reduced number of recombiners may be available during certain periods of shutdown operation depending on the maintenance schedule. Therefore, the fraction of available PARs is varied in the MAAP runs for shutdown operation, and a recombiner capacity equivalent to all small PARs and 25 percent of the large PARs installed at each location should remain functional and available during shutdown operations so that the results of the Shutdown Level 2 PRA LRF results remain valid.

The results of the assessment of the containment failure probabilities following Hydrogen loads from both deflagration and flame acceleration are presented below.

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

No	U.S. EPR PRA Based Insight	Disposition
27	**Sequences contributing to the shutdown LRF** Containment isolation failures are the largest contributors to the total shutdown LRF. The high contribution of containment isolation failures is expected for the shutdown events where there is less restriction on containment isolation and containment is open for outage activities. Release categories corresponding to phenomena challenging the containment integrity have a very small contribution to the shutdown LRF. Hydrogen loads are still an important challenge as some of the primary system hydrogen discharge occurs in areas not equipped with Passive Autocatalytic Recombiners (PARs).	Tier 2, Section 19.1.6.4.1; Tier 2, Section 19.1.6.4.5
28	**Importance of passive systems in the Level 2** Passive systems (gravity driven core melt cooling system and PARs) are used in the long term mitigation actions. Because of this timeframe they do not show any importance based on LRF importance measures. Reduced PARs availability has been considered as a result of damage from early phenomena in the containment. The range of PARs availability considered included 100%, 50% and 25%. Failure of the core cooling system including the spreading area does not lead to additional release categories in the LRF.	Tier 2, Section 19.1.5.2.3.7; Tier 2, Section 19.1.6.3.2.2
29	**Containment leak and rupture failure modes** Containment failure modes are separated into leak and rupture. The release categories and LRF reported represent the total failure from both.	Tier 2, Section 19.1.6.3.2.3
30	**PAR Availability and Maintenance** Recombiner capacity equivalent to all small PARs and 25% of the large PARs installed at each location should remain functional and available during shutdown operations so that the results of the Shutdown Level 2 PRA LRF results remain valid. In addition, during shutdown operations the IRWST, the reactor pit, and the equipment rooms housing the steam generators and reactor coolant pumps are susceptible to flame acceleration due to high hydrogen concentrations.	Tier 2, Section 19.1.6.3.2.2

RAI 572, Question 19-365